THE STUDY OF THE CAUSAL RELATIONSHIP OF FINANCIAL DEVELOPMENT AND ECONOMIC GROWTH

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I dedicate this Work to God
And to My Parents.
ABSTRACT

The present enquiry concerns whether there is a bi-directional causal relationship between financial development and economic growth. It contributes to the century of debate revolving around the issue of whether the financial sector is 'supply-leading' or 'demand-following' that is first raised by Patrick (1966). A new theoretical model is developed to study the bi-directional relationship of the finance-growth nexus. The model shows that the provision of liquidity in the banking system, by preventing premature liquidation of capital and improvement of risk sharing through inter-mediation, results in a larger capital accumulation in the economy. This justifies the existence and development of the financial sector in the economy. Financial development in turn can exert a positive effect on long-run economic growth through the interest-rate channel by increasing bank competition and by increasing the efficiency of financial intermediation. Economic growth in the real sector will generate more saving, thereby exerting a positive external effect on banking productivity and raising the wage rate for the bank. This will lead to a further financial development. The interaction will continue until the marginal productivity of labour becomes equal across the real sector and the financial sector.

A maximum of 161 countries with a maximum time span ranging from 1965 to 2004 is included in the cross-country empirical analysis using the Granger-Causality test with optimal lag-length selection criteria and the Simultaneous Equation Model Approach, to examine the bi-directional relationship. Results from the Granger-Causality test suggest that economies will shift from the demand-following pattern in the early stage of development to a supply-leading pattern at the later stage of development, and thereby refutes the Patrick (1966) hypothesis that supply-leading pattern dominates in the early stage. Results from the Simultaneous Equation Model Approach suggest that the relationship for the finance-growth nexus is reciprocal and give rises to a cumulative process. Policies that foster financial development and economic growth, such as private property rights protection, trade liberalisation policy, removal of inflation tax, population control, investment in education, raising private investment and government public expenditure, will therefore exert a cumulative beneficial effect to the economy. Insufficient financial development might therefore be a reason for the emergence of poverty trap, and insufficient economic growth might lead to underdevelopment of financial system that prevents the economy from taking off.
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1 Introduction

Economics is concerned with the study of the production, distribution and consumption of scarce resources. Since the time of Adam Smith, economists have been preoccupied with the notion of economic growth. Though critics may question the wisdom of prioritising economic growth as a policy objective or as the end question of economic inquiry, there is a general consensus that economic growth is able to serve as an effective means to achieve the prosperity of a nation, in order to raise living standards and the well-being of the people. During the past few decades, the world has provided a natural experiment. On one hand, countries which experienced spectacular economic growth, like Japan and Germany in the post-war period and the Asia Pacific countries during the past three decades have generally seen the rise of the prosperity of nations and the improvement of living standards of its citizens. On the other hand, countries like sub-Saharan African countries, where economic growth was stagnant, have seen widespread poverty and insufficient economic and human development. The notion of economic growth has therefore aroused interest for economists and policymakers.

The current study is indirectly motivated by two recent historical incidents. The first incident was the Asian financial crises in 1997. Many Asian economies were badly hit during these crises. The growth rate stumbled, and the economy collapsed for the crisis-hit countries. Though the current study is not a study of financial crises and their short-term effects, the incident has raised an interesting question on how a country's financial development can affect long-run economic growth. The second incident is the transformation of Hong Kong towards a service-oriented economy during the 1980s. Before the 1980s, the Hong Kong economy was supported by the manufacturing industry, and the city had experienced high economy growth during the 1960s and 1970s. With the increasing prosperity of the city, Hong Kong has transformed into a service-oriented economy, where the financial industry has gradually become the pillar of the economy. The city has become an international financial centre in the 1990s, with a highly developed and sophisticated financial structure that serves as a backbone of the economy. The historical development of Hong Kong has raised another interesting question on how a country's economic growth can affect its financial development in the economy. Drawing the two incidents together, one can raise an interesting topic in discovering the mechanism governing the relationship between financial development and economic
growth. Is financial development influenced by economic growth? Or is economic growth induced by financial development? Or is the effect simultaneous and bi-directional? These are the questions that this thesis attempts to answer.

A sub-theme derived from the above question is the notion of causality. The awareness of what causes what in the world and why it matters is central to economic thoughts, and many important generalisations in economics are in causal claims. Therefore the above problems can be rephrased into the question of whether financial development causes economic growth, or whether economic growth causes financial development.

The current thesis therefore looks at the causal relationship between financial development and economic growth. There was once a powerful and widely held belief, which descended from Adam Smith to Karl Marx, that financial development is not 'productive', in the sense that no real goods emerge at the end of the financial process. Much of the post-1945 analysis of development continues to embrace this viewpoint. They assert that financial development only serves as the 'lubricant' for the real economy, but nothing more (Jao 1997). With the progress of economic theory in each decade, economists start to re-examine the linkage between finance and growth. Nowadays, modern economics believes that financial development is an integral and essential element in economic development, though its significance on economic growth is still questionable compared with other economics factors such as human capital and technological progress.

This study contributes to the century of debate revolving around the issue of whether the financial sector is 'supply-leading' or 'demand-following' with reference to the real sector (Patrick 1966). Though there is a perceived idea that there is a mutual interaction of supply-leading and demand-following elements in banking and finance in the long run, the bi-directional linkage between financial development and economic growth has remained a generalised idea without a firm formal theoretical foundation. While there is ample literature to formalise the one-way relationship from finance to growth, models that formalise the bi-direction relationship remains scant. This study has therefore filled this gap by formalising the bi-directional relationship governing financial development and economic growth.

Though Patrick (1966) crystallised the idea of the 'demand-following' and 'supply-leading' approach, the first model to formalise the bi-directional relationship of
the finance-growth nexus only appeared in the early 1990s. Two important papers in this area are from Berthelemy and Varaoudakis (1996) and Greenwood and Smith (1997). The present study synthesises the framework of Greenwood and Smith (1997) with the model of Berthelemy and Varaoudakis, with the following new elements:

- Firstly, the present model is able to provide a more vivid micro-foundation to justify the existence of the financial sector and to explain its behaviour. Greenwood and Smith (1997) justify the existence of the financial intermediary as a mean to provide liquidity insurance. This study generalises the Greenwood and Smith framework (1997) by introducing the wage cost, financial technology and bank's production function to model the behaviour of the banks, as well as to examine the efficiency links of the channelling of saving into productive investment.

- Secondly, the present study applies the overlapping generations liquidity-insurance framework into the Berthelemy and Varaoudakis (1996) model in order to formalise the bi-directional relationship of the finance-growth nexus. The Berthelemy and Varaoudakis (1996) model is essentially an endogenous growth model with an infinite horizon. Hence the application of an overlapping generation framework into their model can shed new light by tackling the issue of heterogeneous and finite horizon households, and by allowing the synthesis of two strand of literature, i.e. liquidity-insurance framework in the endogenous growth model with micro-economic foundations.

- Thirdly, there is a body of literature to show that legal factors can impact on financial development. However, theoretical analyses in the current literature seldom incorporate these legal factors into their analytical model to study the effect of financial development on economic growth. Hence, this study can fill the gap in the literature by incorporating the account of a legal view of finance into the theoretical analysis.

The empirical investigation of the finance-growth nexus has blossomed since the 1990s following the seminal investigation by King and Levine (1993). Most studies, using various form of econometric analysis, have suggested that the finance-growth nexus does hold. However, this literature mainly focuses on the impact of financial development on economic growth without studying the reverse or simultaneous impact of economic growth on financial development. Therefore, the study aims to fill this gap in
the literature by studying the bi-directional relationship of financial development and economic growth.

Investigating the finance-growth nexus involves the issue of causality. Almost all tests for temporal causation in the literature are conducted using the methodology known as Granger Causation pioneered by Clive Granger in 1969. However, the application of this methodology to examine the finance-growth nexus has remained scant. Chapter 5 therefore fills this gap by applying the Granger-Causality test, with optimal lag-length selection criteria, to examine the causal relationship between financial development and economic growth.

The Granger-Causality is a test of forecastability and association with no reference to economic structure. The development of the Rational Expectations Hypothesis also questions the relevancy of temporal ordering for causal distinction. Besides, one needs to know the universal information set to ascertain the effect of deleting the history of one variable in order to determine causal direction. Hence, chapter 6 will counteract these problems by looking at a structural simultaneous equation system in order to draw causal interpretation and form the basis for policy analysis. Recent literature in this area has mainly focused on the impact of financial development on economic growth without studying the reverse or simultaneous impact of economic growth on financial development. Besides, when running the growth regression, most studies tend to use the 5-year average data instead of the annual data to conduct the panel time-series analysis. Therefore, by studying the relationship in both directions rather than in one way, and by using annual time-series observations, this study is able to make a contribution by filling these gaps in the literature.

The two Causality testing approaches in Chapter 5 and 6 are different, in terms of the conceptual basis and timing structure. Chapter 5 is based on the concept of temporal causation, which looks at the knowledge of the current value of a series helps in predicting the future value of a second series. Causal direction is identified through temporal order, where the fundamental assumption is the temporal priority assumption that assumes cause will always occur before the effect. In contrast, Chapter 6 is based on the concept of cross sectional (also called instantaneous or contemporaneous) causation, which explores the knowledge of the current value of a series helps in predicting the current value of a second series. Causal direction in this case is identified through the introduction of a sensible mechanism (simultaneous equation system with multi-variables), where the mechanism itself and the additional controlled variables chosen are
supported by economic theory, in order to estimate the (instantaneous) relationship between the observed inputs and decisions (causes) and the observed output (effects).

In the light of the above, this study is able to provide breakthroughs and to fill in the existing gap in both the theoretical and empirical literatures in the area of the bi-directional finance-growth relationship.

This study is organised as follows. Chapter 6 reviews the theoretical literature on the finance-growth nexus. Much of the post-1945 analysis of development has concentrated on real processes and mainstream economic thought tended to relegate financial development to secondary importance prior to the 1960s. Financial development was seen as the effect of economic development rather than the cause. With the development of economic theory in each decade, economists started to re-examine the linkage between finance and growth, arguing that financial development was a neglected but integral and essential element in economic development. The historical studies by Gerschenkron (1962) and Cameron (1967), the first detailed empirical studies by Goldsmith (1969), the McKinnon-Shaw school of the financial liberalisation thesis and the breakthrough of the theory of intermediation using micro-approach during the 1970s and 1980s, and the development of new growth theory in the early 1990s, has provided economist with an ample formal theoretical foundation on how financial development will exert a positive and significant influence on economic growth. Therefore, the chapter aims to provide the reader with a brief history of the theoretical linkage of financial development and economic growth in the past decades, in order to provide a deeper understanding of the dynamics of the finance-growth nexus.

Chapter 3 formalises a theoretical model that examines the bi-directional relationship between financial development and economic growth. This chapter aims at delivering a formal theoretical mechanism that describes the dynamics between financial development and economic growth that is able to derive some refutable hypotheses for later empirical analysis. To a certain extent, the model is descriptive in nature in order to describe the bi-directional relationship, and the technique of calibration will not be applied in the present study. The framework of Greenwood and Smith (1997) and the model of Berthelemy and Varoudakis (1996) are synthesised into a new model, taking into the account of legal view of finance, to which in turn allows the reader to understand the bi-directional process between financial development and economic growth. The main conclusion is that the provision of liquidity in the banking system, by preventing
Introduction

premature liquidation of capital and improvement of risk sharing through inter-mediation results in a larger fraction of a risky asset (i.e. capital investment in this model) to be held in the portfolio, thereby improving capital accumulation in the economy. This justifies the existence and development of the financial sector in the economy. Financial development in turn can exert a positive effect on long-run economic growth through the interest-rate channel by increasing bank competition and by increasing the efficiency of financial intermediation. Economic growth in the real sector will generate more saving, thereby exerting a positive external effect on banking productivity and raising the wage rate for the bank. This will lead to a further expansion in the financial sector (i.e. financial development). The interaction will continue until the marginal productivity of labour becomes equal across the real sector and the financial sector. In sum, the model is able to provide a theoretical foundation for the bi-directional relationship between financial development and economic growth. The theoretical model derived in chapter 3 provides the theoretical underpinning for the empirical works for this study.

Chapter 4 provides a survey of empirical studies of the finance-growth nexus, and discusses the dataset that are to be used for the empirical analysis in later chapters. Previous empirical work, using various forms of econometric analysis, has suggested that finance-growth nexus does hold. However, most papers focus mainly on the impact of financial development on economic growth without studying the reverse or simultaneous impact of economic growth on financial development. The analysis in later chapters can fill the gap in the literature by studying the bi-directional relationship of financial development and economic growth. Chapter 4 also discusses the data sets to be used for empirical analysis in Chapter 5 and 6. A maximum of 161 countries are included in the analysis using annual observations with a maximum time span ranging from 1965 to 2004. Four measures of the extent of financial development, namely 1. Domestic Credit provided by the private sector as a percentage of GDP; 2. Quasi-Liquid Liabilities (M3-M1) as a percentage of GDP; 3. Stock Market Capitalisation as a percentage of GDP; and 4. Stocks-traded as a percentage of GDP – are used as a proxy for financial development.

Chapter 5 looks at the notion of causality and applies the Granger Causality test framework to examine the causal relationship between financial development and economic growth. The temporal causality questions of the finance-growth nexus will be examined using the standard Granger Causality test with Akaike Final Prediction Error criteria and Schwarz Bayesian Information criteria. The results show that there is evidence of reverse-causality in the finance-growth nexus, though only around one-half
of countries show significant linkage between these two economic variables. The results also suggest the economy will shift from a demand-following pattern, where economic growth will cause a rising demand, in the early stages of economic development. In the later stages, supply-leading pattern will be observed, where financial development will induce further economic growth.

Chapter 6 looks at a structural simultaneous equation model to draw causal inferences on the relationship between financial development and economic growth, and forms the basis for policy analysis. The Two-stage-least-square (2SLS) estimation technique is used to estimate the economic growth equation and the financial development equation in a 2 equation system. With reference to economic structure, the results show that the relationship of financial development and economic growth is bidirectional and give rises to a cumulative process. Insufficient financial development might therefore be a reason for the underdevelopment of a country, and insufficient economic growth might lead to underdevelopment of the financial system, which in turn could prevents the economy from taking off. The determinants of economic growth and financial development are identified in this chapter, which in turn serves as a reference for policy formulations.

Chapter 6 provides with some concluding remarks. This final chapter also suggests future a research agenda that can be extended from this study.
2 A Brief History of the Theoretical Linkage of Financial Development and Economic Growth

2.1 Introduction

This chapter aims to review the literature related to financial development and economic development from a chronological point of view.

There was once a powerful and widely held belief, which descended from Adam Smith to Karl Marx, that financial developments are not 'productive', in the sense that no real goods emerge at the end of the financial process. In his work 'A Treatise on Money' (1930), Keynes used a metaphor of transport facilities to illustrate that bank credit "is the pavement along which production travels, and the bankers if they knew their duty, would provide the transport facilities to just the extent that is required in order that the productive powers of the community can be employed at their full capacity"\(^1\) (Arestis 2005; Keynes 1930). In a similar line of thought, there is a famous argument of Joan Robinson, that "where enterprise leads finance follows. The same impulses within an economy which set enterprise on foot make owners of wealth venturesome, and when a strong impulse to invest is fettered by lack of finance, device are invented to release it... and habits and institutions are developed"\(^2\) (Patrick 1966; Robinson 1952). In the modern day, the topic of financial development is notably absent from the entries of several seminal surveys on development literatures, such as the 'Pioneer of Development Economics' and the New Palgrave Dictionary of Economic Development (Eatwell, Milgate, and Newman 1989; Levine 2003; Levine 1997; Meir and Seers 1984).

While this view is still embraced by some modern economists, the intellectual breakthrough of economic theory in more recent times has allowed economists to re-examine the linkage between finance and growth. With the subsequent development of the finance-growth nexus decades, such as the historical studies by Gerschenkron (1962) and Cameron (1967), the first detailed empirical studies by Goldsmith (1969), the McKinnon-Shaw school of the financial liberalisation thesis, the development of the theory of intermediation using micro-approach during the 1970s and 1980s, and new growth theory and the accompanying second generation financial models of the 1990s,

\(^1\) p.202 in volume 2 (Keynes 1930)
\(^2\) p.86-87 (Robinson 1952)
economists nowadays general believe that financial development will exert a positive and significant influence on economic growth.

This chapter aims to survey the intellectual development of finance-growth nexus in the past decades. Section 2.2 discusses the standard view before 1960 that de-emphasize the importance of financial sector on economic development. Section 2.3 reviews the early development of the finance-growth nexus and the development of Gurley and Shaw's theory of intermediation before 1960, Section 2.4 surveys the historical studies such as Gerschenkron (1962), Cameron (1967), and Goldsmith (1969) that support the importance of financial development using a country-study approach. Section 2.4 looks at McKinnon-Shaw's financial liberalisation thesis, which justify the development of financial sector for economic development. This section will also look at the development of micro-economics theory that justifies the existence of financial sector during the 1970s. Section 2.6 summarises the theoretical progress of the emergence of a financial system and it short-run simultaneous relationship with the real activities during the 1980s. Section 2.7 looks at the development of second generation financial models that focus on the long-term relationship between financial development and economic growth during the 1990s. The functional approach to financial system and recent developments in this field will also be discussed in this section. Section 2.8 concludes.

2.2 The Literatures before 1960

This section surveys the literature before the 1960s that de-emphasised the role of financial development in economic development. Theory before the 1960s was dominated by the Keynesian arguments that put emphasis on real processes and favoured the policy of 'financial repression'. Therefore, understanding these ideas will help readers to recognise the significance of the finance-growth nexus.

2.2.1 Post-Keynesian Approach on Economic Development after 1945

Much of the post-1945 analysis of development has concentrated on the real process. The essential parts of the complex process of development consists of a rise in the share of real capital formation in national expenditure and a relative expansion of foreign trade, accompanied by equally dramatic political and social changes, such as government expansion, population growth, urbanisation, improvement in human capital and natural resources (Toye 1992). The implication is that financial development is relegated to
secondary importance. While the importance of the financial system has still been recognised, its development was seen as a natural response to the changing demands from the development of the ‘real’ sector.

Microeconomic justifications of the ‘real factors’ emphasis of economy theory has stemmed from the classical economics of finance and the publications of the famous theorem of Modigliani and Miller in 1958. In a perfect capital market, the value of a firm is independent of its financial decision and capital structure in a perfect capital market according to the Modigliani-Miller Theorem\(^3\), and investment throughout the economy is efficient according to the Fisher Separation Theorem\(^4\). Together, they implied that using the standard assumption in economic theory of the presence of a perfect capital market, investment throughout the economy is efficient regardless of the financial variables, because all the profit-maximising firms face exactly the same cost of capital for any investment project (Auerbach and Siddiki 2004). The above proposition can be

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\(^3\) The publication of the Modigliani-Miller (MM) Theorem in 1958 shows that firms’ financial structure and dividend policy have no effect on firms’ level. The two propositions of the MM theorem are as follows (Modigliani and Mullineux 1958).

I. That a firm’s total returns are unaffected by the firm’s financial decisions and that investors can borrow on the same terms as firms, then the firm’s debt-equity ratio cannot affect its value;

II. That the total returns of a firm are unaffected by financial decisions and investors can buy and sell securities on the same terms as the firm, then the firm’s dividend policy can have no effect on its value.

Assumptions required for the Modigliani-Millar Theorems are as follows: 1, Control aspects of shares ignored; 2, Shareholders can lend and borrow at the same interest rate as firms; 3. No bankruptcy; 4 Tax ignored.

\(^4\) The Fisher separation theorem implies that when there are perfect capital markets where the firm can borrow and save in the same rate, the owners’ decision about whether to invest will depend only on the returns their forecasts from the investment and on the interest rate, but not on their preference regarding personal consumption. The productive decision is to be governed solely by the objective market criterion (the present-value rule) represented by attained wealth, without regard to the individual subjective preferences that enter into their consumptive decision. This will lead to a maximum-wealth productive solution, which is the best attainable provided that the individual is then going to make market exchanges (lending and borrowing) to attain a time-consumptive criteria. In other words, productive optimisation of the firm can be entirely separated from the consumptive optimisation of the individual, and the firm is conceptualised as a set of possible production plans from which the most profitable one is chosen.

The assumptions of this result are that 1, markets are both complete and perfect, where there is a single price ratio, competitively determined, governs for exchanges between funds of any pair of dates, so that equilibrium is instantaneously and costless attained. 2, Individuals are going to make market exchanges (lending and borrowing) to attain a time-consumptive optimum after the firm’s productive decision. (Hirshleifer 1970; Milgrom and Robinson 1992).
summarised by the traditional Arrow-Debreu general equilibrium model of resource allocation, whose results showed that the allocation of resources is Pareto efficient and firms will optimise their input on the frontier of economy production function in the state of competitive equilibrium. Hence there is no scope for intermediaries to improve welfare. (Arrow 1953; Debreu 1959; Freixas and Rochet 1997). Given the above arguments, economists tended to hold the view that financial structure and variables can have no effect upon real economic outcomes in the business world. Of course, one can argue against the assumption of perfect capital markets. Yet the above analysis provides intellectual justification for ignoring financial consideration in macroeconomic model.

From the macro-economic perspective, economists were wary of the negative impact of financial factors on the society, and believed that the main factors to accelerate economic development were real factors. The theory of the liquidity trap developed by Keynes illustrated that excessive holding and the mismanagement of money, together with inadequate investment will cause economic disruption (Keynes 1936). Kalecki (1972) showed that financial institutions appear to be a pre-existing constraint and an obstacle towards economic development, and therefore its development will exert a negative impact on the economy (FitzGerald 1990; Kalecki 1972; Toye 1992).

5 In this general equilibrium model, if firms and households have unrestricted access to perfect financial markets, then at competitive equilibrium intermediaries will make a zero profit, and the composition of intermediaries' balance sheet have no impact on other economic agents (Arrow 1953; Debreu 1959; Freixas and Rochet 1997).

6 The policy implication of the MM Theorem on privatisation is that selling equity in government enterprise and using the proceeds to retire debt has no real effect. The implication on government finance is that whether government expenditure is financed by tax of debt has no real effect, the similar line of though of the Ricardian Equivalence (Kesley 2001).

7 According to the Keynes theory of liquidity trap, when the current interest rate is extremely low, it cannot fall further and individuals therefore expect the rate to rise. In this liquidity trap scenario, they will hold money instead of bonds to avoid capital loss. A floor to the nominal interest rate is set. At the liquidity trap, planned saving at the full-employment level of income will exceed planned investment, and the disequilibrium can only be resolved by a fall in real income to reduced planned saving if it is a laissez faire economy. Alternatively, the government can conduct expansionary monetary policy to reduce interest rate. However, this will resulted with inflationary consequences. Another way is to tax money to discourage the demand of holding money. Therefore, according to the above analysis, taxing money, though repressing the financial development, will induce welfare-enhancing effects on the society so that full-employment levels of income can be attained (Fry 1995; Keynes 1936; Keynes 1937).

8 According to Kalecki, the main factor to accelerate economic development is the real factor. The volume of investment is not subject to financial constraint, and the problem of
Marxian economists have placed substantial emphasis on the dominant and destructive role of the financial system on the process of capitalist economic development. Their work, pioneered by the analytical work of Hilferding on Finance Capital (1910), recognised the important role of financial system in economic development. Financial development was seen as the determinants rather than the product of economic development in the early stage of development. However, the resulting development of monopolies and cartels will have a detrimental and destructive effect to the society. The Marxist writers provided rationale for state intervention and financial repression for economic development. Lenin’s work of imperialism (Lenin 1916) was based upon Hilferding's work. The crucial role and the destructive force of the financial system in society caused him to nationalise all Russian banks as the fastest way of ending capitalism and assuming control over the entire Russian Economy immediately after the 1917 Bolshevik revolution (Fry 1995). After the 2nd world war, the world saw the development of the capitalist welfare state in Western Europe, and widely used financial repression policy in developing countries in order to modernise their economies. (Bottomore 1981; Fry 1995; Hilferding 1910).

2.2.2 Neoclassical-growth Model

The traditional argument for the role of finance in the economy fell into two classes. First, finance and financial institutions increase the efficiency of the use of investment funds. However, as already shown above, on the assumption of perfect capital market, investments are efficient regardless of financial consideration, as the firm will optimise its input on the frontier of economy production function in the state of competitive equilibrium.

Second, in the traditional macroeconomic analysis where saving is equal to investment, financial development can increase the saving rate. The Harrod-Domar Model developed during the early 1940s suggests that higher saving implies higher financing the real process of development is restricted to domestic taxation, the self-finance of enterprises and the negotiation of foreign credits. A more rapid growth is the removal of obstacles of the expansion of agriculture, such as rural moneylenders and the influence of vested interests upon the government (FitzGerald 1990; Kalecki 1972; Toye 1992).
economic growth\(^9\) (Barro and Sala-i-Martin 2004; Domer 1946; Harrod 1939). However, the significance of the above argument was reduced by the original version of Neoclassical growth, which showed that saving only influences the steady-state level of income but not economic growth (Auerbach and Siddiki 2004).

The original version of the neoclassical Solow Growth model was an extension of the Harrod-Domer Model\(^10\). The results of the model stated that steady state, long run per-capita economic growth rate is zero, and the absolute magnitudes of output and capital will grow at the given exogenous population rate\(^{11}\). Saving and investment will only affect the steady-state level of income but not income growth, though they lead to a higher short-run income growth during the transition towards the steady state\(^{12}\) (Barro and Sala-i-Martin 2004; Solow 1956). The implication is that any saving increased generated by financial development will not affect the economic growth rate in the long-run. The results thus limited the analysis of the role of financial development and investment policy on economic growth. It was only until the emergence of endogenous growth theory that permitted economists to overcome this problematic result (Auerbach and Siddiki 2004).

2.2.3 Tobin's Portfolio Allocation Model

Tobin in his seminal work developed the link between money and economic growth. (Tobin 1965). In his model, money is treated as a durable asset yielding a stream of services to money-holders. Individuals will choose between two assets, money and productive capital. If there is a rise of return on capital relative to money, they will increase the ratio of capital to money in their portfolios. The portfolio shift will increase capital accumulation based on Solow's neoclassical growth model (Solow 1956). This

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\(^9\) The mathematical conclusion from the original version of Harrod-Domer model is that the saving rates over the capital-output ratio equals the output growth rate.

\(^{10}\) Solow extended the Harrod-Domer Model by taking labour as a factor of production, introducing technology as a third independent variable. The model assume constant returns to scale for the production function, and positive and diminishing marginal returns to each factor input. The ratio of capital output and capital labour are not fixed as in Harrod-Domer Model.

\(^{11}\) If the model assumes labour augmenting technological progress, long-run per capita economic growth rate will equal to the technological growth rate, which is the steady rise in the efficiency of labour and is exogenous given in the model.

\(^{12}\) One of reason is due to the assumption of diminishing marginal return of capital in the model.
effect will lead to a greater per capital income attained in the steady state, and a greater economic growth during the transition from a lower to a higher capital-labour ratio. In summary, lowering the rate of return of money-holdings will foster economic development. (Fry 1995; Tobin 1965).

The Tobin model will yield an ambiguous effect of reducing interest rate, i.e. the return on money, on economic development as the effect depends on the choice between inside money and outside money according to Fry (Fry 1995). With outside money being used in the model, one can conclude that taxing money or monetary growth that generates inflation will reduce the return on money and lead to higher growth. However, once the model is modified, so that outside money is being substituted by inside money that is backed entirely by loans by the private business sector, and where an inflation hedge was included as a choice of portfolio, a lower relative return on money caused by monetary growth or by taxing money will reduce real money demand, and hence reduce funds available to finance productive investment (Fry 1995; Lee 1980; Sidrauski 1966).

Hence, the above analysis shows that financial development in this case will have an ambiguous effect on economic development, and the effect is determined by the interest rate and as well as the choice of money in the model. Given that half of the money supply in the developing countries is ‘inside’, using the broad definition of money (Fry 1995), it seems that the Tobin model provided economists with rationale for financial repression to foster economic development.

2.2.4 The Literature on Financial Repression

The concept of financial repression is used primarily in developing countries to describe any of a variety of burdensome controls of taxation regimes that inhibit the development of an efficient financial system. Generally speaking, financial repression is a combination of rationing of bank credit or foreign exchange, accelerating inflation, reserve requirement and the nominal interest rate ceiling, in order to direct resources allocation and to act as a discriminatory tax on financial system. (Fry 1995; Honohan 1992).

13 Outside money is money that represents a claim the private sector has on the government, such as currency; Inside money is a monetary claim of one member of the private sector on another, such as demand deposit (Gurley and Shaw 1960; Kalecki 1944; Mayer 1992).
14 Such as gold and jewellery
Financial repression can be justified as a second-best strategy to finance government expenditure given the government low tax raising-power as well as the idea that the financial sector can be easily controlled and taxed. Besides, both Keynes liquidity trap theory, the Tobin portfolio model and the structuralists\textsuperscript{15} suggest that credit shortage as a result of relative high equilibrium interest rate will lead to a loss of growth potential. Setting the interest-rate ceiling below the full-equilibrium level can therefore serve as a tax on money, which raises investment level and the relative attractiveness of holding productive capital as well as reducing the cost of capital, which in turn will accelerate economic growth. (Fry 1995; Honohan 1992)

The post-World War era therefore saw the prevalence of financial repression in the developing countries. Financial institutions appear as publicly subsidised agencies for directing resources to socially desirable developmental investment (Eshag 1983). Implicit in this view is that financial development only remains of secondary importance and the essential element in economic development.

2.2.5 Summary

While the post Keynesian approach, the Marxist view and the literature of financial repression has became dominant in the field of economic development, a new strand of literature has developed from this background, arguing that financial development was a neglected but integral and essential element in economic development. (Goldsmith 1969; Gurley and Shaw 1955; Gurley and Shaw 1967; McKinnon 1973; Shaw 1973). The empirical analyses conducted by Goldsmith (1969), and the theoretical model developed by McKinnon and Shaw (1973) have became seminal pioneer works, and formed the main intellectual basis for the analysis of finance-growth nexus. The following sections review these developments.

\textsuperscript{15} From the structuralists viewpoint, higher interest rate will increase short-run inflation through a cost-push effect, and dampen economic growth because of reduced supply of real credit volume
2.3 The Development of the Finance-Growth nexus before 1960s

2.3.1 Earlier intellectual development

The early intellectual development of the finance-growth nexus can be traced back to the 17th and 18th century, where earlier writers, such as John Locke, Adam Smith and Jeremy Bentham, had advocated the liberal attitude to finance that sound money and unrestricted financial intermediation are beneficial to society (Bentham 1787; Fry 1995; Lock 1695; Smith 1776). In the late 19th century, Bagehot, in his classic work *Lombard*, has stressed the importance of the banking system, and highlighted scenarios where banks could foster innovations and future growth by identifying and financing productive investment (Arestis 2005; Bagehot 1873). In the early 20th century, Schumpeter in his work explicitly emphasised the essential and integral part of financial development on the process of economic development. According to Schumpeter, financial institutions are key agents in this process, as they evaluate and finance entrepreneurs in their initiation of innovation activity and the bringing of new products to market, which is the central process of economic growth. (Fry 1995; King and Levine 1993a; Schumpeter 1911)

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16 Schumpeter has written the followings in his work *The Theory of Economic Development*:

"He can only become an entrepreneur by previously becoming a debtor...
Granting credit in this sense operates as an order on the economic system to accommodate itself to the purpose of entrepreneur, as an order on the goods which he needs: it means entrusting him with productive forces. It is only thus that economic development could arise from the mere circular flow in perfect equilibrium...
The banker, therefore is not so much primarily the middleman in the commodity 'the purchasing power' as a producer of this commodity. However, since all reserve funds and savings to-day usually flow to him, and the total demand for free purchasing power, whether existing or to be created, concentrates on him, he has either replaced private capitalist or become their agent; he has himself become the capitalist par excellence. He stands between those who wish to form new combinations and the possessors of productive means. He is essentially a phenomenon of development, though only when no central authority directs the social process. He makes possible the carrying out of new combinations, authorises people, in the name of society as it were, to form them. He is the ephor of the exchange economy." (p.102, 107, 74) (Schumpeter 1911)
2.3.2 Fisher Debt-Deflation Theory of Great Depression

Depression-era economists believed that the behaviour of the financial system was largely responsible for the depression of the time, where the severity of the economic downturn resulted from a poorly performing financial market. Fisher (1933), when explaining the great booms and depression of the time, named over-indebtedness followed by deflation as the main serious disturbances that affect all other economic variables to deviate away from the equilibrium and result in severe financial crisis, as in the U.S. Great Depression from 1929-33. Fisher showed that the over-indebtedness followed by deflation will lead to a rise in real interest rate which in turn depressed output. Accordingly, when output and prices decrease during the crisis, borrower's real debt increases. The massive deterioration in borrower net worth induce them to cut consumption and investment, which sends the economy further down, continuing the spiral of falling output and deflation. The Fisher Debt-Deflation Theory of the Great Depression therefore served as a pioneer work to link financial systems and aggregate real activity. However, the dominance of Keynesian thought of emphasis on real factors on the process of economic development turn the economist away from the above direction. It is only until the work of Gurley and Shaw (1955) that redirected the economist attention towards the overall interaction between financial structure and real activity. (Fisher 1933; Gentler 1988).

2.3.3 Gurley and Shaw’s Theory of Intermediation

Traditional economic theory modelled financial intermediary as a passive channel in the standard credit multiplier approach through which monetary policy is conducted in the assumed perfect competitive market. The development of the theory of firms gave new insight to explain the behaviour of financial intermediaries. Gradually economists

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17 Gentler note that the earlier idea related to debt-deflation were from the works of Veblen (1904) and Hawtrey (1926) (Gentler 1988; Hawtrey 1926; Veblen 1904).
18 The Neo-classical theory of firm was found by Alfred Marshall (1890), whose exposition on the demand-supply analysis and the theory of value and distribution has become the tradition textbook theory of partial equilibrium analysis. Based on the Ricardian theory of cost of production, Marshall appeals to the device of a representative firm to derive the supply schedule in the system. Taking into account of the notion of increasing returns of scale, internal and external economies of scale, diminishing marginal return of factor inputs and competitive environment in the long run, representative firms are price-taker, and they are willing to supply output to a point where
borrowed the idea from the literature in firms and industrial organization to analyse the sector of financial intermediaries, to see financial intermediaries as profit-maximising firms, to explain the emergence of financial intermediaries in terms of transaction costs, and to model financial intermediaries as firms that optimally react to the market structure and competition. This micro-economic analysis gave economists a greater understanding for the channels in which financial development can affect the real course of economic progress.

Traditional analysis of banks was limited to the framework of multiple deposit creation systems and money supply processes. Financial Intermediary was a passive channel through which monetary policy is affected. Fractional Reserve Banking System\(^{19}\), where banks retain only a fraction of a client's deposit to satisfy the demands of depositors, is a mechanism that affects the market supply price. The market supply price is equal to the marginal cost of production in the long run. (Marshall 1920). Hence, the neoclassical theory of firm was born, though it aims to predict the effect of specific changes in market force, rather than to provide a complete explanation of behaviour of the firms (Blaug 1980). Representative Firm as conceived by Marshall is a long-period average business unit, representative of the organisation of a given line of production to stand in for the behaviour of the industry (Robbins 1928), and the purpose of inventing this notion is to reconcile the intertemporal behaviour of firms with its short-run dynamic profit maximising characteristic of the firm and the long-run industry static equilibrium conditions in the Marshallian system (Archibald 1987).

Pigou (1928) extend the Marshallian analysis by formalising the theory of perfect competition and monopoly (Pigou 1928). Chamberlin (1933) and Robinson (1933) make a significant extension by introducing the model of imperfect and monopolistic competition, and their analysis has provided the realistic and empirical testable axiomatic foundation for the theory of product market supply and factor market demand in the Marshallian analysis of value and distribution. The notion of imperfect competition and monopolistic competition has become an integral part of Marshall's analysis of firm in the competitive industry. This completes the transition from the Marshallian to the modern theory of firm (Chamberlin 1933; Moss 1984; Robinson 1933).

Under this line of development, the orthodox theory of firm is a file of optimising methods. A firm is seen as a profit maximising agent who endowed with a known and given technology and operating subject to a well-defined market constraint. According to this view, the behaviour of firm is seen as less important to investigate, so long as the system is able to produce testable predictions of the effect of specific changes in market forces and to justify the upward sloping supply schedule (Archibald 1987; Blaug 1980).

\(^{19}\)The first formal analysis of fractional reserve banking and liquidity management, and the idea of scale economies of financial intermediaries can be traced back to Edgeworth (1888). He showed that based on observed behaviour of bank deposits over time, banks can calculate the amount of cash reserves needed to satisfy withdrawals of deposits, so long as withdrawal is a stochastic event and depositors' actions are independent of each other. He shows that cash holding only needs to increase as the square root of the number of deposits to prevent a bank from running out of reserves, and hence demonstrate the existence of economies of scale in reserve holdings\(^{19}\) (Edgeworth 1888; Lewis 1995).
for withdrawals and invests the remainder in loans to generate income, plays an important part in the process of multiple creations of bank credit and deposit to determine aggregate money supply in the whole economy. However this approach cannot justify the behaviour of financial intermediation on the following grounds:

- the reasons for banks to hold reserve;
- ignores the role of profit maximisation for a bank to determine its portfolio and loan selection decision\textsuperscript{20};
- The existence of non-bank financial intermediation.

The issue of uncertainty and the role of profit maximisation spurred the 'new view' of financial intermediation expounded by Gurley and Shaw (1956) and Tobin (1963). Gurley and Shaw challenged the traditional view that monetary system determines money supply. They stated that monetary system is competitive with other non-bank financial intermediaries. Their hypothesis is that commercial banks and the monetary system have retrogressed relating to other financial intermediaries generally.\textsuperscript{21} Tobin in his paper further described the 'new view' of financial intermediation. The essential function of financial intermediaries is to satisfy simultaneously the portfolio preferences of lenders (savers) and borrowers (investors), and they will lend out their excess reserves to a point where the marginal return on lending is equal to the marginal cost of attracting and holding additional deposits. Gurley and Shaw (1960) in their subsequent work stressed the role of economies of scale on both sides of the balance sheet and in arbitraging

\textsuperscript{20} Orr and Mellon (1961) explore the potential effects of uncertainty in the cash flows of banks on the expansion of bank credit. He extends Edgeworth's analysis in two ways. First, a bank should be treated as a profit-maximising agent. As cash holding yields no interest, a bank will want to balance the marginal revenue from additional credit against the marginal costs of being short of reserve. Second, traditional analysis states that credit expansion is equal to the circulated money time the deposit-creation multiplier (which depends on the required reserve ratio), without specific reference to portfolio and loan selection decision. This approach ignores uncertainty - the essence of reserve holding - and the role of profit maximisation in determining credit expansion (Lewis 1995; Orr and Mellon 1961).

\textsuperscript{21} Their arguments are as follows: 'Primary security issues depend on aggregate deficits, and the latter in turn are related to the income level. At any income level, the diversification effect of these issues means that financial intermediaries must grow to hold primary yields steady. If income is rising, too, there is an incremental demand for money and perhaps for other indirect assets for transactions and contingency balances, requiring additional intermediary growth. To the extent that the issues of non-monetary intermediaries are competitive with money balances of whatever type, the required growth of the monetary system is reduced by the expansion of other intermediaries'. (p.265-266)(Gurley and Shaw 1955)
various market segments (Gurley and Shaw 1955; Gurley and Shaw 1960; Lewis 1995; Tobin 1963).

Hence the path-breaking work of the new view of the 'theory of intermediation' pioneered by Gurley and Shaw (1955) redirected economists' attention towards the microfoundation of the financial intermediary, and set a new agenda for the subsequent research on bank and non-bank financial intermediary and their respective impact at the macro-economic level (Lewis 1995). Traditional analysis of money and banking was within the context of the process of money creation. Building on the above new approach, economists in the subsequent generations developed the transaction cost approach and information cost approach to provide justification of the existence of financial intermediary and explanation of their behaviour, which shed light on the transmission mechanism through which financial development can affect the real economic outcome.

2.4 Pioneer Literature of the Finance-Growth Nexus in the 1960s:

Historical Studies

Theories before the 1960s were dominated by the Keynesian arguments in favour of financial repression. They provided overwhelming support for the Keynes (1936) and Robinson (1952) thesis that a financial development is a natural response to the changing demands from the development of the 'real' sector, i.e. finance follows growth, and not vice versa. Given this background, there were breakthroughs on the finance-growth nexus during the 60s. Based on the earlier economic thought developed by Schumpeter and others, and the detailed case studies of the interactions of finance and economic growth in successful industrialised nations as well as less developed countries, several works were published to provide empirical evidence for the importance role of finance sector in the process of economic development. This period saw a surge of interest and a growing academic debate in this area (Eschenbach 2004).

2.4.1 Gerschenkron (1962)

Gerschenkron in his analysis of economic backwardness (Gerschenkron 1962), stated that banking is "one of the basic factors which historically were peculiar to economic situation in backward countries and made for higher speed of growth and different
productive structure of industries"\(^{22}\). He distinguished countries into categories according to their degree of economic development in the 19\(^{th}\) century, and analysed the role of banks in the industrialisation process accordingly as follows.

- In England, the most advanced country, the gradual process of industrialisation will result in a considerable accumulation of capital in industry that is sufficient for further long-term investment. The role of the financial sector in this case serves mainly as a source of short-term capital, and its effect to drive industrialization is therefore limited;

- In a relatively backward country, like Germany, where capital is scarce and diffused, but with a high scope of industrial movement and advanced technology, banks are conceived as specific instruments to supply long-term capital and entrepreneurial talents for industrialization;

- In a backward country, like Denmark, with no comparable features of industrialisation, the presence of financial institutions will not drive industrialisation because of the absence of investment prospect;

- In a backward country, like Russia and Austria, with scope of industrialisation but without a developed financial system that is able to supply long-term capital, state intervention and policy that aids banks are necessary to supply capital to drive the process of industrialisation.

- In a backward country, like Hungary, where there is state intervention but without policy that aids banks, banks prove to be inadequate, state subsidies alone tend to hinder the promotion of industry due to inefficiency.

Therefore, though financial development is neither necessary (as in England) nor sufficient (as in Denmark) to drive industrialization, Gershenkron has successfully emphasised the positive role of banks in the process of economic development (as in Germany, Austria and Russia). His work has laid a foundation for the development of the finance-growth nexus.

2.4.2 Patrick (1966)

Drawing from Joan Robinson's (1952) famous claim that "where enterprise leads finance follows", and Gerschenkron's work (1962) as mentioned above, Patrick crystallised the idea of "demand-following" and "supply leading" approach in addressing the causality

\(^{22}\) p.11 (Gerschenkron 1962)
questions between financial development and economic growth, and attributing the two patterns to specific phases of development process

- Demand following pattern – The evolutionary development of a financial system is a continuous and spontaneous response to the rising demand of financial services established by the process of economic development. Finance is therefore passive and permissive in the growth process, and the causality runs from growth to finance.

- Supply leading pattern – The creation of financial institutions and their supply of their financial assets, liabilities and related financial services induced economic growth, by channelling savings to productive investment in modern sectors and by stimulating entrepreneurial activities in these sectors. The causality runs from finance to growth.

According to Patrick, in the early stages of development where there is inadequate provision of financial services, the supply leading pattern dominates. Gradually, the economies will shift towards the demand-following pattern during the later stage of development. (Eschenbach 2004; Patrick 1966).

The contribution of Patrick lay in his advocate of supply-led finance for the promotion of economic development. He crystallized the demand-supply approach of the finance-growth nexus to address their causal direction in different stages of economic development, thus providing an empirically testable framework in this field for the subsequent work in this area.

### 2.4.3 Porter (1966)

Porter stressed the effect of the qualitative aspect of financial development on economic growth. A developed financial system is ultimately necessary for economic development. It is the qualitative aspect of financial development, such as ‘the promotion of banking habit’, ‘the monetization of the economy’, and the ‘mobilization of saving’, rather than the quantitative aspects, such as expansion of the number of bank offices, that provide a sounder basis for more rapid growth (Porter 1966).
2.4.4 Cameron (1965, 1967, 1972)

Using the historical approach, Cameron in his works coordinated and contributed to several historical studies of banking and economic development in Europe, Japan, Louisiana and United States during the 18th and 19th century, in order to address the problems regarding financing economic development (Cameron et al. 1967; Cameron 1972a).

In his earlier works (1965), he claimed that “financial system is a necessary but not sufficient condition for sustained and successful industrialization... and that the character and efficiency of the financial sector influence the rate, direction, and extent of development.” (Cameron 1965)

In his first book on banking and economic development (1967), after looking at the experience of successful industrialized nation, Cameron concludes that “banking system can play a positive, growth-inducing role as well as responding passively to the demand for financial service”. There is no one-size-fits-all model of banking system for all economies, and the effectiveness of its growth-inducing role in turn depends on the following structural characteristics (Cameron 1967):

- Legal status of Banking;
- The quantitative aspects of financial structure – density, relative size of banking sector, size and concentration of bank power;
- Branch banking verses unit banking system;
- Competition in Banking;

However, in his second book (1972), when extending the studies to more countries, his earlier conclusion regarding the growth-inducing role of bank was modified. Though it is clear to him that “banking systems are not neutral with respect to economic development and the notion that banking systems are passive agents responding to the demand of financial service cannot be sustained”, he now argued that “this is not to say that banking systems invariably make a positive, growth-inducing contribution. Clearly, they do not...the fundamental dynamics of economic development lie outside the banking

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23 Cameron analysis included the following European economies: England, Scotland, France, Belgium, Germany, Russia, Austria, Italy, Spain and Serbia.
24 England, Scotland, Belgium, France, Germany and Japan.
25 Austria, Italy, Spain, Serbia, Louisiana and the United States
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system, and the way the system is structured can either significantly hasten or retard development\(^{26}\) (Cameron 1972b).

Therefore, according to Cameron, the effect of financial development on economic growth remains ambiguous. It is being affected by the structural characteristic of the countries financial system. However, though the results were not conclusive, Cameron's works provided several historical evidences and insights for the importance of financial sector on economic growth.

2.4.5 Goldsmith (1969)

Goldsmith was the first to provide significant empirical evidence about the correlation of finance and growth for a cross-section of countries (Eschenbach 2004). In his seminal work (1969), Goldsmith defined financial development as the change in financial structure\(^{27}\). He summarised the two views about financial development. One view states that countries follow a universal path of financial development, marked by certain regularities governing the evolution of the financial structure. According to this view, the variations of financial development are solely due to countries in different phases of non-financial economic development. An alternative view is that countries follow different paths of financial development\(^{28}\). Government and foreign participation in the ownership and management of financial institutions will therefore exert influence in the course of financial development.\(^{29}\)

Next, he tried to identify the economic factors which determine financial development by formalising a theoretical model using a macro-approach. The model uses the Financial Inter-relations Ratio (FIR) as a proxy to financial development\(^{30}\). He shows that the value of FIR is positively related to the new issue ratio and all of its components, the price of financial assets and the share of price-sensitive issue. It is negatively related to the rate of growth of real income, the general price level and the average capital-output ratio\(^{31}\).

\(^{26}\) p.24 (Cameron 1972b)  
\(^{27}\) p.39 (Goldsmith 1969)  
\(^{28}\) Goldsmith argues that countries follow the second course of financial development are characterised by the rudimentary form of indigenous financial structure in the early nineteenth century.  
\(^{29}\) P.40-43 (Goldsmith 1969)  
\(^{30}\) Ch. 2 (Goldsmith 1969)  
\(^{31}\) p.95 (Goldsmith 1969)
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For the empirical testing of the model, he used a sample of 35 countries to test for the effect of the level of national income (GNP) on financial development. He finds that GNP exerts a positive and significant effect on financial development, though the sign becomes negative when the sample is limited to developed countries.

In the last part of the book, Goldsmith addressed the effect of financial development on economic growth. He concluded that the financial development accelerates economic growth and improves economic performance to the extent that it facilitates the migration of funds to the best user, i.e. to the place in the economic system where the funds will yield the highest social returns\(^{32}\). (p.400) However, he gives no empirical evidences to support his argument.

Goldsmith’s work has several drawbacks. The problems of the theoretical model were that it lacked micro-economic foundations, and it didn’t explain the endogeneity of the variables that determine financial development. The econometrics method employed suffered a series of econometric problems such as lack of data observation, mis-specification, and the problems of stationarity and exogeneity.

Yet his work represents a significant development on finance-growth nexus. He was the first one to thoroughly quantify financial development for quantitative analysis. Though Goldsmith has treated its result with caution, stating that it is difficult to make a generalisation regarding their causal role because the results are not robust\(^ {33}\), his analysis highlighted the important and implicitly causal role of financial development to economic growth. Subsequent literature regarding financial development followed his path to construct financial indicators to address the causality issue, and to identify the effect of the exogenous component of financial development on economic development. Goldsmith’s work therefore broke ground for later empirical research conducted, and he could be seen as a pioneer of systematic analysis of the relationship between financial development and economic growth.

\(^{32}\) p. 400 (Goldsmith 1969)
\(^{33}\) p.387 (Goldsmith 1969)
2.5 Literature in the 1970s: Justification of Financial Sector and McKinnon-Shaw Financial Liberalisation Thesis

With the development of the literature in the early decades, economists are able to formalise economic model to justify the existence of financial sector, and its impact on economic development. This chapter looks at the McKinnon-Shaw school of financial liberalisation thesis, which justify the development of financial sector for economic development, and the advance in the micro-economic theory, which justify the existence of financial sector, during the 1970s.

2.5.1 Micro-Economic Perspectives that justify the Existence of Financial Sectors

This subsection surveys the advance in the micro-economic analysis, particular the development of information economies, financial imperfection and the theory of financial intermediation, during the 1970s. These developments offer a new paradigm for economists to analysis the role of the financial intermediary in the macro-context, lead to a partial rejection of the traditional framework that financial intermediary has no effect in macroeconomic equilibrium, and provide the explanation and justification for the existence and the role of the financial intermediary in the whole economic system. The discovery of financial imperfection justifies the existence of financial market and intermediaries and its beneficial role to the whole economy. These theories provide the intellectual justification for financial consideration in real economic outcomes. Economists later incorporate these ideas to serve as the micro-foundation of their macroeconomic models to study the effect of financial development on economic development.

2.5.1.1 Imperfect Capital Market, Principle-Agent problem and the relevancy of financial structure

The Classical Economics of Finance, based on the Fisher Separation Theorem and the MM Theorem, yielded the conclusion that financial considerations are irrelevant to the
real economic outcomes in the presence of perfect capital market, and investment throughout the economy is efficient regardless of the financial variables project. Yet there were subsequent progress in the literature on economics of information, which justified the existence of intermediaries and challenge the above hypothesis.

2.5.1.1.1 Imperfect Capital Market

The concept of imperfect capital market has already been popular discussed in the economist literature according to Stigler (1967). Based on the efficiency argument, he recasts the underlying reasons of capital market imperfection as follows:

- Inability to borrow funds and access to capital, which results in the failure of capital to flow into fields in which higher rates would be returned than obtainable otherwise;
- The presence of monopoly power in the capital market, which leads to serious inefficiencies in the allocation of capital.
- Inefficiency of market due to the presence of information cost of acquiring complete knowledge of the price that clears the market (Stigler 1967).

The theory of capital market imperfection challenges the underlying assumption of Fisher Separation Theorem. Given the imperfections, development of financial markets, through improving the extent of capital market imperfection, may exert a positive effect on real economic outcomes on the ground of efficiency argument.

2.5.1.1.2 Relaxation of the assumption of M-M Theorem

The results of the Modigliani-Millar theorem (1958) showed the irrelevancy of financial structure in real economic outcomes. Yet Modigliani and Millar demonstrated in their subsequent work that the existence of tax subsidies on debt interest would cause the value of levered firm to rise by the amount of the capitalized value of the tax deduction, which implies that firms should be financed almost entirely with debt in order to maximize their value (Modigliani and Millar 1963). Setting aside the questions whether the results are consistent with observed behaviour, the above analysis provided intellectual proof that financial structure is relevant to the real economic outcomes once certain assumption of
MM theorem is relaxed. Subsequent development in the literature of information economics further established the link between financial structure and real economic outcomes.

2.5.1.1.3 Principal Agent Problem.

The development of agency theory provided a framework for the economic analysis of contractual relationship. An agency relationship is defined through an explicit or implicit contract in which one or more persons (the principals) engage another person (the agent) to take actions on behalf of principals. The contract involves the delegation of some decision-making authority to the agent. Jenson and Meckling (1976) defined agency costs as the sum of following:

- the monitoring expenditures by the principal,
- the bonding expenditures by the agents,
- the residual loss result from the reduction in welfare experienced by the principal due to this divergence between agent’s decisions and those decision which would maximize the welfare of the principal.

In other words, agency costs encompass all transaction costs and information costs involved for structuring, administering and enforcing such contracts (Jenson and Meckling 1976; Smith 1989).

Jenson and Meckling (1976) offered the first systematic economic analysis to show that the debt-equity ratio choice could distort incentives for manager and borrowers, which in turn widen the divergence of interest between the principal (lenders, Entrepreneur & shareholders) and agent (managers and borrowers) and raises the agency costs. They show that there is agency cost associated with debt and equity finance, where inadequate managerial equity holdings might reduce managerial incentive for effort and innovativeness, and encourage excessive risk-taking for a leverage firm (Jenson and Meckling 1976).
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Meckling 1976; Milgrom and Robinson 1992). This consideration indicates that financial structure can affect parties’ incentives in a way that alters the total value of firm.

2.5.1.1.4 Signalling theories

The developments of the signalling theories, pioneered by Ross, Leland and Pyle, and Bhattacharya in the later 1970s, demonstrate that financial decision can affect what investors believe about the firm’s prospects.

- Ross (1977) developed an incentive-signalling model, showing that under asymmetric information changes in the financial structure can alter the market’s perception and hence the value of the firm. A signal equilibrium is possible where firms with higher anticipated future earnings take on more debt. The market will therefore treat this as a possible signal and the share price rises. The analysis implies that a high debt-equity ratio signalled valuable equity shares\(^{38}\) (Ross 1977);

- Leland and Pyle (1977) showed that the fraction of a project owned by the entrepreneur can be a signal of profitability of the project. In equilibrium managers will hold more equity in a firm with higher expected returns. Investors can therefore make deductions about the value of the firm from the fraction of equity owned by the manager. Hence, a high level of share of ownership by management signalled high value per share (Kesley 2001; Leland and Pyle 1977);

\(^{37}\) If a firm has issued debt, there is the possibility of moral hazard and could induce excessive risk-taking by managers. As bondholders care about earnings in the event of bankruptcy, but shareholders do not, by making risky investment the firm can transfer wealth from states in which it is bankrupt to states in which it is not risky, which has the same effect of transferring wealth from bondholders to shareholders. Therefore, debt may encourage excessive risk-taking by shareholders (Jenson and Meckling 1976; Kesley 2001).

\(^{38}\) The idea of the model is that increasing debt raises the probability of bankruptcy, which is costly to managers. Firms with higher cash flows face lower probability of bankruptcy. Managers are better informed about future earnings than the markets. Therefore, firms with lower cash flow do not wish to raise a high level of debt because of the bankruptcy cost. Besides, the model shows that there exists an equilibrium that managers in the lower cash flow firm does not wish to falsely signal that their firm as a high cash flow one by raising debt, as the manager’s share of the gains from a false signal is less than her share of the bankruptcy cost (Kesley 2001; Ross 1977)
Bhattacharya (1979) developed the first model of dividend signal, showing that dividends can be a signal of future profitability. The model can explain why firms pay dividends despite the tax disadvantage (Bhattacharya 1979; Kesley 2001).

Financial signalling therefore serves as a way to transmit information to the shareholder. Hence, the financial structure will exert an impact upon the real economic outcomes in the business world.

2.5.1.2 Theory of Financial Intermediation – Portfolio, Liquidity Insurance, Industrial Organisation and Transaction Cost Approach

Traditional economic theory models financial intermediary as a passive channel in the standard credit multiplier approach through which monetary policy is conducted in the assumed perfect competitive market. The development of the theory of firms gives new insight to explain the behaviour of the financial intermediary. Gradually economists borrowed the idea from the literature in firms and industrial organisation to analyse the sector of financial intermediary, to see financial intermediary as a profit-maximising firm, to explain the emergence of financial intermediary in terms of transaction costs, and to model financial intermediary as firm that optimally react to the market structure and competition. In the meantime, the development of the Theory of Risk Sharing and Insurance and the Modern Theory of Portfolio Management has allowed economists to apply these frameworks in the context of financial systems, which in turn sheds light on

39 The economic theory of decision taking under risks uncertainty was first appeared in David Bernoulli’s solution (1738) to the famous St. Petersburg Paradox. The St. Petersburg Paradox posed the following situation: A coin is flipped repeatedly until the first head is obtained. If the first head appeared on the nth toss, then the payoff is $2^n$ unit. The paradox comes as expected return for this game is infinite since there are potentially an infinite number of flips, yet the real world people would not be willing to pay an infinite amount of money to play this game. This pose a problems of expected value maximization as an explanation of human behaviour (Kesley 2001).

Fisher (1906) pioneered the idea that uncertainty about future asset returns can be described in terms of a probability distribution, and Hicks (1934) appeared to have been the first to suggest that preferences for investment count be represented as preferences for the moments of probability distributions of their returns, and to propose that preferences could be presented by indifference curves in mean-variance space (Brennan 1989; Fisher 1906; Hicks 1934; Milgrom and Robinson 1992).

Regarding the aspects of risk-sharing, Knights (1921) appears the first to offer an extensive account of the ways in with capital market facilitate risk-sharing, and try to distinguish between the concept of risk and uncertainties. According to Knight, the
the transmission mechanism through which financial development can affect real economic outcomes. Hence, all these developments in microeconomic literature have given economist a greater understanding for the channels in which financial development can affect the real course of economic progress.

2.5.1.2.1 Portfolio Approach to Financial Intermediary and Economies of Scope

The development of the Modern Portfolio Theory began with the classical contributions of Markowitz (1952), has inspired later economists for a paradigm change in modelling banking behaviour and provides an adequate means to analyse the risk-taking behaviour of financial intermediary, which in turn sheds light on the transmission mechanism through which financial development can affect real economic outcomes.

situations with risk are where the probability of an unknown outcome can be determined, and the outcome thus could be insured against. Uncertainties are the case where the probability distribution of a random outcome is unknown (Archibald 1987; Knight 1921).

All the above contributions serve as an antecedent for the development of the Theory of risk-Sharing and Insurance, and the Modern Theory of Portfolio Management. The modern portfolio theory begins with the classical contributions of Markowitz (1952), who for the first time applied the principles of marginal analysis to the choice of optimal portfolios. He observed that the process of selecting a portfolio as ‘starting with the relevant beliefs about future performances and ends with the choice of portfolio’. In his model, he assumed investors’ preferences depend on the mean and variance of the aggregate portfolio return, and related these parameters to the portfolio composition and the parameters of the joint distribution of security returns. His work serve as a pioneer work in the field of modern portfolio theory (Brennan 1989; Markowitz 1952);

Tobin (1958) developed the first separation theorem in portfolio theory to analyse the choice between risky asset and cash. By introducing the concept of efficient frontier, he shows that the portfolio decisions can be separated into the choice of the optimal combination of risky asset and the cash/risky asset ratio (Brennan 1989; Tobin 1958);

Sharpe (1964) and Lintner (1965) build on the portfolio theory analysis by Markowitz (1952) and Tobin (1958) to develop the first equilibrium model of asset pricing under uncertainty – the famous Capital Asset Pricing Model (CAPM). Assuming investors’ preferences depend on the mean and variance of the aggregate portfolio return, the homogeneous beliefs of investors about the joint distribution of security returns, with a further assumption that all investors can borrow and lend at a risk-less rate, then there exists a single portfolio of assets such that any risk-averse investor would optimally invest a portion of his wealth in the risk-less asset and the remaining fraction in the identified portfolio. The results derive from the restriction of the pricing formula, where the expected rate of return of any investment over the risk-less rate must be proportional to the beta of the asset (the covariance of the asset return on the identified portfolio over the variance of the market portfolio). (Brennan 1989; Lintner 1965; Milgrom and Robinson 1992; Sharpe 1964)
Pyle (1971) and Hart and Jaffee (1974) offered a new paradigm of the theory of Financial Intermediation. They consider the portfolio choice of a price-taking firm with risk and return as criteria, and apply the Modern Portfolio Theory and the CAPM framework to model banking behaviour. Pyle (1971) shows that yield relationships can explain the emergence of bank portfolio and its intermediation activities between its portfolio assets and liabilities. By incorporating an arbitrary number of assets and liabilities and additional constraints, Hart and Jaffee (1974) obtain a competitive theory of financial intermediaries, where all the composition of the balance sheet are determined in the same way as the portfolio of an individual investor (Freixas and Rochet 1997; Hart and Jaffee 1974; Pyle 1971).

The portfolio approach provides a framework to explain idiosyncratic risks faced by any financial transaction, and justifies the existence of financial intermediary because of the economies of scope explanation. Financial intermediaries have a comparative advantage in holding risky market portfolio and able to diversify their portfolio securities in order to minimise their idiosyncratic risks (Freixas and Rochet 1997). Looking from the above micro-analysis, financial development is able to benefit the economy by raising the average efficiency of investment projects in the economy through minimising the idiosyncratic risk.

2.5.1.2.2 Liquidity Insurance

The Theory of Risk Sharing and Insurance was built on the foundations of the expected utility theory and the state preference approach by Eisner and Strotz (1961), Borch.

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41 Pyle (1971) shows that if excess return of deposit is negative and the excess return (over the riskless rate) of the loan is positive, and if the covariance between the deposit and loan return are positive, then banks will decrease deposits and increase loans. The demand of deposit (loan) is an increasing function of its excess return and a decreasing function of its variance and the return of loan (deposit). (Freixas and Rochet 1997; Pyle 1971).

42 Economies of scope refer to efficiencies associated with increasing or decreasing the scope of marketing, distribution, and the changes in number of different type product.

43 The path-breaking work of Von Neumann and Morgenstern (1944) has put a sound logical foundation on the uncertainty literature by placing the theory of choice under uncertainty in a rigorous axiomatic basis. Their expected utility hypothesis has become an essential element in the micro-economics literatures. (Brennan 1989; von Neumann and Morgenstern 1944). The conventional wisdom that economic agent will maximise the expected value of their project was under challenged, as the theory was incapable to model human behaviour under risk such as risk aversion, insurance purchase,
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(1962) and Arrow (1963, 1965). They explore the compatibility of economic and insurance theory, and show that when insurance company offer insurance at a fair premium, a risk-averse individual will choose to fully insure to maximize his utility. Hence the insurance coverage is dependent on the level of risk-aversion of an economic agent. The principle of risk-sharing - that sharing independent idiosyncratic risks reduces the aggregate cost of bearing them - form the basis of all financial insurance contract and therefore justify the existence of insurance company. (Arrow 1963; Arrow 1965; Borch 1962; Eisner and Strotz 1961; Kesley 2001; Milgrom and Robinson 1992; The History of Economic Thought Website 2006b; Wilson 1968).

The development of the theory of risk sharing and insurance, and together with the idea of scale economies in reserve holdings of the fractional reserve system, imply that banks are pooling independent risks of deposit withdrawals and providing liquidity insurance to depositors against idiosyncratic shocks that affect their consumption need. Bryant (1980) models the notion of liquidity insurance, showing that the market diversification and gambling (Kesley 2001). The development of expected utility was thus able to set out a new research agenda for modelling human choice under risk. Subsequent works by Friedman and Salvage (1948) conduct the utility analysis of choices involving risk. They formalise the notion of risk-aversion to explain the human risk-taking attitude. Risk-averse (risk-loving) preference was being modelled by a concave (convex) von-Neuman-Morgenstern utility function over income. Later on, Arrow (1965) and Pratt (1964) apply the expected utility theory to analysis risk that are specifically financial in nature, and developed the measure of risk aversion as the ‘concavity’ of the utility function over money income (Arrow 1965; Friedman and Savage 1948; Milgrom and Robinson 1992; Pratt 1964);

44 The State-Preference approach to uncertainty is pioneered and formalised by Arrow (1953) and Debreu (1959). Preferences are formed over state-contingent commodity bundles, where commodities can be differentiated not only by their physical properties and location in space and time, but also by their location in different mutually-exclusive state of nature, and the individual optimum is where the expected marginal utility of commodity per unit of money income are equal across the state. This condition was known as the ‘Fundamental Theorem of Risk’ by Arrow (1953) Yaari (1969) integrated the theory of risk aversion into this approach to analysis individual’s risk premium (Arrow 1953; Debreu 1959; Kesley 2001; Milgrom and Robinson 1992; The History of Economic Thought Website 2006b; Yaari 1969)

45 The assumption of competitive insurance markets will reduce the expected profits of the insurance company to zero due to competition. The insurance premium in this case will equal to its cost, and insurance in this case is said to be actuarially fair (Kesley 2001). Borch (1962) and Wilson (1969) use the portfolio mean-variance approach to arrive the similar results, that risks are shared efficiently when the share that an individual bear in each risk is equal to his share of the total risk tolerance (a function of individual risk-aversion) of the group, which thus minimise the total risk premium of the group (Milgrom and Robinson 1992).
allocation can be improved by a deposit contract offered by a financial intermediary in an economy where agents are individually subject to independent liquidity shocks (Bryant 1980; Freixas and Rochet 1997). In this sense, financial development can achieve Pareto improvement for market allocation through provision of liquidity.

The function of banks in the provision of liquidity insurance is similar to those services provided by the specialist insurance services. Arrow (1974) explores the compatibility of economic and insurance theory, and argues that the risk-shifting functions of insurance are universal in the whole economic system as well as in financial systems, but with limits due to the presence of moral hazards. Stock market, future markets and forward exchange contracts can be seen as forms of insurance to cope with uncertainty. In this sense, the whole financial system can perform risk-shifting function and thereby improve efficiency for market allocation (Arrow 1974; Lewis 1995).

2.5.1.2.3 Industrial Organisations approach

Industrial organisations, through the theoretical contribution of the analysis of imperfect competition by Chamberlin (1933), and the historical setting of the rise of modern manufacturing around the turn of 20th century, emerged as a distinct field of mainstream economics that focus on markets for manufacturing product that cannot easily be analysed in Marshall's competitive model. This line of thought focuses on the investigation of firms' behaviour for resources allocation and distribution, and its main objective is to develop tools to analyse market processes and their consequences for economic performance (Schmalensee 1987). The course of economic development widens the scope in this field, and sectors other than manufacturing sector are included in this field. Nowadays, with the development of game theoretic approach, industrial organization becomes a field of economics that studies firms' behaviour, market structure and their interaction.

Gradually economists apply this approach to analyse the sector of financial intermediary. This approach gradually becomes one of the pillars of the microeconomic theory of financial intermediary, which allows economists to model financial intermediaries as firms that optimally react to the market structure and competition, rather than as a passive channel in the standard credit multiplier approach through which monetary policy is conducted in the assumed perfect competitive market.
Klein (1971) and Monti (1972) first provide the analytical frameworks for a monopolistic banking that yield testable results. They apply the marginal analysis to consider the equilibrium of a financial intermediary possessing some degree of monopoly power and able to set loan interest rates in some market. Their result shows that a monopolist bank will set its volume of loans and deposits in such a way that the Lerner indices (price minus costs divided by price) equal inverse elasticity. This implies that more substitutes to banking product in the market will reduce the intermediation margins and reduce the market power for the monopolistic bank (Freixas and Rochet 1997; Klein 1971; Monti 1972). Seen from this light, financial development that improves market competition will reduce the mark-up for the monopoly power, and achieve Pareto improvement for market allocation.

2.5.1.2.4 Transaction Cost Approach

The transaction approach of analysing firms' behaviour was originated by Kaldor (1934) and Coase (1937), in response to the challenge of the neoclassical theory of firm originated by Marshall and Pigou during the cost controversy debates in 1920s 47 and Kaldor critique in 1934 48. The purpose of Coase's paper (1937) is to bridge what appears
to be a gap in economic theory between the assumption that resources are allocated by means of the price mechanism, and the assumption that this allocation is dependent on the entrepreneur coordinator originated by Kaldor (1934). A new conceptual framework has developed, where the starting point of analysis is to look at individual firms rather than with the industry, and to trace historically at how and why firms come into being. Coase explains the existence and scope of the firm as a consequence of the costs of market transactions\textsuperscript{49}. Firm is an area in which allocations are proceeded by coordination and planning rather than solely rely on the markets so as to minimize transaction costs (Buckley and Michie 1996; Coase 1937; Kaldor 1934). The introduction of transaction cost and the dichotomy of coordination through the market and within the firm therefore serve as the foundation of the institutional theory of firm\textsuperscript{50}.

\textsuperscript{49} The transaction cost list includes the cost of discovering the relevant price in the price mechanism, and the cost of negotiating and concluding the contract for an exchange transaction.

\textsuperscript{50} With the emergence of the theories of agency costs, property rights, and transaction cost theories of the firm, a growing body of literature has developed subsequently to extend the Coase analysis. Following are the surveys by Buckley and Michie (1996) to trace the development of the idea of the institutional approach of firm (Buckley and Michie 1996).

- Richardson (1972) shows that a simple firm/market dichotomy misses the essence of business behaviour, for in reality the firm enters into many different collaborative relationships (Richardson 1972);
- Alchian and Demsetz (1972) shows that team production is crucial in firms, therefore difficulties of metering outputs and monitoring workers are essential elements of management (Alchian and Demsetz 1972);
- Jenson and Meckling (1976) uses the agency cost theory to illustrate the nature and incidence of the costs of monitoring in the context of principal-agent problem (Jenson and Meckling 1976);
- Williamson (1979) illustrates the importance of transaction costs in determining the governance (ownership and direction) of the firm by reference to key concepts such as opportunism (self-seeking with guile), transaction specific, and the role of information (Williamson 1979);
- Hart (1989) shows the importance of property rights as support for a contract-based theory of the firm (Hart 1989).
Based on the transaction-cost analysis pioneered by Coase (1937), and the new view of financial intermediary originated by Gurley and Shaw (1955), Benston & Smith (1976) use the transaction-cost approach to explain why financial intermediaries come into existence. They view the role of the financial intermediary as creating specialised financial commodities. They see the demand for these financial commodities as a derived demand. By acquiring financial commodities, inter-temporal and intra-temporal transfers of consumption may be achieved. The emergence of financial intermediary reduces the transaction costs of effecting inter- and intra-temporal consumption decision. Therefore, the existence of transaction cost justifies the emergence of financial intermediaries.

2.5.1.3 Concluding Remarks for this subsection

The above developments in economic theory provide the intellectual justifications for financial considerations in real economic outcomes. Economists later incorporate these ideas to serve as the micro-foundation of their macroeconomic model to study the effect of financial development on economic development. Yet, these models do not explain what makes the intermediary come into existence, and thus what functions it performs. The literature in the 1980s therefore tends to solve this problem by endogenising the development of financial intermediaries within the model.

2.5.2 First Generation Financial Growth Model: The McKinnon-Shaw Financial Liberalization thesis

Until the early 70’s, the dominant theoretical work relating financial conditions to economic development detected possibilities of negative or, at best, neutral effects of financial development on income levels or growth rates. In 1973, both McKinnon and Shaw break grounds and develop macroeconomic theoretical models in which financial development accelerate economic growth. Their works challenge the dominant post-Keynesian theoretical position, and become the main intellectual basis for subsequent analysis on finance-growth nexus.
2.5.2.1 The writings of McKinnon and Shaw

The writings of McKinnon and Shaw aim to refute the financial repression thesis and to advocate financial liberalisation and development as a growth-enhancing economic policy. Financial repression - a combination of rationing of bank credit or foreign exchange, accelerating inflation, reserve requirement and the nominal interest rate ceiling, in order to direct resources allocation and to act as a discriminatory tax on financial system - will result in low savings, low investment, credit rationing and inefficiencies. Table 2-1 summarises sources of financial repression and their corresponding consequences.

Table 2-1: Source of Financial Repression and their consequences.

<table>
<thead>
<tr>
<th>Source</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation Tax</td>
<td>Households will remove savings to purchase unproductive inflation hedges (such as land) where inflation is accelerating (or when real interest rate is low). Price of inflation hedges will increase, which lead to increases in household wealth. This induces a higher current and future consumption, but lowers saving out of current income.</td>
</tr>
<tr>
<td>Deposit-rate Ceiling</td>
<td>Deposit-rate ceiling will result in a spread between loan rate and deposit rate. It increases current consumption against future consumption, and therefore reduces current savings below the social optimal level.</td>
</tr>
<tr>
<td>Loan-rate ceiling</td>
<td>Loan-rate ceiling will results in non-price rationing of loan-able fund. Credit is allocated not according to marginal productivity of investment project, but according to discretion by bankers or by government. The average efficiency of investment is therefore reduced. It will also discourage financial institution to take risks, as risk premium cannot be charged. The return of investment will fall below the market equilibrium level.</td>
</tr>
<tr>
<td>Reserve</td>
<td>Reserve Requirement serves as an implicit tax imposed on financial</td>
</tr>
</tbody>
</table>

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### A Brief History of the Theoretical Linkage of Financial Development and Economic Growth

<table>
<thead>
<tr>
<th>Requirement</th>
<th>institutions, where the rate rises in step with inflation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Allocation Programme</td>
<td>These programmes often discourage prompt loan repayment and result in high delinquency and high default rate, thereby increasing the fragility of the whole financial system.</td>
</tr>
</tbody>
</table>

Source: (Fry 1995)

Table 2-2 outlines the framework of the theoretical models developed by McKinnon and Shaw, in which they provide the intellectual basis for financial liberalisation and development in fostering economic development.

**Table 2-2: McKinnon’s Complementarily Hypothesis and Shaw’s Debt Intermediation View.**

<table>
<thead>
<tr>
<th>McKinnon’s Complementarily Hypothesis</th>
<th>Shaw’s Debt-Intermediation View</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Money</strong></td>
<td><strong>Assumption</strong></td>
</tr>
<tr>
<td>Outside Money Model</td>
<td>All economic units are confined to self-finance. Firms cannot borrow to finance investment</td>
</tr>
<tr>
<td></td>
<td>Indivisibilities in investment. Potential Investors must accumulate money balances prior to their investment. So there is inter-temporal complementarily of deposits and physical capital.</td>
</tr>
<tr>
<td><strong>Focus</strong></td>
<td>The role of deposits in encouraging self-finance investment.</td>
</tr>
<tr>
<td><strong>Idea</strong></td>
<td>The role of deposits in expanding the lending potential of financial intermediaries.</td>
</tr>
<tr>
<td>Financial liberalisation (higher)</td>
<td>Financial liberalisation (higher)</td>
</tr>
</tbody>
</table>

---

51 Under the credit allocation programmes, financial institutions are required to allocate minimum percentages of their asset portfolios for loans to the priority sectors (selected by government) of the economy at a subsidised loan rate.
Financial liberalisation and development, on this account, raise the incentives to save and the credit availability, by means of spreading risks and transforming the maturity of debt structure in ways more attractive to savers and borrowers, thereby benefiting the society through the generation of additional savings and resulting in a more efficient resources allocation of loan-able funds for productive purpose. In other words, financial development stimulates growth and structural change of in the real economy through increase of intermediation. (Toye 1992)

2.5.2.2 Subsequent extension of McKinnon-Shaw framework

The First Generation Financial Repression model has emerged to extend the original McKinnon-Shaw framework in specific ways to illustrate the negative impact of financial impression on economic growth. The common essence of these models is that growth-maximising deposit rate is the competitive free market equilibrium rate. Financial liberalisation policy - where interest rate ceiling will be abolished, where reserve requirement tax eliminated, where credited allocation programme abandoned, where inflation is stabilised, and where there is a competitive free entry for financial system - will optimise the real supply of credit and raise the average efficiency of investment, thereby maximising economic growth and minimising the contractionary effects of monetary stabilization programmes.

Table 2-3 summarises these models.

Table 2-3: Summary of First Generation Financial Repression models.

Financial Repression, Economic Dualism & Inequality (Fry 1995)
<table>
<thead>
<tr>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>McKinnon 1973</td>
<td>Using the Fisher analytical framework and neoclassical production functions with declining marginal returns to capital, McKinnon shows that differential access to credit produced by financial repression foster economic dualism i.e. the coexistence of both modern and traditional production techniques, as entrepreneur without access to finance cannot switch to the modern technology. It results in investment inefficiencies and income inequality.</td>
</tr>
<tr>
<td>Krugman 1978</td>
<td>Based on the McKinnon framework (1973), Krugman argues that financial repression results in income inequality and investment inefficiencies, but not necessarily economic dualism. Modern and traditional techniques will coexist and be optimised when individuals face the same market-borrowing line. Yet financial repression worsens income distribution because money holders are implicitly taxed to subsidised favoured borrowers when there is credit rationing.</td>
</tr>
<tr>
<td>Cho 1984</td>
<td>Based on the McKinnon framework (1973), Cho shows that interest-rate ceilings worsen income distribution. Economic rent goes to larger borrowers rather than the small savers/lenders when the interest rate is lower than the market equilibrium. It will lead to greater economic concentration that tends to reduce efficiency. It will also foster capital-intensive production methods, which thereby reduce demand for labour and create a large dispersion of wages.</td>
</tr>
<tr>
<td>Galbis 1977</td>
<td>Using the Harrod-Domer production functions, Galbis constructs a 2 sector model to show that financial repression fosters economic dualism, which thereby creates inefficiencies when returns to capital are constant. Liberalising interest rates will move deposit money from the traditional sector to modern sector, and thereby increases average inefficiencies of investment.</td>
</tr>
</tbody>
</table>

**Formal Macroeconomic Models**

<table>
<thead>
<tr>
<th>Basic idea</th>
<th>Description</th>
</tr>
</thead>
</table>
| Kapur 1976; Mathieson 1980 | 1. Based on Harrod-Domer production functions  
2. Financial repression is exerted through fixing the deposit (not the loan) rate of interest below the market equilibrium and reserve requirement; |
3. High reserve requirement lowers the deposit rate ceiling at any given loan rate;
4. Accelerating inflation lowers the return of holding money and hence deposit. Households are induced to hold unproductive inflation hedge.
5. The banks' liabilities contract, and consequently also its asset, which reduces the credit supply for productive investment, and therefore economic growth;
6. Policy implication – Reduced reserve requirement at a given inflation rate increases the scope of banking system for lending activities, which thereby increase economic growth.

2.6 Literature in 1980s: Short-Run analysis of Finance on Output Fluctuations

The McKinnon and Shaw framework and the subsequent development of financial liberalization literature offer the intellectual basis for the country to pursue a financial liberalisation policy to deepen its financial system in order to achieve rapid economic development. However, the policy prescription was a mixed blessing. The Latin American and Southern Cone experiments in financial liberalisation during the late 1970s and the early 1980s saw the unintended negative consequences and problems as the direct results of new freedoms in the financial market (Diaz-Alejandro 1985). Liberalized financial systems may be more prone to macroeconomic instability (Dornbusch and Reynoso 1989). The assumption of free market under the financial liberalization thesis ignores issues such as oligopoly and the problem of asymmetric information.

As a result of the mixed experiences with financial liberalization policies, with the significant progress in the field of micro-analysis in the asymmetric information, economists challenged the intellectual basis of McKinnon-Shaw financial liberalization model, and offer new insights in understanding the process of financial development\textsuperscript{52}.

\textsuperscript{52} The financial crisis episodes experienced by the Latin American countries during the late 1970s and early 1980s led to the development of the first generation financial crisis model – a form of speculative model. The crisis literature was inspired by the research on government price-fixing schemes in exhaustible resource markets by Salant and Henderson (1978). They analyse the effects of government sales policies on the real price

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On the other hand, advances in the economics of information and incentive facilitated the theoretical progress of the emergence of financial system and its short-run simultaneous relation with the real activities. Based on the context of Akerlof's (1970) paper on the 'lemons' problem, the finance literature examines the allocative consequences of informational asymmetries in financial markets at the micro-level which may have significant real effects. A new approach of studying intermediation and banking has developed. It endogenises intermediaries as optimal responses to the information problems which may disrupt financial markets. With the advances in the literature on financial market inefficiencies and intermediation, and with the advances in business cycle analysis, a series of works synthesise the literature and focus on the role of financial factors in output fluctuations (Gentler 1988).

of gold, and argue that the government attempts to peg the price or to defend the price-ceiling with sales from its stockpile will result in an eventual sudden speculative attack. Speculators will acquire all the government gold stock at a fixed price, which will therefore deplete government stocks and result in a break-down of price-stability policies. This in turns will provide a capital gain for the speculator as the price of gold will then rise until it reaches the market equilibrium in the perfect foresight solution (Salant and Henderson 1978; Wang 2005).

Focusing on the balance-of-payment crises, Krugman (1979) put forward the approach of 'bad' fundamentals, arguing that a fixed-exchange-rate regime together with excessive fiscal policies and monetary expansion to finance large budget deficits will result in an unsustainable credit expansion, which can only be financed by the depletion of foreign exchange reserves. The reason is that under a pegged exchange rate system central banks cannot depreciate their currency. Therefore, whenever investors rebalance their portfolios by selling domestic assets, the central bank has to intervene to maintain the system by using foreign reserves to purchase these assets in order to maintain the fixed rate. Under rational expectations investors will anticipate that there will be a discrete jump in the price of foreign exchange once the central bank has sold out all its research, and therefore he can earn a windfall gain by exchanging his domestic currency for foreign currency before. This will lead to the collapse of a fixed exchange rate system once the central bank has run out of its reserve, and hence the currency crisis – a discrete change (depreciation) of domestic currency (Krugman 1979). Flood and Garber (1984) further modified the Krugman model to identify the timing of speculative attacks. There will be speculative attacks once the shadow floating exchange rate (the floating rate that would prevail if the exchange rate is not fixed) exceeds the fixed rate. It will quickly drive all central banks' reserves to zero, and therefore results in the collapse of the fixed-exchange-rate regime and currency crises (Flood and Garber 1984).

The Krugman-Flood-Garber model provides insight to explain the financial crises experienced by many Latin American countries after the country experiment in financial liberalization policy in the late 1970's and 1980's. This approach indicates that irresponsible government policies and unsound economic fundamentals are potential causes for financial crises.
2.6.1 Market Imperfections: Asymmetric information, Credit Rationing and Financial Fragility

The problem of asymmetric information, where the entrepreneur who seeks finance has information about the project that is not freely available to the provider of finance, is traced back to Stigler (1967), Akerlof (1970) and Leland and Pyle (Akerlof 1970; Leland and Pyle 1977; Stigler 1967).

According to this view, the existence of financial intermediaries is treated as an endogenous response to costly and heterogeneous information. There are two types of information asymmetries: ex ante or ex post. Ex ante asymmetry (adverse selection problem) exists when the entrepreneur knows more than the lender about the probability distributions of future returns from a project. Ex post information asymmetries (moral hazard) come about when the lender is unable easily to observe the entrepreneur’s choice of investment methods and the effort put into making the project a success (Lewis 1995).

Given the problems of information imperfection, several economists question the wisdom of financial liberalization on economic development, and argue that there is an important role for government intervention, and even financial repression due to pervasive market failure. (Stiglitz 1994)

The literature on asymmetric information provides an intellectual basis for market failures. Disequilibria in the credit market may have causes other that government intervention or financial repression policies. Stiglitz and Weiss (1981) show that the inability of lenders to identify accurately borrowers’ probability of repaying debt may lead to credit rationing, adverse selection and moral hazards, which distort the workings of financial markets and the role of interest rates as a resources allocation mechanism. Price of credit (interest rate) may affect the nature of the transaction. The bank is unwilling to raise interest rates to its market clearing level, as high interest rates may attract bad borrowers (adverse selection) or induce borrowers to undertake more risky investment projects (moral hazard), thereby raising the borrowers’ probability of default. Therefore, excess demand of credit occurs, and equilibrium in the credit market will be characterised by credit rationing (Stiglitz and Weiss 1981). The argument indicates microeconomic shortcomings of a free credit market. When quality is dependent on price due to incentive and selection effect, the first Theorem of Welfare Economics will not hold, i.e. free and competitive markets will not deliver the Pareto efficient allocation due
to imperfect information and externalities. Credit rationing is consistent with Pareto efficiency, and there are possibilities that tax and subsidy intervention can attain Pareto improvement. (Stiglitz 1987). The above is therefore indirectly attacking the investment efficient argument by financial liberalization thesis.

Not only does an adverse selection problem result in credit rationing, but also financial collapse. Mankiw (1986) constructs a theoretical model to show that when borrowers have greater information concerning their own riskiness than lenders (asymmetric information), a small change in the exogenous risk-free interest rate can cause large (discontinuous) changes in the allocation of credit and the efficiency of the market equilibrium. There is a possibility that credit markets will cease to exist (financial collapse) at a higher interest rate, as a high interest rate may attract bad borrowers (adverse selection) and thereby raise the borrowers’ probability of default and lower the expected return of lending. Banks will stop lending if the expected return falls short of given required market returns, and thus leading to financial collapse. Potential investors are therefore unable to raise the necessary capital even though the projects are socially profitable. Therefore, there is an inherent undesirable equilibrium (financial collapse) by raising interest rates in the unfettered financial market. To an extreme, it may result in financial crisis (Mankiw 1986). Again, the efficient argument by the financial liberalization thesis was questioned by the these models.

2.6.2 The Role of Financial System to reduce Market Imperfections

Monitoring and screening is essential to tackle the problem of asymmetric information and the agency cost. Yet it is by nature a public good, and the market tends to under-supply below the socially optimal point due to the free-rider problem, coordination failures and duplicated monitoring costs among dispersed investors (Bhattacharya, Boot, and Thakor 2004b).

- The first paper to rationalise the existence of financial intermediaries as the provision of screening and monitoring is by Leland and Pyle (1977), which shows that an information-gathering agency will emerged as financial intermediaries to internalise the information into its loan portfolio to capture the full return of

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53 Public goods are characterised as non-rivalry and non-excludable in consumption. The free ride problem refers to the tendency for individuals to let others provide them (Varian 2003).
information provision, which in turn can overcome the problems of the sub-optimal information provision\textsuperscript{54}. Yet there is a problem of adverse selection of the loan portfolio, and the level of self-financing can serve as a signal to partially overcome the problem\textsuperscript{55}. Since the ‘signalling cost’ increases less rapidly than the size of the coalition, the formation of the financial institutions by coalitions of borrowers can obtain better financing conditions than by borrowing individually (Freixas and Rochet 1997; Leland and Pyle 1977).

- The delegated monitoring theory of financial intermediation pioneered by Diamond (1984) suggests that banks have a comparative advantage in providing post-finance monitoring, i.e. tackling the moral hazard problem (Bhattacharya, Boot, and Thakor 2004b; Freixas and Rochet 1997). Diamond (1984) shows that a financial intermediary can operate as an entity to which lenders/depositors will delegate the task of monitoring and enforcing loan contracts, thereby economizing on the costs of monitoring project outcomes by exploiting size advantage and diversification\textsuperscript{56}. (Diamond 1984).

- Ramakrishna and Thakor (1984) provide a theory of financial intermediaries as brokers to rationalise the existence of non-depository financial institutions\textsuperscript{57}, which consists of coalitions of information producers, to provide pre-financing

\textsuperscript{54} Owing to the public good aspects of information, purchasers of information can share or resell their information to others without diminishing its usefulness to themselves. The information provider may only be able to appropriate only a fraction of totality of what is the buyers’ willingness-to-pay. The problem of appropriability of returns will be solved in this case, as the cost of the financial institution to provide information is embodied in the return of the loan portfolio, which is a private good. Thus return of information provision can be captured through the increased value of its portfolio.

\textsuperscript{55} Yet owing to asymmetric information, purchaser of information cannot distinguish good information from bad, which in turn will lower the average portfolio return of information. This problem can be overcome through signalling. Recall in the above discussion of signalling theory, the level of equity ownership by managers serves as a signal of project qualities. Therefore, the insider equity holding can serve as a signal of the quality of a firm’s information and the assets selected on the basis of this information. (Leland and Pyle 1977)

\textsuperscript{56} Monitoring costs can be duplicated among dispersed investors. A Financial intermediary is able to pool the funds of many investors and diversify over many investment projects. This could reduce per-project costs of resolving informational asymmetry to that of unduplicated monitoring (Bhattacharya, Boot, and Thakor 2004a).

\textsuperscript{57} One example is the credit rating agencies. A point to note is that a financial institution does not engage in asset transformation and funding in the Ramakrishnan and Thakor model, as distinct from the model of Diamond (1984) and Boyd & Prescott (1986)
screening service in order to lower the information production cost (Bhattacharya, Boot, and Thakor 2004b; Ramakrishnan and Thakor 1984).

- The themes of the coalition view of financial intermediaries to provide pre-financing screening service monitoring and evaluation to tackle adverse selection problems of would-be borrowers and to engage in asset transformation was further developed by Boyd and Prescott (1986). They construct a general equilibrium showing that the coalitions of heterogeneous agents can improve the market equilibrium outcome by producing costly information on the attributes of would-be borrowers to allocate loans and to set term, and to allow for cross-subsidisation so that each agent has an incentive to reveal truthfully the characteristic of his project (Boyd and Prescott 1986; Freixas and Rochet 1997).

The above argument can be summarised in Williamson (1987) who reviews paper information-based approaches to financial intermediation. Banks have an informational advantage over other intermediaries in credit markets to perform pre-financial screening and post-financial monitoring service because they can obtain private information as they are their customers' bookkeepers. Once the loan is made, the transactions account becomes a continuing source of credit information, allowing banks to monitor and identify problem loans. These spillovers mean that banks can select claims which have a lower default risk than other loans. Such informational economies of scope prompt the joint packaging of payments and loan services and the co-existence of these activities by banks (Lewis 1995; Williamson 1987).

Therefore, the above argument demonstrates that financial institution emerge to provide screening and monitoring in order to reduce the information problem and agency cost from the micro-economic perspective.

Yet Stiglitz (1985), Shleifer and Vishny (1986) and Boyd and Prescott (1986) show the inadequacy of capital markets to provide such monitoring services to achieve efficiency in equilibrium situation.

58 A Coalition of information producers will reduce the moral hazard cost, as the propensity to generate unreliable information by each information producer is decreasing with group size.

59 Assume that each entrepreneur (agents) has private information about their project (either good or bad). Agents who had bad projects have no incentive to reveal their type. The emergency of F.I (coalitions of agents) by providing evaluation and allowing cross subsidization - to decrease the returns of good types and to increase returns for a bad type a way that each agent has an incentive to reveal truthfully the characteristic of his project will improve market equilibrium outcome (Freixas and Rochet 1997).
Stiglitz (1985) reviews the role of capital markets to tackle the principal-agent problems. He argues that control mechanisms exercised by the shareholders cannot exercise effective control over management due to the failure of Stockholder Meetings, takeovers, and “voting with Dollars” as control devices. There are other control mechanism, such as banks, concentrated equity ownership, and managerial reputations to alleviate the problems. Yet they are imperfect and subjected to bias, and the equilibrium attained will not be efficient even ignoring the free-rider problem (Stiglitz 1985).

The ‘public good argument’ demonstrates the inefficiencies of the stockholder meetings as a control device. The marginal benefit for the shareholders to obtain information to vote intelligently is less than the marginal cost, as evidence shows that the shareholder views himself as only having a negligible effect on the outcome. An information problem therefore exists, and no rational shareholder will expend resources to obtain the necessary information to determine whether a manager is a good manager and evaluate alternative management teams (Stiglitz 1985).

The reason why takeover mechanisms are not effective are as follows: 1, A takeover will only be successful when the firm over-pays for the takeovers because of adverse selection problems; 2, The public good nature of information means too little searching for information in the market; 3, The inefficiency of the stockholder meeting makes value-enhancing takeovers difficult, as it is in the interest of the small shareholders to withhold their shares if they foresee a rise in his shares; 4, Current managers are in a position to take strategic action that deter (or encourage) takeovers for their own gains rather than maximising the value of the firm (Stiglitz 1985).

‘Voting with dollars’ is a control mechanism where firms that do no use resources efficiently cannot raise additional capital, yet this mechanism is only effective when capital is raised from the market and managers have considerable discretion over their cash flow (Stiglitz 1985).

The nature of loan contract allow banks to focus their attention on information gathering to those associated with the probability of default and the net worth of the firm in low-return states. The public good nature of searching for information in this case was resolved by having a single lender (the bank) (Stiglitz 1985).

If there are few large shareholders, and each has enough stake in the firm that his private incentives for controlling the manager are sufficiently great, then there will be a sufficiently large expenditure on information acquisition by these individuals that effective control will be exerted (Stiglitz 1985). Besides, the model constructed by Shleifer and Vishny (1986) shows that the presence of a large minority shareholder provide a partial solution to the free rider problem of monitoring, as the presence of a large shareholder is likely to provide an incentive for outsiders to monitor and evaluate the performance of the incumbent management (Shleifer and Vishny 1986)

Manager is concern for his good reputation as he is being judged by the insiders and outsider of his firm (Stiglitz 1985).

As lender only concern with the bottom part of the tail of the distribution of returns, loan contracts will require firm to undertake relative low risk project even though the expected return is much lower, which therefore result in inefficiencies. Regarding concentrated-equity-ownership structure, it will results in limited risk diversification, and
In the general equilibrium constructed by Boyd and Prescott (1986) discussed above, they show that the securities market arrangement cannot implement the optimal equilibrium because agents have no incentive to reveal their true quality type of project under this control mechanism (Boyd and Prescott 1986).

The above reviews the literature of micro-analysis of information problems regarding monitoring to reduce agency cost and principal agent problems. Though they show that there is market mechanism for financial institutions to develop to counteract the information problem, the attained equilibrium will not be Pareto efficient. Therefore, the above is indirectly attacking the efficiency argument by financial liberalization thesis, as information asymmetries will lead to capital misallocations and monitoring costs. However, they also demonstrate the importance of financial development in the economy to reduce the information cost and to improve efficiency.

2.6.3 Credit Channel and Macroeconomic Consequences

In conventional Keynesian, Monetarist, and Classical model, the main real/financial interaction stems from activities in the market for the medium of exchange, such as goods market and money market, but not from the performance of financial markets for borrowing and lending. Yet Depression-era economists believed that the behaviour of the financial system was largely responsible for the time of the Great Depression. According to Fisher ‘debt-deflation’ views, poorly performing financial markets result in excessive borrowings before the crisis. When output and price decrease during the crisis, borrowers’ real debt increases. The massive deterioration in borrower net worth induces them to cut consumption and investment, which sends the economy further down, continuing the spiral of falling output and deflation (Gentler 1988).

The theory of intermediation pioneered by Gurley and Shaw to Tobin stressed the significance of the financial system and the importance of financial intermediation in the credit supply process. According to their theory, the role of intermediaries to facilitate the flow of loanable funds between savers and borrowers plays an important factor governing the interest of the large shareholders may not coincide with the small shareholders. Beside, the small shareholders can continue to free-ride on the efforts of the large shareholders. Concerning manager’s reputation, investors in the stock markets are only concern with short-term gain, rather than long-term return. Therefore, manager will focus only on short-term gain even though it is not in the best of shareholders, and thus result in inefficiencies.
general economic activity. As intermediaries are involved, the importance of money diminishes, as money stock becomes a less exact measure of the flow of intermediary credit, and the liabilities of the non-bank intermediaries provide an alternative form for holding liquid balances. Money supply is less controllable as changes in money stock held by central banks may be offset by changes in close money substituted in a financially sophisticated economy. Rather than money stock, it is the economy’s overall ‘financial capacity’, i.e. the borrower’s ability to absorb debt without reducing current or future spending that constitutes an important determinant of aggregate demand. Intermediaries are therefore relevant as they extend borrowers’ financial capacity (Gentler 1988).

2.6.3.1 Monetary Channel

The macroeconomic literature following the Keynesian theory of liquidity preference and the time series work of Friedman and Schwartz (1963) shifts the emphasis to money, as opposed to credit, as the connection between financial markets and real activities. The result is that in both Keynesian and Monetarist framework, money is the only financial aggregate that determines output, and only through the channel of money supply can other aspects of financial systems affect the real economy.

The monetary view expounded by Friedman and Schwartz (1963) stresses the channel of money as the transmission mechanism. During the period of banking crisis, solvent banks have to increase their reserves in order to repay the withdrawals from depositors. The ratio of cash to deposits increases, which in turn decreases the credit multiplier and leads to a rapid fall of money supply. According to the traditional IS/LM framework, the LM curve will shift to the left, which leads to a higher interest rate and lower output. Therefore, bank failure will turn into a wider financial crisis when there is a rapid fall of money supply, which may results in deflation and output decrease (Friedman and Schwartz 1963; Tarazi 2001)

2.6.3.2 Credit Channel

The development of the Modigliani and Miller (MM) theorem (1958) has shifted economists away to study the role of financial structures in credit supply processes. Yet in the late 1970s and 1980s, a series of empirical work, which involves a reconsideration of the role of financial factors in the Great Depression and the significance of money for the
post-war time series relationship between money and output, has redirected interest toward studying the relevance of the rest of the financial system (Gentler 1988).

The idea that a banking crisis can affect the economy through the non-monetary financial market and the credit channel first appeared in the work of Mishkin (1978). Mishkin indicates that the severity of the Great Depression and the contraction of aggregate demand was due to the weakness of borrowers balance-sheet (Mishkin 1978). Following Mishkin's study, Bernanke (1983) analysed the relative importance of monetary channel verse the rest of the financial systems in the Great Depression, and concluded that the collapse of the financial system was an important determinant for the depths and persistence of the Great Depression, and monetary factors alone are quantitative insignificant to explain for these phenomena (Bernanke 1983).

Bernanke and Blinder (1988) provide a modified version of a traditional IS-LM framework into which they incorporate a bank lending channel, and thus showing the transmission mechanism through which balance sheet activities can affect the aggregate output without substantially affecting the interest rate. Increase in bank reserves will increase first, credit supply and hence investment demand, and second the quantity of money. The IS and LM curve will therefore shift to the right (Bernanke and Blinder 1988). In another paper, Bernanke and Gentler (1989) develop a simple neoclassical model of business cycle, to show that higher borrower net worth in the balance sheet will reduce the agency costs of financing, and therefore increase investment and aggregate demand (Bernanke and Gentler 1989).

2.6.3.3 Instability of financial sector, Bank Panics, Bank Contagion, Systematic Risk and Macroeconomic Consequences

The failure of a financial institution has a great knock-on effect and macroeconomic consequences. Friedman and Schwartz highlight bank failure as a major cause of the Great Depression (1929-1933) in the United States (Friedman and Schwartz 1963). Drawing on the historical studies of financial panics, there are two fundamentally different types of theories of banking panics articulated by economists in the early 80's to explain the phenomena of bank failure. The common element of all these theories is the hypothesized existence of an information asymmetry between banks and depositors, which creates the possibilities of information externalities that change the perceptions of the risk of bank deposits and thus lead to bank panics (Gorton 1988). The first type of
theory is concerned with the fragility for individual banks, while the second type is related to the aggregate shock and systematic risk of the whole economic system.

The first type of theory views panics as random manifestations of ‘mob psychology’ or ‘mass hysteria’ rooted in individual collected psyches\(^{67}\) (Gorton 1988). The classical banks run models developed in the early 1980s designed to articulate this view, and address the instability of a single bank with fractional reserve holdings\(^{68}\). Diamond and Dybvig (1983) show that Banks issue deposits to provide households with insurance against idiosyncratic shocks that affect their consumption needs, and use some fraction of these liquid liabilities to finance profitable but illiquid investments. There is an inherent undesirable equilibrium (bank run), where the fear of bankruptcy by a too large number of depositors will result in panic and withdrawal in excess of the current expected demand for liquidity under the exogenously imposed first-come-first-served rule for deposits withdrawal. This generates a negative externality for the bank experiencing the liquidity shortage, and increase in bank probability of failure even though it may be solvent during the run. Therefore, there exists a bank-run equilibrium where a solvent bank will collapse (Diamond and Dybvig 1983). But they also generate an externality for the whole banking system if the agents view the failure as a symptom of difficulties occurring throughout the industry\(^{69}\) (Freixas and Rochet 1997).

The second type of theory argues that panics are systematically related to the occurrence of economic events that change the depositors’ perceptions of risk due to information asymmetry between banks and depositors. These lines of argument can be subdivided into 3 different hypotheses (Gorton 1988). Seasonal Hypothesis cites extreme seasonal fluctuations as the cause of panics\(^{70}\) (Miron 1986). Failure Hypothesis points to

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67 According to Gorton (1988), the tradition from of the view was expounded by the historical studies of Noyes (1909), Gibbons (1968) and Kindleberger (2000) (Gibbons 1968; Gorton 1988; Kindleberger 2000; Noyes 1909). However, one has to depart from the assumption of rational behaviour in order to model this traditional view (Bernanke 1983).

68 Under the fractional reserve system, long-term and liquid loans and investment are financed by demand deposit.

69 One can distinguish between bank runs and bank panics. Bank runs affect individual banks, whereas bank panics concern the whole banking industry and as a consequence the payment system (Freixas and Rochet 1997).

70 According to Gorton (1988), the traditional view was first put forward by Jevons (1884) with reference to England, and subsequently by Andrew (1906) and Kemmerer (1910). Their historical studies point to a tendency for the panics to occur during the seasons (such as the ‘spring revival period’ from March to May, and the ‘crop-moving period’ from September to November) normally characterised by a stringent money
the unexpected failure of a large (financial) institution as the immediate cause of panics\textsuperscript{71} (Aharony and Swary 1983; Mayer 1975). Recession Hypothesis cites severe recession as the causes of panics, because depositors expected large number of banks to fail during recession\textsuperscript{72} (Gorton 1985).

As mentioned above, the failure of a financial institution has a great knock-on effect and macroeconomic consequences. Contagion is a term used to describe the spillover of the effects of shocks from one or more firms to others\textsuperscript{73}. The risk of widespread failure contagion is often referred to as systematic risk, for which it is non-diversifiable and is inherent in the financial system (Kaufman 1994). The contagion effect of bank failure, where bankruptcy of a single bank may cause the loss of public confidence in the banking system as a whole and is thus likely to set off runs on other banks, will disrupt the monetary system and the general economic stability (Aharony and Swary 1983). Banking crisis will therefore initiate deflationary consequences that can limit investment and economic growth through transmission mechanism of money and credit channel (Tarazi 2001).

Using the credit channel described above, one can examine the effect of the banking crisis on the economy. When facing massive withdrawals during the crisis period, credit supply decreases, and hence leads to a reduction of investment demand and market, high interest rates, depressed stock price and firms failure (Andrew 1906; Gorton 1988; Jevons 1884; Kemmerer 2006).

Miron (1986) presents a model to articulate the traditional view. In his model, panics can be thought of as periods when the costs of running the banking system are especially high, and it is likely to occur in seasons with high-loan demand or low-deposit demand, and the frequency of financial panics are correlated with the seasonal movement in nominal interest rate (Miron 1986)

\textsuperscript{71} One reason is that such failures result in a loss of confidence of the solvency of all banks, and thus lead to depositor withdrawal and panic (Gorton 1988). The failure of a single large financial institution may cause the loss of public confidence in the banking system as a whole and is thus likely to set off bank runs - the contagion effect. The Failure Hypothesis therefore justified the ‘too-big-to-fail’ doctrine, where governments will come into rescue when the large financial institution becomes insolvent to avoid the knock-on effect to the whole economy (Aharony and Swary 1983; Mayer 1975).

\textsuperscript{72} According to Gorton, the idea was bring forward by writers including Mitchell (1941) and Fels (1959), which see bank panics as ‘primarily endogenous’ parts of the business cycle (Fels 1959; Gorton 1988; Mitchell 1941). Gorton (1985) presents a model to show that when without full information, a panic can be rationally triggered when depositors decided to withdraw all their deposits from banks because of the fears expected a capital loss due to an unfavourable state of the bank investment (Gorton 1985).

\textsuperscript{73} Economist further distinguishes shocks originated in firms within industry, and shocks originated outside the industry.
quantity of money circulating in the economy. Output will decrease in this case. Besides, bank failures may disrupt the ongoing loan relations and lead to higher intermediation cost, which will result in decreases in investment and output. Seen from this light, financial development, through government regulation and policy (such as capital adequacy ratio and deposit insurance scheme) that aim to reduce the systematic risk and banking crisis in the financial system, will exhibit a positive impact on aggregate output.

2.6.4 Summary

With the advances in the literature on financial market inefficiencies and intermediation, and with the advances in business cycle analysis, a series of works synthesise the literature and focus on the role of financial factors in output fluctuations. Financial development in this context reduces the information cost and improves the efficiency in the economy, and hence exhibits a positive impact on aggregation output. Yet macroeconomics researched in 1970s and 1980s focuses on the understanding of the causes of short-term aggregate fluctuations. It is only until the development of endogenous growth literature in the mid-1980s that economist shift their focus to the long run relationship between financial development and economic growth.

2.7 Literature in the 1990s: Financial Development and Economic Growth in the Long-Run

With the development of the new (endogenous) growth theory, there is a resurgence of interest in the relationship between financial intermediation and economic growth. For centuries economists have been preoccupied with that growth of nations. Since the time of Adam Smith, the classical economists have provided the basic economic concept - such as capital accumulation, diminishing returns and return to scale – that form the basis of the subsequent development of modern economic growth theory starting in the early 1920s. The analytical nature of several traditions of the modern economic growth theory - the Keynesian Economic Growth theory, the Neoclassical Solow-Growth Model, the Ramsey-Cass-Koopmans Optimal Growth Framework, has allowed economists to have a deeper understanding of the underlying mechanism of the growth process. The main conclusion of the neoclassical growth theory is that in the long-run steady state, the economy grows at an exogenous population growth rate plus the rate of technological progress, with the cause of economic growth unexplained. Starting from 1980s there were
major innovations of growth theory – known as The New (Endogenous) Growth Theory - where economists tried to determine the long-run growth rate within the model rather than treating the origin of economic growth as exogenous. The emphasis on scale effect, knowledge accumulation together with the source of technological innovation, opened a new way to understand economic growth, and allow economist to formulate growth theories that are more applicable and better fit to the stylised facts in the modern world.

In traditional neoclassical growth theory, the financial sector is treated as the equilibrium of the supply of savings and the demand for investment. Capital is automatically allocated to the most efficient projects with marginal returns greater than the equilibrium interest rate. The financial system enters into the mechanism through its influences on the spread between deposit and loan rates. In this sense a more efficient financial system can lead to higher investment. However, higher investment through a more efficient financial system could only affect the short run economic growth and be related to the level of the per worker capital stock or to the level of productivity, but not to their perspective long-run growth rates, as growth in the model only depends on exogenous technical progress (i.e. exogenous total factor productivity growth) (Stiglitz 1998).

The new growth theory places emphasis on the scale effect, knowledge accumulation and innovations shows that long-run economic growth can be endogenous within the system, and open a new way to show that growth can be related to preferences, technology, income distribution and institution arrangement, without resorted to exogenous technical progress. Therefore, it provides the theoretical underpinning to study the relationship between the development of financial system and long run economic growth.

The central focus of the financial development in the endogenous growth literature is that finance generates an external effect on aggregate investment efficiency that counteracts the effect of the diminishing marginal product of capital accumulation.

2.7.1 Greenwood and Jovanovic (1990)

To a certain extent the work of Greenwood and Jovanovic (1990) represents the first major work in the literature to explore the long-run relationship between financial development and economic growth. Drawing from the Goldsmith-McKinnon-Shaw view on economic development and Kuznet’s (1955) hypothesis on the inverted-U shape
relationship between economic growth and income distribution\textsuperscript{74}, they formalise the bi-directional relationship between financial development and economic growth. Growth provides the investment resources to the development of financial structure, while financial structure in turn allows for higher growth through efficient use of financial resources and better information provision due to intermediation process. In the early stages of development, growth is slow as the financial structure is largely unorganised. As income levels rise, financial structure becomes more developed, and thereby fosters economic growth. In the meantime, income inequality across the rich and poor widens. In the advanced stage of development, an economy has a fully developed financial structure, attains a stable distribution of income across people, and has a higher growth rate than the state of the financial autarky in the early stage (Greenwood and Joyanovic 1990; Kuznet 1955).

\textbf{2.7.2 Growth promoting through Liquidity provision by Financial Intermediation - Bencivenga & Smith (1991)}

Based on the work of Romer (1986) in the growth literature and the overlapping generation liquidity-insurance framework proposed by of Diamond and Dybvig (1983) in the finance literature, Bencivenga & Smith (1991) construct a model to show that financial intermediation can provide liquidity in the market and thereby able to alter the composition of savings in a way that is favourable to capital accumulation. This will exert a positive external effect in production and real economic growth. While positive externality in Romer’s framework is due to stock of knowledge production, in Bencivenga & Smith framework it is due to the efficient allocations of savings that is resulted from liquidity insurance provided through financial inter-mediation\textsuperscript{75}. In sum, through liquidity provision, financial intermediation lead to efficient use of saving that will exert a beneficial result on long-run economic growth (Bencivenga and Smith 1991; Diamond and Dybvig 1983; Romer 1986).

\textsuperscript{74} Kuznet hypothesis states that that income inequality of a country will worsen during the early stage of development and improve at later stage.

\textsuperscript{75} As observed by Bryant(1980), financial intermediation can also prevent the premature of illiquid capital asset and prevent misallocation of invested capital due to liquidity needs(Bryant 1980).
2.7.3 Multiple Growth Path

Drawing from Galbis's (1977) idea on the economic dualism of financial repression policy, Saint-Paul (1992) analyses the effects of financial market on technological choice and the division of labour. In his model, there is a trade-off of between two available technologies\textsuperscript{76}. Agents can choose technologies that either give technological flexibility or high productivity. In the presence of negative demand shocks to consumer preferences with the absence of financial institutions, risk-averse individuals may prefer technology that provides technological flexibility instead of high productivity. In this context, the presence of financial markets allows individuals to diversify their portfolios to insure themselves against negative demand shocks, while at the same time to opt for a more productive technology. This fosters a greater division of labour, thereby leading to economic development. The mathematical results give rise to the possibilities of economic dualism and the existence of multiple equilibria. In the low equilibrium, financial markets are underdeveloped and people choose less productive but flexible technologies. Therefore, there is not much risk exposure, and the incentive to develop financial markets is limited. The economy is thus trapped in a state of underdevelopment. In the high equilibrium, the financial market is developed and technology is specialised, risky and productive. This creates a need for financial market and result in economic growth (Eschenbach 2004; Saint-Paul 1992).

Zilibotti (1994) further introduces the idea of 'thick' financial-market externalities to account for multiple equilibria. The basic idea is that the financial market determines the intermediation cost and the amount of capital stock that is potentially available for intermediation, which in turn affects capital productivity. An economy with a capital stock above a certain threshold will have a 'thick' financial market that lowers the intermediation margins and reduces the intermediation cost, as the fixed costs are spread over more agents. This encourages more intermediated capital stock, which improve capital productivity and stimulates growth. Conversely, the 'thin' financial market economy with have the opposite effect and prevents growth from taking off as the use of intermediated resources is limited by the size of financial market. Hence it give rise to multiple equilibria (Berthelemy and Varoudakis 1996b; Zilibotti 1994)

\textsuperscript{76} There are two technologies in the model. The first is flexible and allows product diversification, but has low productivity. The second is rigid, more specialised and productive
2.7.4 King and Levine (1993)

By considering the delegated monitoring theory of financial intermediation pioneered by Diamond (1984), King and Levine (1993) introduce the notion of imperfect credit market and agency cost in the finance literature into the Schumpeterian model originated by Aghion & Howitt (1992) and Grossman and Helpman (1991) in the endogenous growth literature to explore the relationship between growth and finance. They show that the more developed the financial systems, the higher the probability to generate innovation due to the lower intermediation cost as a result of scale economies, and the faster the rate of economic growth. It is because financial systems can affect entrepreneurial activities through evaluating entrepreneurs, pooling resources, diversifying risk and valuing the expected profits from innovative activities, thereby enhancing the probability of successful innovation that result in economic growth (Aghion and Howitt 1998; Eschenbach 2004; King and Levine 1993a).

2.7.5 Pagano (1993)

Pagano (1993) introduce costly financial development (i.e. the presence of financial intermediation cost) into the endogenous growth literature. He assumes that a proportion of the flow of saving is lost in the process of financial intermediation. By considering the simplest AK model in endogenous growth literature, the model shows that financial development can affect growth by funnelling saving to firms, by improving the efficiency of allocation of capital, by affecting saving rate, by diversifying risk, by encouraging household borrowing and by altering real interest rate (Fry 1995; Pagano 1993).

2.7.6 Monetary growth in the endogenous growth literature

The first that places money into the general equilibrium macro-framework is by Tobin (1965). However, his model does not incorporate optimising behaviour on the part of economic agents, and therefore cannot model the money demand and explain why people hold money and its significance at a macro level. Subsequently, Sidrauski (1967) and Clower (1967) pioneered the ‘money-in-utility-function’ (MIU) approach and Cash-in-Advance’ (CIA) model respectively, where they place money into the general equilibrium
framework that is consistent with the optimizing behaviour of economic agent. To take into account of the transaction role of money, Brook (1974) incorporated the Shopping-Time Model developed by Baumol (1952) and Tobin (1956) into the MIU framework. The development of monetary growth model during these periods thus allows economists to analyse the impact of money on the real economy. With the development of the endogenous growth literature in the 1990s, economists are able to introduce finance into the growth model through the channel of money balances to study the long run relationship between financial development and economic growth. (Baumol 1952; Brock 1974; Clower 1967; Sidrauski 1967; Tobin 1956; Tobin 1965; Walsh 1998). The development of monetary growth models allows economists to analyse the impact of money on the real economy. With the development of the endogenous growth literature in the 1990s, economists are able to introduce finance into the growth model through the

77 Sidrauski (1967) pioneers the ‘money-in-utility-function’ (MIU) approach that place money into the general equilibrium framework that is consistent with the optimizing behaviour of economic agent. The model assumes that money enters directly into the utility function of the representative agent, thereby guaranteeing positive money demand and yielding positive value for money. The model is able to establish relationship between inflation and capital stock, and displays the properties of both neutrality (which state that price will response to the change in the level of nominal money so that the real money level remains the same), and super-neutrality of money (which that in equilibrium, the steady-state value of capital-labour ratio, consumption and output are all independent of the growth of nominal money supply or inflation), that fit the steady-state equilibrium in the neoclassical growth model. Subsequent economists further extend the MIU framework to explore the quantitative effects of monetary growth (inflation) on the real economy (Sidrauski 1967; Walsh 1998).

Clower (1967) provides a more direct approach to capture money as the role of medium exchange. The model explicitly assumes money is needed for transaction in order to purchase consumption and investment goods, and individuals therefore face a ‘cash-in-advance’ constraint to finance their purchases. Inflation in this case therefore acts as a tax on purchase that requires cash, and thus exhibits significant impact to the real economy. The model exhibits super-neutrality of money that parallel to the results in the MIU framework (Clower 1967; Walsh 1998).

78 The MIU approach simply assumes that money yield is positive and does not take into account of the transactions role of money. The first formal models of money demand that emphasis on the role of transactions cost formulise the notion that money facilitates transactions is by Baumol (1952) and Tobin (1956). In the model, larger holding of money will allow the individual agents to reduce the shopping time – i.e. the time needed to devote for transaction, and thereby allowing more time for leisure. Brock (1974) incorporates this shopping-time model into the MIU framework. In his model, the inter-temporal utility maximisation for consumer involves choice between consumption, leisure, and shopping. Money therefore yields indirect utility by increasing the time available for leisure through reducing the shopping time. The level of real money balance thus has a significant impact to the real economy (Baumol 1952; Tobin 1956; Walsh 1998).
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channel of money balances to study the long run relationship between financial development and economic growth.

De Gregorio (1992) introduces finance into endogenous growth frameworks through the channel of monetary growth theory. Based on the shopping time model, by making the cost of delivering a unit of goods by firms a decreasing function of real money balances, shopping time is reduced by higher money balances. The inter-temporal utility maximisation depends on consumption, leisure, and shopping. In this way, changing financial conditions can affect both the demand and the supply of labour, and thereby affects productivity of capital through an externality effect. In this way, financial development that reduce the liquidity reserve holdings by the economy as a whole can produce an externality in production through reduction in shopping time, which in turn produces a higher equilibrium growth rate (De Gregorio 1992; Fry 1995).

2.7.7 Financial Repression and Economic Growth

With the development of the endogenous growth theory, there is a renewed interest to examine the issue of financial repression or government interventions in the presence of market failure in financial sector in the context of the new framework, to look at its impact on long term economic growth.

2.7.7.1 Inflation Tax

Roubini and Sala-i-Martin (1992) examine financial repression in the context of Romer’s (1986) model of endogenous growth with non-decreasing returns to capital. In their model governments might opt for policies of financial repression and accelerate inflation. This results in easy inflationary revenue, but reduces the amount of financial services in the whole economy and induces individuals to carry a larger stock of nominal money. The negative effect of financial repression on the productivity of capital and the quantity of savings will inhibit capital accumulation by reducing the marginal product of capital inputs, and therefore reduce growth (Eschenbach 2004; Fry 1995; Romer 1986; Roubini and Sala-i-Martin 1992).
2.7.7.2 Credit Rationing in the Endogenous Growth Literature

Bencivenga and Smith (1993) present another endogenous growth model related to market failure based on Romer (1986) framework. In this model credit rationing and real growth are jointly determined and are inversely related in equilibrium, supporting the conventional notion that credit rationing has permanent adverse effects on economic development. Various versions of government interventions designed to affect the credit allocation are examined, with substantial different implications for policy (Bencivenga and Smith 1993; Eschenbach 2004).

2.7.8 Stock Market Development

A significantly large number of studies have been written about the importance of stock markets for the development process, and incorporate the stock market development into the endogenous growth framework.

2.7.8.1 Levine (1991)

The finance literature associated with Townsend (1979), Diamond and Dybvig (1983) and Diamond (1984) construct models in which financial contracts emerge as optimal responses to an economy’s informational and risk characteristics. Levine builds on this premise to construct an endogenous growth model in which the stock market emerges to allocate risk and explores how stock markets alter investment incentives in ways that change steady stage growth rates. Based on the Lucas idea (1988) of endogenous growth through human capital accumulation, the model show that stock market permanently accelerated human capital accumulation by increasing firm efficiency and fraction of resources devoted to the firm through reducing liquidity risk and firm-specific productivity risk. The positive externality of human capital production will stimulate growth in the long run. The model also shows that impeding or taxing financial market

79 Firstly, stock markets insure investors against the firm-specific productivity risks by allowing the risk-averse investors to hold diversified portfolios, and thereby increasing the fraction of resources allocated to the firm. Secondly, stock markets reduce liquidity risk by eliminating the possibility of the premature withdrawal of capital from firm, and thereby encouraging firm investment and prevent unnecessary shocks to technological innovation (Eschenbach 2004).

2.7.8.2 Atje and Jovanovic (1993)

Atje and Jovanovic (1993) apply the approach of Greenwood and Jovanovic (1990) to the stock markets. Using AK structure with no diminishing returns to capital as a result of financial intermediation, the model shows that the stock market results in a higher return on investment because it insures investors against idiosyncratic risk and creates more information about investment projects. This stimulates capital accumulation and hence steady-state growth rate (Atje and Jovanovic 1993; Eschenbach 2004).

2.7.9 Functional Approach (Levine 1997)

With the development of the micro-approach towards financial development and the endogenous growth framework in the 1980s and 1990s, economists are better able to understand the link between financial development and economic growth, and there is a burgeoning of literature that examines their linkage. The review paper by Levine in 1997 provides an up-to-date review in these areas, and offers an alternative analytical framework to study the finance-growth nexus based on the functional approach.

The review paper provides ample theoretical reasoning and empirical evidence that the development of financial systems is vital link to economic growth process. The functional approach that the paper advocated challenges the conventional distinction between the 'real' and 'financial' sector. Thus it offers a new view of the finance-growth nexus: the financial system is a real sector, and the quality of its functions provided is a critical and an inextricable part of growth process. This new approach also highlights the importance of the relationship between financial structure and the functioning of the financial system (Levine 1997).

Financial market and institutions emerge to reduce the costs of acquiring information and making transactions. According to Merton and Bodie (1995), the primary function of the financial systems is to facilitate the allocation of resources, across space and time, in an uncertain environment. The review paper further breaks them into the following 5 functions:

1. Facilitating the trading, diversification, and management of risk;
2. Acquiring information about investments and allocating resources;
3. Monitoring managers and exerting corporate control;
4. Mobilizing and pooling savings;
5. Facilitating the exchange of goods and services

Financial development occurs when financial instruments, markets, and intermediaries ameliorate the effects of information, enforcement and transaction costs. Thus financial development involves improvement of the above functions performed by financial system (Levine 1997; Merton and Bodie 1995).

The growth literature shows that capital accumulation and technological progress are the two key elements in affecting steady-state economic growth. Seen from this light, financial systems can influence steady state economic growth by affecting capital accumulation and technological progress. By altering saving rates and by reallocating savings among different capital producing technology, financial systems can influence the rate of capital accumulation. It can affect technological progress by mobilising savings to finance the most promising productivity activities and diversifying risk. Figure 2-1 is the summary of how financial system affect economic growth (Levine 1997).

Figure 2-1: The Functional Approach of Financial Development to Economic Growth
2.7.10 Recent Development

2.7.10.1 Multiple Growth Path & Bi-direction Causal Relationship

The casual relationship between financial development and economic growth has long been a debate in the history of economic thoughts since the early 20th century as mentioned in the first few sections in this chapter. Though Patrick (1966) crystallised the idea of 'demand-following' and 'supply-leading' approach, the first model to formalise the bi-directional relationship of the finance-growth nexus only appears in early 1990s by Greenwood and Jovanovic (1990)\textsuperscript{80}. Subsequent economists further formalise theoretical model to understand this intertwining process.

2.7.10.1.1 Berthelemy and Varaoudakis (1996)

Berthelemy and Varaoudakis (1996) extend the Saint-Paul (1992) framework to consider multiple growth paths. They introduced reciprocal externalities between the real and financial sector into a Romer (1986) learning-by-doing endogenous growth framework. They assume a positive influence of the financial sector via the volume of savings by lowering the intermediation margin cost through increasing banking competition. The mechanisms work as follows: First the financial sector channel savings to more productive uses by collecting and analysing information about investment opportunities. In return, the expansion of the real sector causes an increased volume of savings and will induce more competition through internal economies of scale in the banking sector\textsuperscript{81}. It will exert a positive externality effect on the financial sector because of the improvement of labour productivity and bank efficiency due to increase in volume of saving, and thereby expanding the size of the financial market. This two-way causality gives rise to a cumulative process, which causes multiple equilibria due to the positive external effect of real-sector saving on bank productivity. Insufficient financial development might be a reason for the emergency of poverty trap (Berthelemy and Varoudakis 1996c; Berthelemy and Varoudakis 1996b).

\textsuperscript{80} See section 2.4.2 and 2.7.1.
\textsuperscript{81} The model assumes that financial intermediation margin is inversely related to the number of competing banks that increases with the size of financial market because of assume free entry to the market.
2.7.10.1.2 Greenwood and Smith (1997)

Based on the Bencivenga & Smith (1991) framework, Greenwood and Smith (1997) shows that there is a bi-directional relationship between financial development and economic growth. Financial development promotes growth through efficient allocation of resources to its highest value use in the economic system. Growth in turns facilitates greater transaction and leads to the formation of financial markets through lowering the fixed costs associated with the market establishment. This facilitates greater specialisation, and thereby further increases the subsequent equilibrium growth rate through learning-by-doing as in Romer (1987) model (Bencivenga and Smith 1991; Greenwood and Smith 1997; Romer 1987).

2.7.10.2 Legal View of Finance

In the past 10 years, a line of research pioneered by La Porta et al. has focused on the role of the legal system to identify the determinants and in explaining cross-country differences in financial development. The legal view of finance emphasizes the following two channels in which the legal system can influence financial development (Beck, Demirguc-Kunt, and Levine 2001a)

- Political Channels: This channel stresses that legal traditions differ in terms of the priority they attach to private property rights and the rights of investors in firms, and the protection of private property rights and outside investors from the basis of financial development, so that historically determined differences in legal tradition help explain international differences in financial development today (La Porta et al. 1997; La Porta et al. 1998; La Porta et al. 1999; La Porta et al. 2000).

- Legal Adaptability Channels: This channel stresses that legal traditions differ in terms of their abilities to adapt to changing commercial and financial conditions, and legal systems that adapt quickly to minimise gaps between the needs of the economy and the legal system's capabilities will more effectively promote contracting and financial development (Beck and Levine 2002; Johnson et al. 2000).

Hence there is a body of literature to show that the legal factor can impact financial development. However, many theoretical analyses in the current literature seldom
incorporate these legal factors into the model to study the effect of financial development on economic growth.

2.8 Summary and Reflections

Much of the post-1945 analysis of development has concentrated on real process and mainstream economic thought tend to relegate financial development into secondary importance prior to 1960s. Financial development was seen as the effect of economic development rather than the cause. With the advances of economic theory in each decade, economists start to re-examine the linkage between finance and growth, arguing that financial development was a neglected but integral and essential element in economic development. The historical studies by Gerschenkron (1962) and Cameron (1967), the first detailed empirical studies by Goldsmith (1969), the McKinnon-Shaw school of financial liberalisation thesis and the breakthrough of the theory of intermediation using micro-approach during the 1970s and 1980s, and the development of new growth theory in the early 1990s, has provided economist with formal theoretical foundation on finance-growth nexus. Seen from the light, financial development will exert a positive and significant influence on economic growth.

One question that readers can ponder on is the rediscovery of the narrative and historical approach in the study of finance-growth nexus. Many authors ascribe to political, social and cultural factors in financial development as well as economic growth. For example, the theory of financial liberalisation and the legal theory of finance are essentially related to rule-based policy. However, these qualitative factors are not easily quantified and their intensity is difficult to be measured and be used for statistical analysis. Therefore, the narrative, historical and country-study approach will still have a lasting role in the study of finance-growth nexus (the works by Charles Kindleberger (1993) on the financial history is a standard example)(Kindleberger 1993). Since the historical studies in 1960s, economists seem to have turned their attentions to discover a generalised theory that is analytic in nature, and some progress has been made. With the passage of time and the changing of economic environment in the past 40 years, perhaps the rediscovery the narrative, historical and country-study approach may able to allow economists uncover a new set of stylised facts in the 21st century.

On the other hand, though progress has been made on the theoretical study on finance and development, especially from the microeconomic perspective, when
compared with other fields, it seems that economists are unable to develop a simple generalised theory of finance that can serve as the foundation to explain macroeconomic behaviours in an elegant way. In the field of International Trade, the foundations are the Ricardian and Heckscher-Ohlin theory of trade. In the field of economic growth, the foundations are the Solow-Model and the Endogenous Growth Theory. Though the first-generation financial model of financial liberalisation may able to serve this purpose, its significance is still being questionable compared with those seminal works in other fields. Therefore, it is reasonably to conclude that the underlying mechanism of the development of financial systems and its influence on macroeconomic outcomes are still unable to reduce to a single-unified theory.

Another issue to reflect on is the definition of financial development and its scope. As the country financial systems become more sophisticated nowadays, a clearer definition and scope is needed for understanding the process of financial development and its impact to macroeconomic outcomes. Fry (1995) has defined financial systems as an entity that performs two basic functions, namely (1), administering the country’s payments system; and (b) intermediating between savers and investors (Fry 1995). Implicitly it implies that financial development can be defined as the improvement of the country financial systems in performing these two functions Levine (1997) define financial development as the situation when financial instrument, markets, and intermediaries ameliorate the effects of information, enforcement and transaction costs. Yet questions may still be asked about its scope. Should the country payment system be included in the scope of the study of financial development? Can capital account liberalisation be treated as the same as financial development, given its lacks of empirical support in influencing growth (Eichengreen 2001)? Does regulations foster or hinder the development of financial structure?

A related question is about the relationship between financial liberalisation and financial development. It seems to the present author that financial liberalisation is a cause of financial development rather than is financial development itself. The former describes policy, while the latter describes a process. Besides, whereas financial development is domestic in nature, financial liberalisation can contain both domestic (e.g. removal of interest rate ceiling) and international (capital account liberalisation) aspects. Therefore one need to distinguish between these two terms when studying the finance-growth nexus. The present study aims to look at the casual relationship between domestic
A Brief History of the Theoretical Linkage of Financial Development and Economic Growth

financial development and economic growth, while financial liberalisation is outside our scope.

In sum, this chapter has provided readers with the brief history of the theoretical linkage of financial development and economic in the past decades, in order to provide a deeper understanding of the dynamics of finance-growth nexus.
3 Theoretical Model

3.1 Introduction

This chapter develops a theoretical model that studies the simultaneous relationship between financial development and economic growth. The reason that motivates the current chapter is that much empirical analysis in the literature that study the causal relationship between financial development and economic growth are lacking formal theoretical foundation. Hence this chapter aims at delivering a formal theoretical mechanism that describes the dynamics between financial development and economic growth which is able to derive some refutable hypotheses for later empirical analysis. The model is based on two papers that have provided a valuable insight to the study of this field.

This study contributes to the century of debate revolving around the issue of whether the financial sector is ‘supply-leading’ or ‘demand-following’ with reference to the real sector (Patrick 1966). Though there is a perceived idea that there is a mutual interaction of supply-leading and demand-following elements in banking and finance in the long run, the bi-directional linkage between financial development and economic growth has remained a generalised idea without a firm formal theoretical foundation. While there are several paper that formalise the one-way relationship from finance to growth, models that formalise the bi-directional relationship remain scant. This study has therefore filled this gap by formalising the bi-directional relationship governing financial development and economic growth.

The new element in this study comes from the modification of several functional forms and parameters, new specification of relationship as well as synthesis of two existing framework. Though Patrick (1966) crystallised the idea of ‘demand-following’ and ‘supply-leading’ approach, the first model to formalise the bi-direction relationship of finance-growth nexus only appears in early 1990s. Two important studies in this area is from Berthelemy and Varaoudakis (1996) and Greenwood and Smith (1997). The present study synthesises the framework of Greenwood and Smith (1997) with the following breakthroughs:

- First, the present model is able to provide micro-foundations to justify the existence of the financial sector and to explain its behaviour by specifying the
bank’s production function. Greenwood and Smith (1997) justify the existence of the financial intermediary as a mean to provide liquidity insurance. This study improves the Greenwood and Smith framework (1997) by introducing the wage cost and the financial technology to model the behaviour of the banks, as well as to examine the efficiency links of channelling savings into productive investment. Besides, there is a body of literature to show that legal factors can impact financial development. However, many theoretical analyses in the current literature seldom incorporate these legal factors into their analytical model to study the effect of financial development on economic growth. Hence, the specification of bank’s production function is able to allow these ideas to be incorporated into the model.

- Second, the present study applies the overlapping generation liquidity-insurance framework into Berthelemy and Varaoudakis (1996) model in order to formalise the bi-directional relationship of the finance-growth nexus. Berthelemy and Varaoudakis (1996) model is essentially an endogeneous growth model with an infinite horizon. Hence the application of an overlapping generation framework into their model can shed new light by tackling the issue of heterogeneous and finite horizon household, and by allowing the synthesis of two strand of literature, i.e. liquidity-insurance framework into the endogenous growth model with micro-economic foundations.

Table 3-1 summarises the distinction of the model in this chapter from the original Greenwood and Smith (1997) and Berthelemy and Varoudakis (1996) model. The new model derived in this chapter is able to provide the theoretical underpinning of the empirical analysis in later chapters. Readers can refer to the literature review in the previous chapter to explore the historical development of the theoretical linkage between financial development and economic growth.
Table 3-1: Comparison between the model in this study, Greenwood and Smith (1997) model and Berthelemy and Varoudakis (1996) model.

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time horizon</strong></td>
<td>Two-period overlapping generations</td>
<td>Infinite horizon</td>
<td>Two-period overlapping generations</td>
</tr>
<tr>
<td>Bank's production function</td>
<td>No.</td>
<td>No.</td>
<td>Yes</td>
</tr>
<tr>
<td>Labour Market Dynamics</td>
<td>No.</td>
<td>Yes.</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of sectors</td>
<td>three</td>
<td>Two.</td>
<td>three</td>
</tr>
<tr>
<td>Introduction of bank’s wage cost</td>
<td>No.</td>
<td>Yes.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Theoretical Basis</strong></td>
<td>Liquidity Insurance</td>
<td>No.</td>
<td>Yes</td>
</tr>
<tr>
<td>Bi-directional finance-growth relation</td>
<td>Yes.</td>
<td>Yes.</td>
<td>Yes</td>
</tr>
<tr>
<td>Efficiency of Financial Intermediation</td>
<td>No.</td>
<td>Yes.</td>
<td>Yes</td>
</tr>
<tr>
<td>The legal view in finance</td>
<td>No.</td>
<td>No.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
The chapter is organised as follows. Section 3.2 reviews those theoretical frameworks that are relevant to the model in this chapter. Section 3.3 studies the growth enhancing effect of financial development through the channel of liquidity provision. This section is mainly built on the Greenwood and Smith (1997) framework. The difference from the model here from the original one stems from the modification of the function from of final good production technology and young agent’s utility function, and the introduction of the wage cost in the financial sector the analysis. Besides, the section will introduce the financial technology that measures the efficiency of a bank’s channel from saving into productive investment. To take into account the legal factors as the determinant of financial development, the financial technology will be modelled as an increasing function of the legal factors in the analysis. The main conclusion from this section is that the provision of liquidity in the banking system, by preventing premature liquidation of capital and improvement of risk sharing through inter-mediation, results in a larger fraction of risky assets (i.e. capital investment in this model) to be held in the portfolio, and thereby improving capital accumulation in the economy. This justifies the development of a financial sector in the economy.

Section 3.4 analyses the interaction of the real and financial sector to study the two-way bi-directional relationship between financial development and economic growth. This section is mainly built into Berthelemy and Varaoudakis (1996) framework. The modifications of the environment in the two-period overlapping generation model in section 3.3 will carry into section 3.4, to allow the synthesis of Greenwood and Smith (1997) framework into Berthelemy and Varaoudakis (1996) analysis. The main conclusion of this section is that financial development can exert a positive effect on long-run economic growth through the interest-rate channel by lowering the financial intermediation margin and by increasing the efficiency of financial intermediation. Economic growth in the real sector will generate more savings and thereby a positive external effect on banking productivity and raise the wage rate for the bank. This will lead to a further expansion in the financial sector (i.e. financial development). The interaction will continue until the marginal productivity of labour become equal across the real sector and the financial sector. Section 3.5 concludes.
3.2 Background

The theoretical framework in the current chapter mainly focus on the following four areas, namely 1, liquidity insurance; 2, bi-directional relationship between financial development and economic growth; 3, efficiency of financial intermediation, and 4, the legal view in finance, with an aim to synthesise these four aspects into a single model.

3.2.1 Liquidity Insurance

The development of the theory of risk sharing and insurance in the earlier decades allowed economists to apply these frameworks in the context of financial systems, which in turn shed light on the transmission mechanism through which financial development can affect real economic outcomes. Together with the idea of scale economies in reserve holdings of the fractional reserve system, they imply that banks are pooling independent risks of deposit withdrawals and providing liquidity insurance to depositors against idiosyncratic shocks that affect their consumption need. Bryant (1980) model the notion of liquidity insurance, showing that the market allocation can be improved by a deposit contract offered by a financial intermediary in an economy where agents are individually subject to independent liquidity shocks (Bryant 1980; Freixas and Rochet 1997). In this sense, financial development can achieve Pareto improvement for market allocation. Based on Bryant’s (1980) model, Diamond and Dybvig (1983) pioneered the overlapping generation liquidity-insurance framework to study the bank run behaviour (Diamond and Dybvig 1983). The methodology they employed provides a microfoundation to study the behaviour in financial market.

Based on the work of Romer (1986) in the growth literature and the overlapping generation liquidity-insurance framework proposed by Diamond and Dybvig (1983) in the finance literature, Bencivenga & Smith (1991) construct a model to show that financial intermediation can provide liquidity in the market and is thereby able to alter the composition of savings in a way that is favourable to capital accumulation. This will exert a positive external effect in production and real economic growth. While positive externality in Romer’s framework is due to stock of knowledge production, in

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82 For the development of the theory of risk sharing and insurance, readers can refer to the literature review section in the previous chapters in this thesis.
Bencivenga & Smith framework it is due to the efficient allocations of savings that is resulted from liquidity insurance provided through financial inter-mediation. In sum, through liquidity provision, financial intermediation leads to the efficient use of saving that will exert a beneficial result on long-run economic growth (Bencivenga and Smith 1991; Diamond and Dybvig 1983; Romer 1986).

3.2.2 Bi-direction Relationship between Financial Development and Economic Growth

The casual relationship between financial development and economic growth has long been a debate in the history of economic thoughts since the early 20th century. Though Patrick (1966) crystallised the idea of ‘demand-following’ and ‘supply-leading’ approach, the first model formalise the bi-direction relationship of finance-growth nexus only appears in early 1990s by Greenwood and Jovanovic (1990). Drawing from the Goldsmith-McKinnon-Shaw view on economic development and the Kuznet’s (1955) hypothesis on the inverted-U shape relationship between economic growth and income distribution, they formalise the bi-directional relationship between financial development and economic growth. Growth provides the investment resources to the development of financial structure, while financial structure in turn allows for higher growth through efficient use of financial resources and better information provision due to intermediation process. In the early stages of development, growth is slow as the financial structure is largely unorganised. As income levels rise, financial structure becomes more developed, thereby fostering economic growth. In the meantime, income inequality across the rich and poor widens. In the advanced stage of development, an economy has a fully developed financial structure, attains a stable distribution of income across people, and has a higher growth rate than the state of the financial autarky in the early stage (Greenwood and Jovanovic 1990; Kuznet 1955; Patrick 1966).

Subsequent economists further develop theoretical models to understand this intertwining process. Berthelemy and Varaoudakis (1996) extended the Saint-Paul (1992) framework to consider multiple growth paths. They introduced reciprocal externalities.

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83 As observed by Bryant (1980), financial intermediation can also prevent the premature liquidation of illiquid capital asset and prevent misallocation of invested capital due to liquidity needs (Bryant 1980).

84 Kuznet hypothesis states that that income inequality of a country will worsen during the early stage of development and improve at later stage.
between the real and financial sector into a Romer (1986) learning-by-doing endogenous growth framework. They assume a positive influence of the financial sector via the volume of savings by lowering the intermediation margin cost through increasing banking competition. The mechanisms work as follows: First the financial sector channel savings to more productive uses by collecting and analysing information about investment opportunities. In return, the expansion of the real sector causes an increased volume of savings and will induce more competition through internal economies of scale in the banking sector. It will exert a positive externality effect on the financial sector because of the improvement of labour productivity and bank efficiency due to increases in the volume of saving, thereby expanding the size of the financial market. This two-way causality gives rise to a cumulative process, which causes multiple equilibria due to the positive external effect of real-sector savings on bank productivity. Insufficient financial development might be a reason for the emergence of a poverty trap (Berthelemy and Varoudakis 1996b; Berthelemy and Varoudakis 1996c; Saint-Paul 1992).

Based on the Bencivenga & Smith (1991) framework, Greenwood and Smith (1997) show that the relationship between financial development and economic growth is bi-directional. Financial development promotes growth through efficient allocation of resources to its highest valued use in the economic system. Growth in turn facilitates greater transaction and leads to formation of financial market through lowering the fixed costs associated with the market establishment. This facilitate greater specialisation, and thereby further increasing the subsequent equilibrium growth rate through learning-by-doing as in Romer (1987) model (Bencivenga and Smith 1991; Greenwood and Smith 1997; Romer 1987).

### 3.2.3 Efficiency of Financial Intermediation

The main function of the financial intermediaries is to channel savings into productive investment. However, the presence of financial intermediation cost will lead to a loss of the saving in the process of financial intermediation. The work of Pagano (1993) has taken into this phenomenon by introducing costly financial development (i.e. the presence of financial intermediation costs into the endogenous growth literature, and his model

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85 The model assumes that financial intermediation margin is inversely related to the number of competing banks that increases with the size of financial market because of the assumption of free entry to the market.
shows that financial development can affect growth by funnelling saving to firms and by improving the efficiency of financial intermediation. (Fry 1995; Pagano 1993).

3.2.4 Legal View of Finance

In the past 10 years, a line of research pioneer by La Porta et al (1997, 1998) has focused on the role of the legal system to identify the determinants and in explaining cross-country differences in financial development. The legal view of finance emphasises the following two channels in which the legal system can influence financial development (Beck, Demirguc-Kunt, and Levine 2001a)

- **Political Channels:** This channel stresses that legal traditions differ in terms of the priority they attach to private property rights and the rights of investors in firms, and the protection of private property rights and outside investors from the basis of financial development, so that historically determined differences in legal traditions help explain international differences in financial development today (La Porta et al. 1997; La Porta et al. 1998; La Porta et al. 1999; La Porta et al. 2000).

- **Legal Adaptability Channels:** This channel stresses that legal traditions differ in terms of their abilities to adapt to changing commercial and financial conditions, and legal systems that adapt quickly to minimise gaps between the needs of the economy and the legal system’s capabilities will more effectively promote contracting and financial development (Beck and Levine 2002; Johnson et al. 2000).

Hence there is a body of literature to show that the legal factor can impact financial development. However, many theoretical analyses in the current literature seldom incorporate these legal factors into the model to study the effect of financial development on economic growth.

3.2.5 Summary

This study aims to formalise a bi-directional relationship of financial development and economic growth, taking into account of other development in the theory of finance, namely liquidity insurance theory, theory of financial intermediation and the legal view of finance. Next sections describe the model developed in this chapter.
3.3 Growth Enhancing Effect of Financial Development though Liquidity Provision

The framework in this section is built on the Greenwood and Smith (1997) model. According to their model, the provision of liquidity by financial markets allows more fractions of saving to channel into productive capital investment and thereby promoting economic growth. New elements in the model in this chapter, as distinct from the original Greenwood and Smith (1997) model, are the introduction of the labour market, the modification of the final good production function, the introduction of banking sector wage costs, the specification of bank production function and the use of the constant inter-temporal elasticity of substitution (CIES) of the agent's utility function. The analysis will combine these changes into Greenwood and Smith (1997) 2-period overlapping generation framework (Greenwood and Smith 1997).

3.3.1 Environment

Assumptions of the model, based on the Greenwood and Smith (1997) environment, are as follows:

- The economy consists of an infinite sequence of two-period lived overlapping generations;
- Agents born at each date are indexed by \( i \in [0,1] \), and time is denoted by \( t=[0,1...] \);
- Consumption good \( c \), is produced using intermediate input according to constant returns to scale;
- Capital depreciates completely in production;
- Young agents have identical ex ante preferences;
- Agents are risk-averse;
- Agents are assumed to make a savings decision before observing their realisation of individual specific preference shock, \( \varphi \), which is identical and independently distributed (iid) across agents;
- Two assets are assumed to be held, capital and the consumption good;
- Each agent also has access to a technology of storing consumption goods. One unit of consumption stored at \( t \) returns \( n \) units either late in period \( t \) (if investment is interrupted at that date) or at \( t+1 \);
• Agent $i$ is endowed with one unit of labour $L_i(i)$ which is supplied inelastically, non-tradable (i.e. utilise their own labour), and generate no disutility. They act as entrepreneur in the intermediate sector in this model. Only young agents are endowed with labour.

To differentiate from the original Greenwood and Smith (1997) model, the labour market is added in this model. It is assumed that apart agents, there is additional labour force in this economy where labourers can choose to work in the final good sector or the banking sector. $l_y$ represent the proportion of workforce in the economy employed in the final good sector, whereas $l_b$ is the proportion of workforce employed in financial sector with the following schedule:

- $l_b = 0$ in the case of financial autarky
- $l_b = 1 - l_y$ in the case of the presence of banking.

Following Greenwood and Smith (1997) framework, the technology for producing intermediate goods, $x_t(i)$, is given by the following AK form.

$$x_t(i) = A_k(i)$$

A new element is added with regard to the final good sector in this model. The original Greenwood and Smith (1997) framework use immediate goods only as the single factor input for the final good production, whereas in this model labour, together with immediate goods, are used as factors input to produce final goods.

The final good is used for current consumption and investment. Time $t$ final consumption, $c_t$, and time $t+1$ capital stock $k_{t+1}$, are produced using intermediate goods according to the technology which allow one unit of current consumption to be converted into $R$ units of future capital, with $\theta<1$ by assumption. R can also be thought of as the relative price of future capital in terms of current consumption. The constant-return to scale production function for final good is given by the Dixit-Stiglitz (1977) form, where there is a continuum of intermediate goods, measured on the interval $[0,1]$. Final output is produced using labour and the immediate good according to the following function which

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86 To avoid confusion of notation, small letter ‘k’ denotes capital stock, and capital letter ‘K’ denotes capital stock value at current consumption.
exhibit constant-return to scale, where $B$ represents the total factor productivity, and $E$ represents efficiency level of labour in the final good sector.

\[
y_t = B \left( E l_y \right)^{-\alpha} \left\{ \int_0^1 x_i(j)^{\phi} di \right\}^{1-\phi} \\
= c_t + \frac{k_{t+1}}{R}
\]

Greenwood and Smith (1997) assume that agent preferences are determined by their level of consumption and the individual specific preference shock. The model here, while following their assumptions with regard to determinants of preference, uses a constant inter-temporal elasticity of substitution (CIES) utility functional form to model agent’s preference.

Let $c_h$ denote age $h$ consumption by a representative individual ($h = 1, 2...$). Agent preferences are given by the following constant inter-temporal elasticity of substitution (CIES) utility function

\[
u(c_t, c_{t+1}; \phi) = \left[ \left( 1 - \phi \right) c_t + \phi c_{t+1} \right]^{1-\phi} - 1 \\
1 - \sigma
\]

where $\sigma < 1$.

\[\text{For the CIES function, } \sigma > 0 \text{ by assumption, so that the elasticity of marginal utility is equal to } -\sigma. \text{ The elasticity of intertemporal substitution between consumption at between } t_1 \text{ and } t_2 \text{ is given by } \frac{1}{\sigma}. \text{ The higher the } \sigma, \text{ the more rapid is the proportional decline in the marginal utility in response to increase in consumption, and the less willing agents are to accept deviations from a uniform pattern of consumption overtime. Hence } \sigma \text{ is also a measure of the risk-averseness of the economic agents in this model. As } \sigma \to 0, \text{ agent become risk neutral.}
\]

\[\text{The inclusion of } -1 \text{ in the formula is convenient in the literature because it implies that } u(c_t, c_{t+1}; \phi) \text{ approaches } \log u(c_t, c_{t+1}; \phi) \text{ as } \sigma \to 1 (\text{Barro and Sala-i-Martin 2004}).\]
Theoretical Model

The probability of $\phi$ is given by

$$\phi = \begin{cases} 0: \text{with probability } 1 - \pi \\ 1: \text{with probability } \pi \end{cases} \Rightarrow u = \begin{pmatrix} \frac{c_{1r}^{1-\sigma} - 1}{1 - \sigma} \\ \frac{c_{2r+1}^{1-\sigma} - 1}{1 - \sigma} \end{pmatrix}$$

(3-4)

Therefore, agent utility function can be rewrite as follows

$$u(c_{1r}, c_{2r+1}; \pi) = \frac{(1 - \pi)(c_{1r}^{1-\sigma} - 1) + \pi(c_{2r+1}^{1-\sigma} - 1)}{1 - \sigma}$$

(3-5)

3.3.2 Real Good Sectors

Assumptions in the real good sectors are based on the Greenwood and Smith (1997), which are as follows:

- $p_r(i)$ is the price of intermediate goods charged for production of final goods;
- The agent is being modelled as being imperfect competitive. He does not take $p_r(i)$ as given;
- Young agents of intermediate goods obtain capital inputs in a competitive rental market;
- Young agents and goods producers are symmetric in equilibrium (i.e. $x_t(i) = x_h, k_r(i) = k_o$)

3.3.2.1 Final Goods Producer

A new element in this model is that the final goods producer, apart from choosing a schedule of intermediate input, $x_t(i)$, has to take into account the wage cost in order to maximise its profit function $\Gamma$. $\Gamma$ is given by equation (3-6):

$$\Gamma = y_t - \int p_r(i)x_r(i)di - w_l y_t$$

$$= B(E_l)^{1-\alpha}\left\{ \int_0^{\frac{1}{\theta}} \left[ x_r(i) \right] \text{d}i \right\}^\alpha - \int p_r(i)x_r(i)di - w_l y_t$$

(3-6)

80
The first term of the equation, $y_t$, represents the final goods produced for consumption at time $t$ and future capital. The second term represents the cost of using intermediate good available in the market for the production of final goods. The last term is the wage cost, $w_l$, of the production of final goods, where $w$ is the wage rate that is equal to marginal labour productivity in final goods sector.

Following the work of Berthelemy and Varoudakis (1996), it is assumed that the efficiency of labour depends on the capital-labour ratio in the final good sector through an externality effect\footnote{The idea can traced back to the AK model of Rebelo (1991) (Rebelo 1991).}. The idea is that more capital-intensive the economy is, the higher the labour productivity. The functional form of labour efficiency is given as follows.

\begin{equation}
E = \frac{\int_0^1 x_t(i)^{\theta} di}{l_y}
\end{equation}
The first-order condition problem represents the inverse demand function for $x_t(i)$ by the final good producers, and the marginal productivity of labour in the final good sector$^{89}$.

\begin{equation}
 p_t(i) = y_t \left[ \int_0^1 x_t(i)^{\theta} \, di \right]^{-1} x_t(i)^{\theta - 1}
\end{equation}

\begin{equation}
 w = (1 - \alpha) B \left[ \int_0^1 x_t(i)^{\theta} \, di \right]
\end{equation}

### 3.3.2.2 Young Agents (Intermediate Goods Entrepreneur)

Assume that young producers of intermediate goods obtain capital inputs in a competitive market, paying the rental rate $\rho_t$ at time $t$. Their income function is as follows:

\begin{equation}
 \Pi = p_t(i)x_t(i) - \rho_t(i)k_t(i)
\end{equation}

$^{89}$The proof of (3-8) is as follows:

\[
\begin{align*}
\frac{d\Gamma}{dx_t(i)} = 0 & \Rightarrow B \cdot (El_y)^{-\alpha} \frac{\alpha}{\theta} \left[ \int_0^1 x_t(i)^{\theta} \, di \right]^{\frac{\alpha - \theta}{\theta}} \cdot \partial x_t(i)^{\theta - 1} - p_t(i) = 0 \\
& \Rightarrow \alpha \cdot B \cdot (El_y)^{-\alpha} \left[ \int_0^1 x_t(i)^{\theta} \, di \right]^{\frac{1}{\theta}} x_t(i)^{\theta - 1} - p_t(i) = 0 \Rightarrow y_t \left[ \int_0^1 x_t(i)^{\theta} \, di \right]^{-1} x_t(i)^{\theta - 1} = p_t(i)
\end{align*}
\]

The proof of (3-9) is as follows:

\[
\begin{align*}
\frac{d\Gamma}{dl_y} = 0 & \Rightarrow (1 - \alpha) \cdot B \cdot E(El_y)^{-\alpha} \left[ \int_0^1 x_t(i)^{\theta} \, di \right]^{\frac{1}{\theta}} - w = 0 \\
& \Rightarrow (1 - \alpha) \cdot B \cdot E \left[ \int_0^1 x_t(i)^{\theta} \, di \right]^{\frac{1}{\theta}} = w \\
& \Rightarrow w = (1 - \alpha) \cdot B \cdot E \left[ \int_0^1 x_t(i)^{\theta} \, di \right]^{\frac{1}{\theta}} / l_y
\end{align*}
\]
Young agents $i$ will choose values for $x_t(i)$ and $K_t(i)$ to maximise their income function, $\Pi$, subject to the following constraints:

- (3-1) - the technology of producing intermediate good\(^90\);
- (3-8) - the inverse demand function of the intermediate good by the final goods producer\(^91\);

The first order condition of this maximisation problem represents the inverse demand function of capital input by young agents.

\[(3-11)\]^92

\[\rho_t(i) = y_t \left[ \int_0^1 x_t(i)^\theta \, di \right]^{-1} \theta A^\theta k_t(i)^{\theta-1}\]

### 3.3.2.3 Equilibrium

In equilibrium, young agents are symmetric with one another (i.e. $x_t(i) = x_t$, $K_t(i) = K_t$). This implies

\[(3-12)\]

\[y_t = B x_t^\alpha (E)_{y}^{1-\alpha} \]

\[= B A^\alpha k_t^\alpha (E)_{y}^{1-\alpha}\]

---

\(^90\) $x_t(i) = A k_t(i)$

\(^91\) $y_t \left[ \int_0^1 x_t(i)^\theta \, di \right]^{-1} x_t(i)^{\theta-1} = p_t(i)$

\(^92\) The proof is (3-11) as follows:

\[\Pi = p_t(i)x_t(i) - \rho_t(i)k_t(i) = y_t \left[ \int_0^1 x_t(i)^\theta \, di \right]^{-1} x_t(i)^\theta - \rho_t(i)k_t(i)\]

\[= y_t \left[ \int_0^1 x_t(i)^\theta \, di \right]^{-1} A^\theta k_t(i)^\theta - \rho_t(i)k_t(i)\]

\[\frac{d\Pi}{dk_t(i)} = 0 \Rightarrow \rho_t(i) = y_t \left[ \int_0^1 x_t(i)^\theta \, di \right]^{-1} \theta A^\theta k_t(i)^{\theta-1}\]
Substitute (3-12) into (3-11), the inverse demand function of capital by young agent in equilibrium becomes

\[ \rho_t = \theta BA^a \left( \frac{E_i}{k_t} \right)^{1-\alpha} \]  

(3-13)\(^{93}\)

Hence the inverse demand function of inverse demand function of capital by young agents in equilibrium becomes as follows by substituting (3-7) into (3-13)

\[ \rho_t = \theta BA \]  

(3-14)

Let \( S_t \) denote the maximised income of young agents measured in current consumption in symmetric equilibrium\(^ {94} \). Substituting (3-8) (3-12), (3-7), (3-14), (3-10) will give the following.

\[ S_t = (1-\theta)ABk_t \]  

(3-15)\(^ {95}\)

The results show a linear relationship between capital input and young agent’s income in equilibrium. Hence factors that facilitate more capital input will raise the income of the intermediate good producers. An implication of this result is that, if financial intermediation allows more fractions of savings to channel into productive investment, it will be beneficial to young agents by raising their income in equilibrium.

\(^{93}\) \( \int x_i(i) \varepsilon d\varepsilon \) if \( A^a k_t^{1-\alpha} = y_t x_t^{-\alpha} A^a k_t^{1-\alpha} = y_t A^{-\alpha} k_t^{-\alpha} A^a k_t^{1-\alpha} \)

\(^{94}\) In a later section it is assumed that agent will deposit all the income into the bank when the banking sector exists.

\(^{95}\) Proof

\[ S_t = p_x x_t - \rho_t k_t = y_t x_t^{-\alpha} A^a k_t^{1-\alpha} - \theta BA k_t = BA^a k_t^\alpha \left( \frac{E_i}{k_t} \right)^{1-\alpha} - \theta BA k_t \]

\[ = BA k_t - \theta BA k_t = (1-\theta)BA k_t \]

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3.3.3 Savings Behaviour

Saving behaviours are based on the Greenwood and Smith (1997) framework. Two financial market structures will be considered in this section; the case of financial autarky with the absence of financial structure, and the case of banking, where banks perform the role of inter-mediation to channel savings into capital investment.

With the same timing structure activity in each market structure, young agents will undertake productive activity at time \( t \), earning an income of \( w_t \). Next, they will undertake saving-portfolio decisions of how to allocate income among the various assets available to them (hold goods in storage, or invest in capital). The decision must be made before their preference shock, \( \varphi \), is realised. The following summarises their decision.

- With \( \varphi = 1 \), young agent will hold their portfolio and will liquidate their assets and consume only at the old age;
- With \( \varphi = 0 \), young agent will consume and liquidate their asset at young age, and old age consumption has no value for them;

Assume that inter-temporal transfers are not possible, that consumption has to occur before the next generation appears. This means that young consumption can only be finance through their good storage. The timing structure is illustrated in the following figures:

Figure 3-1: Timing Structure (Greenwood and Smith 1997)

Section 1.1.1.1 shows the saving behaviours in the case when bank is absent from the economy, whereas section 3.3.3.2 describes the case for the presence of banking.
3.3.3.1 Absence of Financial Intermediaries (financial autarky)

3.3.3.1.1 Environment

Following the Greenwood and Smith (1997) framework, young agents store goods and invest in productive capital in the absence of any financial intermediaries in the case of financial autarky. Assume the following

- $s_t^a$ denotes the good storage by the financial autarky agent at time $t$;
- $K_t^a$ denotes the capital investment by a financial autarky agent valued in current consumption;
- $n$ denotes the return on good storage, which is independent of when consumption occurs. 1 unit of good stored will yield $n$ units of current consumption when liquidated.

With $\varphi = 0$, young agents will consume and liquidate their asset at young age. It is assumed that capital cannot be rented out because the factor markets have closed according to the time structure in Figure 3-1. As old age consumption has no value for them, and as capital cannot be rented out, it is assumed that they will lose all of their capital investment. The young consumption therefore will be financed by storage only.

With $\varphi = 1$, young agents will hold their portfolio and will liquidate their assets and consume only at the old age. $K_t^a$ and $K_{t+1}^a$ are the current investment and future capital accumulation measured in current consumption. It is assumed that $K_t^a$ units of current investment in turn will receive $K_{t+1}^a$. Recall in (3-2), 1 unit of current consumption invested will convert into $R$ units of capital received at time $t+1$. According to the timing structure, the capital received at time $t+1$ can be rented for $\rho_{t+1}$ per unit in the next period. Together with equilibrium condition in (3-13), the return on capital investment between time $t$ and $t+1$ can be found as follows:

\[ R\rho_{t+1} = RA\theta B \]  

(3-16)

The resources constraint facing the financial autarky agents are as follows

\[ s_t^a + K_t^a \leq S_t \]

(3-17)
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The constraint in (3-17) states that autarky young agent income is used for storing goods and accumulating capital. (3-18) states that young consumption is financed by storage, whereas (3-19) states that old-age consumption is financed by storage and capital returns.

3.3.3.1.2 Optimisation Problem of the Young Financial Autarky Agent’s

The young agent maximisation problem in the case of financial autarky is to maximise their utility function (as in (3-5) subject to resources constraints (3-17), (3-18), (3-19).

\[
\text{Max} \quad \frac{(1 - \pi)(c_{1t}^{1-\sigma} - 1) + \pi(c_{2t+1}^{1-\sigma} - 1)}{1 - \sigma}
\]

Define the fraction of capital held in the financial autarky agent's portfolio as follows

\[
q_t^\sigma = \frac{K_t^\sigma}{S_t} = \frac{K_{t+1}^\sigma}{S_t}
\]
The maximisation problem of agents becomes the following:

\[
\max_{c_{t},c_{t+1},K_{t+1}} \frac{S_{t}^{1-\sigma}[(1-\pi)(n(1-q_{t}^{*}))^{1-\sigma} + \pi n(1-q_{t}^{*}) + (RA\theta B) q_{t}^{*}]^{-\sigma} - 1}{1-\sigma}
\]  \hspace{1cm} (3-22)  \hspace{1cm}  ^{96}

The solution of this optimisation problem is as follows, which summarises the portfolio behaviour of young agents in the absence of financial structure.

\[
q_{t}^{*} = \frac{\left[\frac{\pi \left(\frac{RA\theta B}{n} - 1\right)}{(1-\pi)}\right]^{1/\sigma} - 1}{\left[\frac{\pi \left(\frac{RA\theta B}{n} - 1\right)}{(1-\pi)}\right]^{1/\sigma} - 1 + \frac{RA\theta B}{n}}
\]  \hspace{1cm} (3-23)

where \( \lambda = \left[\frac{\pi \left(\frac{RA\theta B}{n} - 1\right)}{(1-\pi)}\right]^{1/\sigma} \)

The derivation of (3-23) is shown in section-end appendix 3.7.1. The result is similar to that of the Greenwood and Smith (1997) model. The optimal conditions required \( q_{t}^{*} \geq 0 \). Otherwise, there will be no capital in the economy after one period, and resulting in the

\[ \text{The proof of (3-22) is as follows:} \]
\[ \max_{c_{t},c_{t+1},K_{t+1}} \frac{(1-\pi)(c_{t}^{1-\sigma} - 1) + \pi (c_{t+1}^{1-\sigma} - 1)}{1-\sigma} \]
\[ = \max_{c_{t},c_{t+1},K_{t+1}} \frac{(1-\pi)(nS_{t}^{*})^{1-\sigma} + \pi (nS_{t}^{*} + (RA\theta B)K_{t}^{*})^{1-\sigma} - 1}{1-\sigma} \]
\[ = \max_{c_{t},c_{t+1},K_{t+1}} \frac{S_{t}^{1-\sigma} \left[\left(1-\pi\right)\left(n\left(S_{t}^{*} - K_{t}^{*}\right) \left(S_{t}\right)\right)^{1-\sigma} + \pi n \left(\frac{S_{t}^{*} - K_{t}^{*}}{S_{t}}\right) + (RA\theta B) \left(\frac{K_{t}^{*}}{S_{t}}\right)\right]^{-1}}{1-\sigma} \]
\[ = \max_{c_{t},c_{t+1},K_{t+1}} \frac{S_{t}^{1-\sigma} \left[\left(1-\pi\right)\left(n\left(1-q_{t}^{*}\right) \left(1-f^{*}\right) + (RA\theta B) q_{t}^{*}\right)\right]^{-1}}{1-\sigma} \]

\[ \text{88} \]
absence real activities in the steady state. Hence, the existence of optimal condition requires the following condition.

$$\pi R A O B \geq n \iff q^n \geq 0$$  \hspace{1cm} (3-24)

3.3.3.1.3 Economic Intuition

The economic intuition of the optimal condition, i.e. (3-23) and (3-24), state that the average returns of capital must be larger than the return of good storage, so that agents are willing to invest after one-period. The higher the probability for agents to hold their portfolio and liquidate their assets and consume only at the old age (i.e. higher $\pi$) and the more willing the young agents to take risk to accept deviations from a uniform pattern of consumption overtime (i.e. lower $\sigma$), the larger will be the fraction of capital held in the financial autarky agent’s portfolio (i.e. higher $q^n$).

3.3.3.2 Presence of Banking

Section 1.1.1.1 shows the saving behaviours in the case when bank is absent from the economy. This section describes the case for the presence of banking. The original Greenwood and Smith (1997) framework does not specify the bank’s production function. The new element in this model lies on the specification of bank’s production function, where full details will be given in the sub-section 3.3.3.2.2.

3.3.3.2.1 Environment

Banks assume the role of intermediation and provide liquidity into the market. The presence of a bank allows deposits to be taken from young agents to make capital investment and to hold goods in storage by the banks. The behaviours of bank and depositor are given as follows:

- There are $j$ types of bank, where $j=(1,2,\ldots,J)$. i.e. there are $J$ banks operating in the market. They are the Nash competitors to compete against each other for deposits.
- Free entry conditions apply in the credit market. Banks can freely enter into the market;
- Each bank will pay $r_{it}$ per unit withdrawals when depositor withdraws at time $t;$

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- Each bank will pay interest rate \( r_{2t} \) per unit withdrawals when depositor withdraws at time \( t+1 \);
- The announcement of the interest payment \((r_{1t}, r_{2t})\) will be at time \( t \);
- Agents will deposit all their income into \( S_t \), the bank.
- Agents with \( \varphi=0 \) will withdraws early at time \( t \), and consume their post-interest income \((S_t r_{1t})\) at young age;
- Agents with \( \varphi=1 \) will withdraws late at time \( t+1 \), and consume their post-interest income \((S_t r_{2t})\) at old age.

The above assumption implies

\[
\begin{align*}
\zeta_1 &= S_t r_{1t} \\
\zeta_2 &= S_t r_{2t}
\end{align*}
\]

Based on the equilibrium outcomes in Diamond and Dybvig (1983) that all young-period saving are deposited in equilibrium, it is assumed that young agents will deposit all their portfolio income (i.e. \( S_t \) in this model) into the bank. (Diamond and Dybvig 1983).

Assume the following:
- \( S^b_t \), denotes the good storage (per depositor) by the bank at time \( t \);
- \( K^b_t \) denotes the (per depositor) capital investment by the bank valued in current consumption;
- \( n \) denotes the return of good storage, which is independent of when consumption occurs.
- The wage for employment in banking sector is equal to \( w \). It is assumed to be exogenous in this section. In section 3.4, the wage will be endogenous and it is equal to the wage for the employment in final good sector in equilibrium due to the arbitrage condition.
- The average wage cost imposed on each bank, measured in current consumption throughout the agent lifespan, is \( w \cdot v_j \), where \( v_j = \frac{I_b}{J} \) is the level of employment in the financial sector with respect to the number of banks \( J \) in the economy. It is further assumed that the wage cost are incurred but once at time \( t \) (young age), so that they represent some kind of fixed costs of financial intermediation.
- Bank will hold storage as a cushion against early withdrawal, whereas they will finance late withdrawal by liquidating capital investment.
3.3.3.2.2 Bank's Production Function

This study improves the Greenwood and Smith framework (1997) by specifying the bank's production function. Besides, there is a body of literature to show that legal factors can impact financial development. Define the fraction of capital investment at time $t$ in bank's portfolio as

$$q_t^b = \frac{K_t^b}{S_t}$$

(3-26)

Assume the financial technology function $f(\varepsilon, v_j)$ represents the efficiency of banks to channel saving into productive investment is given as follows,

$$f(\varepsilon, v_j) = \varepsilon \cdot (v_j)^\tau$$

where $\varepsilon, \tau > 0$

(3-27)

The above equation states that financial technology depends on the employment in each bank ($v_j$), which equal to the level of total employment in financial sector with respect to the number of banks in the economy ($l_b/J$) in symmetric equilibrium$^{97}$. It also depends on other exogenous factors $\varepsilon$ that increases the efficiency of the banking system, such as the competent legal system as expounded by La Porta (1997).

Therefore the amount of capital accumulated by each bank at time $t+1$ is given by the following bank's production function:

$$K_{t+1}^b = S_t q_t^b f(\varepsilon, v_j) = K_t^b \cdot f(\varepsilon, v_j)$$

$$= \varepsilon \cdot (K_t^b)^\tau \cdot (v_j)^\tau$$

where $\varepsilon, \tau > 0$

(3-28)

The bank production function state that capital accumulated at time $t+1$ depends on the fraction bank's capital investment $K_t^b$ and labour input ($v_j$), at time $t$, as well as the efficiency parameter ($\varepsilon$) that determine the total factor productivity in the financial sector.

$^{97}$ The idea is drawn from Berthelemy and Varoudakis (1996).
Given all the above, the resources constraints faced by each bank are as follows:

\[ S_t^b + K_t^b + wv_j \leq S_t \]  \hspace{1cm} (3-29)

\[ (1-\pi)S_t^b \leq nS_t^b \] \hspace{1cm} (3-30)

\[ \pi r_{2t} S_t \leq R\rho_{t+1} I_{t}^b = \left( RA\theta B \right) K_{t+1}^b \]
\[ = \left( RA\theta B \right) \cdot K_t^b \cdot f(\varepsilon, v_j) = \left( RA\theta B \right) \cdot \varepsilon \cdot (K_t^b) \cdot (v_j)^\tau \]

The constraint in (3-29) states that banks will use all the agent deposits for goods storage, capital investment and wage cost incurred. (3-30) states bank will liquidate all its reserve (good storage) to finance the fraction of savings that withdraw early at time \( t \). (3-31) states that bank the total return of capital investment will be used to finance the late withdrawal by depositors at time \( t+1 \).

3.3.3.2.3 Optimisation Problem in the case of Banking

A representative bank will choose \( (r_{1t}, r_{2t}, S_t^b, I_t^b) \) to maximise the utility of a representative depositor subject to the resources constraint given by (3-29), (3-30), and (3-31):

\[ \max \left( 1-\pi \right) \left( S_t^b r_{1t} \right)^{1-\alpha} - 1 + \pi \left( S_t^b r_{2t} \right)^{1-\alpha} - 1 \]

Substituting (3-25), (3-26), (3-29), (3-30), (3-31), into (3-32) yields the following maximisation condition:

\[ \max \left( 1-\pi \right) \left( S_t^b r_{1t} \right)^{1-\alpha} - 1 + \pi \left( S_t^b r_{2t} \right)^{1-\alpha} - 1 \]

\[ \left( \left( 1-\pi \right) \left( S_t^b r_{1t} \right)^{1-\alpha} - 1 + \pi \left( S_t^b r_{2t} \right)^{1-\alpha} - 1 \right) \]

\[ \max \phi \left( S_t^b r_{1t} \right)^{1-\alpha} - 1 + \pi \left( S_t^b r_{2t} \right)^{1-\alpha} - 1 \]
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The derivation of \((3-33)\) is shown in section-end appendix 3.7.2. The solution of this optimisation problem is as follows, which summarise the saving behaviour in the presence of bank.

\[
q_t^b = \frac{\eta \left(1 - \frac{w \cdot v_j}{S_t} \right)}{(1 + \eta)} 
\]

where \(\eta = \frac{\pi \left( RA\theta_B \cdot f(\sigma, v_j) \right) \frac{1 - \sigma}{a}}{n \cdot 1 - \pi} \)

\((3-34)\) is derived in section-end appendix 3.7.3. The new result according to \((3-34)\) is different from the original framework because of the introduction of the financial technology function and the wage cost, and they will be equal if we take away the financial technology function and the wage cost in our analysis so that \(f(\sigma, v_j)\) and \(w\) are equal to zero. According to \((3-29)\), \(w \cdot v_j \leq S_t\) implies \(q_t^b \geq 0\) and there will always be capital in the economy after one period in the presence of banking. The only case where there is no capital accumulation is when all the deposit received from the bank were used to finance the wage cost, which is obvious as banks will have no spare resources for investment in capital.

3.3.3.2.4 Economic Intuition

The economic intuition of the optimal condition \((3-34)\) shows that the fraction of bank investment in capital will be larger (i.e. higher \(q_t^b\)) if:

- The lower the ratio of the wage cost to the total deposits for the bank (i.e. lower \(\frac{w \cdot v_j}{S_t}\))
- The higher the probability for agents to have late withdrawal of deposits at the old age (i.e. higher \(\pi\));
- The more willing the young agents to take risk to accept deviations from a uniform pattern of consumption overtime by saving in the form of illiquid capital (i.e. lower \(\sigma\));
- The higher the relative return on capital investment over storage (i.e. higher \(RA\theta_B/n\))
• The more efficiency for banks to channel saving into productive investment (i.e. $f(\varepsilon, v_j)$)

Proofs of the above conditions are shown in the section-end appendix 3.7.4.

When agents are risk neutral (i.e. $\sigma \to 0$), $\eta \rightarrow 1$ so that $q_t^b \rightarrow \left(1 - \frac{w \cdot v_j}{S_t}\right)$. This implies that after deducting the wage costs, banks will invest all their deposits for long-term capital.

Calibrated macroeconomic models design to match growth and business cycle facts typically require elasticity of intertemporal substitution in consumption to be one, which correspond to the logarithmic preference case (i.e. $\sigma = 1$). (Guvenen 2003; Lucas 1990; Weil 1989) In this case, $q_t^b = \pi \left(1 - \frac{w \cdot v_j}{S_t}\right)$. It can also be shown that

$q_t^b = \pi \left(1 - \frac{w \cdot v_j}{S_t}\right)$, and $r_{zt} \geq RA \theta B \cdot f(\varepsilon, v_j) \cdot \left(1 - \frac{w \cdot v_j}{S_t}\right)$ if and only if $\sigma \leq 1$, and vice versa 98. The implication is that if agents are less risk averse than the logarithmic reference case, they are willing to accept a yield less than the bank’s net storage return accounted for the wage cost $n \left(1 - \frac{w \cdot v_j}{S_t}\right)$ in the event of early withdrawal, and desire a return in

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Since in general (3-29), (3-30) & (3-31 holds with equality, therefore

$$n = (1 - \pi) r_{zt} S_t \frac{S_t}{S_t} = (1 - \pi) r_{zt} S_t \frac{S_t}{S_t} = (1 - \pi) r_{zt} \left(\frac{1}{1 - q_t^b - \frac{w \cdot v_j}{S_t}}\right)$$

$$\geq (1 - \pi) r_{zt} \left(\frac{1}{1 - w \cdot v_j - \pi \left(1 - \frac{w \cdot v_j}{S_t}\right)}\right) = \frac{r_{zt}}{1 - q_t^b - \frac{w \cdot v_j}{S_t}} \Rightarrow (1 - \frac{w \cdot v_j}{S_t}) n \geq r_{zt};$$

$$RA \theta B \cdot f(\varepsilon, v_j) = \pi \frac{S_t}{L_t} \frac{S_t}{L_t} \leq \frac{r_{zt}}{1 - q_t^b \frac{w \cdot v_j}{S_t} \left(1 - \frac{w \cdot v_j}{S_t}\right)} \Rightarrow (1 - \frac{w \cdot v_j}{S_t}) RA \theta B \cdot f(\varepsilon, v_j) \leq r_{zt}.$$
excess the bank’s net capital investment return $RA\theta B \cdot f(v_j) \left(1 - \frac{w \cdot v_j}{S_i}\right)$ if they withdraw late so that asset are held to maturity, and vice versa.

3.3.4 Comparative Static

The result in section 3.3.3.2 is able to yield a new insight on the justification of the banking system in the economy that is distinct from the original Greenwood and Smith (1997) model. This section compares the result for two cases (i.e. the absence and the presence of banking).

3.3.4.1 The Proposition

According to (3-21) and (3-28), capital accumulation is governed by the following equation in each case.

- $K_{t+1}^a = S_t q_t^a$ without banks
- $K_{t+1}^b = S_t \cdot q_t^b \cdot f(\varepsilon, v_j) = K_t^b \cdot f(\varepsilon, v_j)$ with the presence of banks.

It can be shown that the following proposition.

**Proposition I.**

(a.) $K_{t+1}^b > K_{t+1}^a$ holds if and only if

$$\frac{w \cdot v_j}{S_i} < 1 - \frac{(1+\eta)(\lambda - 1)}{(\lambda - 1 + \frac{RA\theta B}{\eta \cdot f(\varepsilon, v_j)})}$$

$$\left\{ \left(\frac{f(v_j)}{f(v_j)} - 1\right) \left(\frac{n}{RA\theta B}\right)^{\frac{1}{\alpha}} - \left(\frac{1-\pi}{\pi}\right) f(v_j)^{\frac{1}{\alpha}} \left(\frac{\pi}{1-\pi}\right)^{\frac{1}{\alpha}} \left(\frac{(RA\theta B - n)^{\frac{1}{\sigma}} (RA\theta B)^{\frac{1}{\alpha}}}{n^\alpha}\right)\right\}$$

$$= \left(\frac{\pi}{1-\pi}\right)^{\frac{1}{\alpha}} \left(\frac{(RA\theta B - n)^{\frac{1}{\sigma}} (n)^{\frac{1}{\alpha}}}{f(\varepsilon, v_j)}\right) + \left(\frac{(RA\theta B - n)^{\frac{1}{\sigma}} (n)^{\frac{1}{\alpha}}}{RA\theta B - n}\right)$$
The proof of part (a) of the proposition I is shown in the section-end appendix 3.7.5. This requires the wage cost to be sufficiently low. If wage cost is sufficiently low, $K_{t+1}^b > K_t^a$ holds.  

(b.) If agents' preferences are logarithmic ($\sigma = 1$), then the ratio of the capital accumulation with the presence over the absence of bank is as follows:

$$\frac{K_{t+1}^b}{K_t^a} = \frac{f(\varepsilon, v_j) \left(1 - \frac{w \cdot v_j}{S_t} \right) \left(\frac{RA \theta B}{n} - 1 \right)}{\frac{RA \theta B}{n} - 1} > 1$$

$$\Leftarrow f(\varepsilon, v_j) \left(1 - \frac{w \cdot v_j}{S_t} \right) - 1 > -\frac{1}{\frac{RA \theta B}{n} - 1}$$

### 3.3.4.2 Economic Intuition

Recall $\left(1 - \frac{w \cdot v_j}{S_t} \right)$ is the fraction of bank deposit available for productive investment after paying the wage bill. $f(\varepsilon, v_j)$ is the efficiency for bank to channel saving into productive investment, and the efficiency for agents to channel their own resources into

99 The sufficient conditions for $w \cdot v_j > 0$ is $f(\varepsilon, v_j) - 1 > \left(1 - \frac{\pi}{\pi} \right) \left[\frac{RA \theta B \cdot f(\varepsilon, v_j)}{n} \right]^{1-a}$. This state the gross efficiency gap for channel saving into productive investment between bank and agent $f(v_j) - 1$ should be larger than the agents impatience rate $\left(\frac{1 - \pi}{\pi} \right)$ times a function of the relative of bank return to capital over storage $\left[\frac{RA \theta B \cdot f(\varepsilon, v_j)}{n} \right]^{1-a}$.

100 If agents preference are logarithmic, substituting $\sigma = 1$ into (3-23), (3-34) will yield $q_{t+1}^a = \pi (RA \theta B - n) (RA \theta B - n)$ and $q_{t+1}^b = f(\varepsilon, v_j) \cdot \pi \left(1 - \frac{w \cdot v_j}{S_t} \right)$. Therefore,

$$K_{t+1}^b = S_t q_{t+1}^b = S_t \cdot f(\varepsilon, v_j) \cdot \pi \left(1 - \frac{w \cdot v_j}{S_t} \right) > S_t \left(\frac{\pi (RA \theta B - n)}{(RA \theta B - n)}\right) = S_t q_{t+1}^a K_{t+1}^a$$

$$\Leftarrow f(\varepsilon, v_j) \left(1 - \frac{w \cdot v_j}{S_t} \right) > \frac{(RA \theta B)}{n} - 1 + \frac{1 - \frac{1}{\pi}}{\frac{RA \theta B}{n} - 1}$$
productive investment is normalised to one. Though $\pi$ is governed by the occurrence of individual preference shock $\phi$, it can also interpreted as a measure of time preference, and $\frac{1}{\pi}$ can serve as a proxy for the rate of time preference as lower $\pi$ will lead to higher consumption at the young age\textsuperscript{101}.

Part (a) of the proposition 1 state that capital accumulation is larger with the presence of banking than the absence one only if wage cost is sufficiently low.

The economic intuition of part (b) of the Proposition I states that capital accumulation is larger with the presence of banking than the absence one under the logarithm preference case, if and only if the net efficiency gap for channel saving into productive investment between bank and agent $f(\varepsilon, \nu_j) \left(1 - \frac{w \cdot \nu_j}{S_i}\right) - 1$ is larger than a certain thresholds $\frac{1}{\pi \cdot RAOB - n}$, which is inversely related to the rate of time preference $\pi$ and positively related to the relative return on capital investment over storage $\frac{RAOB}{n}$.

\textsuperscript{101} The agent’s utility function can be rewritten as the following discounted utility form which is conventional in the modern economic literature of intertemporal choice.

\begin{equation}
\begin{aligned}
    u(c_{it}, c_{2t+1}) &= (1 - \pi)(c_{it}^{1-\sigma} - 1) + \pi(c_{2t+1}^{1-\sigma} - 1) \\
    &= \left(1 - \pi\right)\left(c_{it}^{1-\sigma} - 1\right) + \pi\left(1 - \frac{\pi}{1 - \pi}\right)\left(c_{2t+1}^{1-\sigma} - 1\right)
\end{aligned}
\end{equation}

where

\begin{equation}
\begin{aligned}
    \rho &= \frac{1}{\pi} - 2 \text{ is the rate of time preference used in the conventional discounted utility function. As } \frac{1}{\pi} \text{ has a one-to-one relationship with } \rho, \text{ it can serve as a proxy for time preference.}
\end{aligned}
\end{equation}
Figure 3-2: Capital Accumulation ratio with respect to wage cost

Note: The assigned parameterized value is as follows:

\[ \sigma = 1, \pi = 0.5, \frac{RA \theta B}{n} = 2.1, f(\epsilon, v) = 1.2 \]

Figure 3-2 shows that with the assigned parameterised value that satisfies the optimal condition required in (3-24), capital accumulation is larger with presence of banks, i.e. \( \frac{K_{t+h}^b}{K_t^a} > 1 \) if banks spend less than 90% on wage. The lower the wage cost, the higher the ratio of capital accumulation in the presence over the absence of banks.
Theoretical Model

Figure 3-3: Capital Accumulation ratio with respect to $\pi$, with different assigned parameterised value for wage cost $\frac{W \cdot V_j}{S_i}$

Note: The assigned parameterized value is as follows: $\sigma = 1, \frac{RA \theta B}{\pi} = 2.1, f(\varepsilon, v_j) = 1.2$

Figure 3-3 shows that the ratio of capital accumulation $\frac{K_{r+i}}{K_i}$ will be larger when $\pi$ (i.e. agent’s probability to consume at old age) is lower. The reason is that if $\pi$ is sufficiently large, there is less probability for agent for prematuresed capital liquidation even in the absence of financial intermediaries, and in both cases more resources are allocated into capital investment. Therefore capital accumulation under the 2 cases tends to converge, and the ratio of capital accumulation tends to converge to one.

With low wage cost (i.e. 0.1 in this case), capital accumulation is always larger in the case of the presence than in the absence of financial intermediaries, irrespective of the value of $\pi$. If wage cost is 0.3, and 0.5, capital accumulation is larger with the presence of banks if wage cost is lower than 0.9 and 0.7 respectively. In sum, with sufficient low wage cost so that most of the bank resources are diverted to productive investment, the presence of banks will accumulate more capital in the society.
Figure 3-4 Capital Accumulation ratio with respect to $f(\varepsilon, v_j)$, with different assigned parameterised value for $\pi$

\[
\frac{K^{b+1}}{K^a}
\]

$\pi = 0.5$

$\pi = 0.75$

$f(\varepsilon, v_j)$

Note: The assigned parameterized value is as follows: $\sigma = 1, \frac{RA \theta B}{n} = 2.1, \frac{w \cdot v}{S_i} = 0.5$

Figure 3-4 shows the ratio of capital accumulation $\frac{K^{b+1}}{K^a}$ will be larger when $f(\varepsilon, v_j)$ (i.e. the efficiency for banks to channel saving into productive investment) is higher. Even considering higher parameterised value of wage cost $\frac{w \cdot v}{S_i} = 0.5$, capital accumulation will be larger in the case of the presence than in the absence of financial intermediaries for all values of $f(\varepsilon, v_j)$ when $\pi = 0.5$. When $\pi = 0.75$, capital accumulation will be larger when $f(\varepsilon, v_j) > 1.3$. This shows that the higher efficiency of banks will offset the negative impact of wage cost and result in greater capital accumulation.

3.3.5 Summary

The new result in this section shows that the fraction of portfolio in capital accumulation is larger in the case of the presence of financial intermediaries, when there is provision of liquidity in the banking system by preventing premature liquidation of capital and improvement of risk sharing through inter-mediation, as well as the more efficient for the bank to channel savings into productive investment, results in a larger fraction of risky asset (i.e. capital investment in this model) to be held in the portfolio. The condition for
this result to hold is that the presence of intermediation (wage) cost should be lower than a certain threshold. In sum, the proportion of saving that is channelled to productive investment is greater in the presence of financial intermediation when intermediation cost is sufficient low.

The case of logarithm preference yields an additional insight that banks are justified to exist to foster capital accumulation when the net efficiency gap for channelling saving into productive investment between bank and agent is large and when agent's rate of time preference is high.

### 3.4 Interaction between the Real and Financial Sector

The above section justifies the existence of financial intermediaries and endogenises the saving behaviour in the economy. It shows that the presence of financial intermediation induces greater savings that can be channelled into productive capital investment. The following will consider the reciprocal externalities between the real and financial sector to model the dynamics between financial development and economic growth. The following section will synthesise the framework of Greenwood and Smith (1997) into Berthelemy and Varaoudakis (1996) model (Berthelemy and Varoudakis 1996a; Romer 1990)\(^\text{102}\).

#### 3.4.1 Agent's Consumption

Whereas Berthelemy and Varaoudakis (1996) model is an infinite horizon model, the present study assumes that the economy consists of an infinite sequence of two-period lived overlapping generation of economic agents. Drawing from (3-5), agent's utility function can be rewritten as follows:

---

\(^\text{102}\) The model also draw reference from the textbooks written by Aghion and Howitt (1998) and Barros and Sala-i-Martin (2004) on the optimal growth theory (Ramsey-Cass-Koopmans type) (Aghion and Howitt 1998; Barro and Sala-i-Martin 2004)
Theoretical Model

\[ \frac{1-\pi}{\pi} \text{ can be thought of as a function that captures time preference. If } \left( \frac{1-\pi}{\pi} \right) > 1, \text{ agents will place greater weight on the first-period than second period consumption.} \]

\[ \left( \frac{1-\pi}{\pi} \right) < 1, \text{ greater weight will be placed on the second period.} \]

As stated in section 3.3.3.2.1, a young agent will deposit all their portfolio income \( (S_i) \) in the banking sector. They will get \( S_i r_{1t} \) if they withdraw their deposit at a young age, and \( S_i r_{2t} \) if they withdraw at the old age according to (3-25). Therefore, the budget constraint facing a young agent is as follows with the presence of bank:

\[ (3-36) \]

\[ S_i = \frac{c_{1t}}{r_{1t}} = \frac{c_{2t+1}}{r_{2t}} \]

Maximising the agent’s utility (3-35) subject to the budget constraint (3-36) will yield the following optimal consumption growth rate.

\[ (3-37) \]

\[ \frac{c_{2t+1}}{c_{1t}} - 1 = \left[ \left( \frac{\pi}{1-\pi} \right) \frac{r_{2t}}{r_{1t}} \right]^{\frac{1}{\sigma}} - 1 \]

The equation state that the rate of consumption growth increases where there is

- an increase in the relative per unit interest payment for late withdrawal over early withdrawal, \( \frac{r_{2t}}{r_{1t}} \)
- an increase with the magnitude of the elasticity of marginal utility of generation consumption, \( \frac{1}{\sigma} \).
• a decrease with the rate of time preference, \( \frac{1-\pi}{\pi} \).

### 3.4.2 The Final Good Sector

Recall in section 3.3.2.1 the final good producer will produce output using the intermediate goods produced by the young agents, and recall the production function for the final good is given by (3-2). In equilibrium, young agents are symmetric with one another (i.e. \( x_t(i) = x_t \)). Physical capital in the real sector is intermediated by the financial sector with the presence of the banks, and therefore it takes into account the improvement of efficiency of channelling savings into investment brought forward by the banks. Recall that in (3-7), the efficiency of labour depends on the capital-labour ratio in the real sector through an externality effect in symmetric equilibrium,

\[
E = \frac{x_t}{l_y}
\]  

(3-7)

The production function therefore is therefore given by (3-12)

\[
y_t = Bx_t^\sigma \left( E_l \right)^{-\sigma} = BA^\sigma k_t^\sigma \left( E_l \right)^{-\sigma} \]  

(3-12)

Profit function is given in (3-6)

\[
\Gamma = y_t - p_t x_t - w_l
\]
The optimising conditions of the representative firm for producing final goods is given by equation (3-38) and (3-39)\(^{103}\):

\[
p_t = \alpha B \quad (3-38)
\]

\[
w = (1 - \alpha)B \left( \frac{x_y}{l_y} \right) \quad (3-39)
\]

Recall from section 3.3.2.2, intermediate good producers will obtain capital in a competitive market, paying the rental rate \(\rho_t\). The cost of using capital in the intermediate good sector is given by equation (3-14)

\[
\rho_t = \theta AB \quad (3-14)
\]

### 3.4.3 The Financial Sector

#### 3.4.3.1 Environment

The environment in section 3.3.3.2.1 forms the basic setup in this section, with further assumption as follows:

- Recall in 3.3.3.2.3, \(f(\epsilon, v_j)\) represents the efficiency of banks to channel saving into productive investment. It is assumed that the efficiency depends on the level of per bank employment in financial sector \((l_y/J)\) and other exogenous factors \((\epsilon)\) that increase the efficiency of the banking system. \(w\) is the wage costs association with the operation of each representative bank.
- \(S_j\) is the saving in bank \(j\). \(S = \Sigma_j S\) is the aggregate saving in the economy.

\(^{103}\) The proof of (3-38) and (3-39) is as follows:

\[
\frac{\partial \Gamma}{\partial x_j} \bigg|_{E_x = \frac{x_j}{l_j}} = 0 \Rightarrow p_t = \alpha B x_j \left( \frac{E_{l_y}}{x_j} \right)^{1-\alpha} = \alpha B
\]

\[
\frac{\partial \Gamma}{\partial l_y} \bigg|_{E_x = \frac{x_j}{l_j}} = 0 \Rightarrow (1 - \alpha)B(E_{l_y})^{-\alpha} x_j^\alpha - w = 0
\]

\[
\Rightarrow w = (1 - \alpha)B \left( \frac{x_y}{E_{l_y}} \right)^\alpha = (1 - \alpha)B \left( \frac{x_y}{l_y} \right)
\]
Theoretical Model

- In symmetric equilibrium, \( S_j = S_i = S/J \), where \( J \) is number of bank in each economy, and \( S_i \) is the deposit (savings) in each representative bank in symmetric equilibrium mentioned in section 3.3.3.2;

- It is assumed that \( c_t = S r_t > n s^b \), i.e. \( r_t > \frac{n s^b}{S_t} \). This condition state for risk-averse agent who consume at their early age, the aggregate return of bank deposit is larger than the storage return (with using the bank deposit function). \( r_t - \frac{n s^b}{S_t} \) represents the excess of interest payment over storage return at early age. This condition guarantees that the optimal wage is positive, as shown in later section.

The ratio per unit real interest payment to the depositors minus 1 i.e. \( \frac{r_{2t}}{r_t} - 1 \) is the net deposit interest rate from young age (time \( t \)) to old age (time \( t+1 \))\(^{104}\). Therefore \( \frac{r_{2t}}{r_t} \) (which is equal to \( 1 + r \)) is used as the discount factor to calculate the present value of old age income valued at young age.

It is assumed that young agents will deposit all their income into the banks and banking will channel savings into productive capital investment. Arbitrage between productive capital and deposit will lead to the result that the marginal product of using intermediate input (i.e., \( \rho_{t+1} \) from (3-13)) is equal to the real rental price of capital in the bank credit market, i.e. \( (1 + i)^{r_{2t}} r_t \), where \( i \) represent the margin of financial intermediation, \( \frac{r_{2t}}{r_t} \) represents the per unit interest payment from young age (time \( t \)) to old age (time \( t+1 \)).

This implies

\[
\rho_{t+1} = A \theta B = \alpha \beta = (1 + i) \frac{r_{2t}}{r_t}
\]

\(^{104}\) Recall \( r_t \) and \( r_{2t} \) is the interest payment when depositor withdrawals at \( t \) and \( t+1 \) respectively. Say \( r \) is the net interest rate from time \( t \) to \( t+1 \). Therefore

\[
r_t (1 + r) = r_{2t} \Rightarrow r = \frac{r_{2t}}{r_t} - 1
\]
The theoretical model examines the revenue of a bank, which is equal to the return of capital investment \((RA\theta B)K_{t+1}^b\) plus the return of good storage \((ns_t^b)\). Therefore, the revenue function in terms of deposit saving \(S_j\) is given as follows:\(^{105}\)

\[
R_j = (1 + i) \cdot q_t^b \cdot f(\varepsilon, v_j) \cdot S_i
\]

where the financial intermediation margin is given in (3-42) by definition

\[
1 + i = \frac{n \cdot s_t^b}{S_t \cdot q_t^b \cdot f(\varepsilon, v_j)} + \frac{(RA\theta B)}{r_{t+1} / r_t} = \frac{n \cdot (1 - q_t^b - \frac{w \cdot v_j}{S_t})}{q_t^b \cdot f(\varepsilon, v_j)} + \frac{(RA\theta B)}{r_{t+1} / r_t}
\]

Recall that the bank has to pay \(r_t\) when there is an early withdrawal at time \(t\), and \(r_{t+1}\) when there is late withdrawal at time \(t+1\). The probability is \((1 - \pi)\) for early withdrawal and \(\pi\) for late withdrawal. Therefore, the present value of the cost of the bank’s borrowing is as follows:

\[
C_j = (1 - \pi) S_t r_t + \frac{\pi S_t r_{t+1}}{r_{t+1} / r_t} = S_t r_t.
\]

Hence, the net present value of the bank’s saving intermediation activities (i.e. revenue minus the cost of borrowing from depositors) is as follows:

\[
\psi_j = R_j - C_j = [1 + i] q_t^b \cdot f(\varepsilon, v_j) \cdot S_t - S_t r_t
\]

One can derive the profit function of each representative bank, which states that the profit of each representative bank, which is equal to the net present value of the bank’s saving intermediation activities minus the wage costs associated with intermediation activities (i.e. \(w \cdot v_j\)), as follows:

\(^{105}\) The proof of (3-41) is as follows:

\[
R_j = ns_t^b + \frac{(RA\theta B)K_{t+1}^b}{r_{t+1} / r_t} = m(s_t^b) \cdot \frac{K_{t+1}^b}{S_t} \cdot q_{t+1}^b \cdot f(\varepsilon, v_j) + \frac{(RA\theta B) \cdot K_{t+1}^b}{r_{t+1} / r_t}
\]

\[
= \left[ \frac{n \cdot s_t^b}{S_t \cdot q_t^b \cdot f(\varepsilon, v_j)} + \frac{(RA\theta B)}{r_{t+1} / r_t} \right] \cdot k_{t+1}^b = (1 + i) \cdot K_{t+1}^b = (1 + i) \cdot q_t^b \cdot f(\varepsilon, v_j) \cdot S_t
\]
Theoretical Model

3.4.3.2 Profit Maximising Conditions

The profit maximising condition with respect to the individual bank’s saving $S_i$, is as follows, where the derivation is shown in the section-end appendix 3.7.6.

$$\Pi_j = \psi_j - w \cdot v_j = [1 + i] g_j \cdot f(\varepsilon, v_j) \cdot S_i - S_i, r_u - w \cdot v_j$$  \hspace{1cm} (3-45)

The results in (3-46) show that the properties of the bank intermediation margin are

- Positively related to the interest rate elasticity of savings $\frac{1}{\gamma}$ \hspace{1cm} (for positive $\gamma$),

where

$$\frac{1}{\gamma} = \frac{\partial S}{S} \cdot \frac{r_u}{\partial (r_u/r_u)}$$ \hspace{1cm} (3-47)

is the optimal bank intermediation margin condition when saving is optimised. $\frac{1}{\gamma}$ is the elasticity of aggregate savings with respect to net interest payments (interest rate). It is assumed that $\frac{r_u}{\gamma} - \frac{n \cdot S_i}{S_i}$ is larger (smaller) than one when it is interest elastic (inelastic), i.e. $\frac{1}{\gamma}$ is larger (smaller) than one, so that the financial intermediation is positive. The results in (3-46) show that the properties of the bank intermediation margin are

106 If financial intermediation margin is negative, bank will cease to operate and there is no economic rationale for the existence of banks in the economy.

107 The proof is as follows:
Negatively related to the financial technology \( f(\varepsilon, v_j) \), that determines the efficiency of bank in channel saving into investment.

The second profit maximising condition with respect to the employment within each bank \( (v_j = l_b/J) \) is as follows:

\[
(3-48) \quad w = \left[1 + \frac{1}{q^b_i} \cdot f'(\varepsilon, v_j) - \frac{n \cdot s^b_i}{S_t} \cdot \frac{f'(\varepsilon, v_j)}{f(\varepsilon, v_j)}\right] \cdot \frac{S_t}{1-n}
\]

The free-entry assumption in the banking sector implies that each bank earn zero profit in long-run equilibrium. Substituting the profit maximizing wage rate \( (3-48) \) into the profit function \( (3-45) \), and with the fact that \( \Pi_j = 0 \), one can yield the following conditions:

\[
(3-49) \quad 1 + i = \frac{r_{it} - \frac{n \cdot s^b_i}{S_t} \cdot \frac{\mu_j}{1-n}}{q^b_i \left[1 - \frac{\mu_j}{1-n}\right] f(\varepsilon, v_j)}
\]

where

\[
(3-50) \quad \mu = \frac{f'(\varepsilon, v_j)}{f(\varepsilon, v_j) \cdot v_j}
\]

Derivations of \( (3-48) \) and \( (3-49) \) are shown in the section-end appendix 3.7.7 and 3.7.8 respectively. \( (3-49) \) is the optimal bank intermediation margin condition when bank’s employment is optimised. \( \mu \) is the elasticity of the financial technology function

As \( r_{it} > \frac{n \cdot s^b_i}{S_t} \) or \( Sr_{it} > ns^b_i \), the second terms in the equation is always positive.
with respect to the per unit bank employment level\(^{108}\). Combining (3-46) and (3-49) yields the following conditions.

\[
\frac{1}{S} \frac{\partial S}{\partial \left( \frac{r_{2i}}{r_{1i}} \right)} = \gamma = \frac{\mu}{1-n} \frac{f'(\varepsilon, v_j) v_j}{f(\varepsilon, v_j) 1-n} = \frac{f'(\varepsilon, v_j) l_b}{f(\varepsilon, v_j) J} \frac{1}{1-n}
\]

(3-51)

The above conditions state that, when savings and bank’s employment are optimised, the elasticity of the financial technology function with respect to the per unit bank employment level, \(\mu\), is inversely proportional to the elasticity of aggregate savings with respect to interest rate \(\frac{1}{\gamma}\).

Substitute (3-46), and (3-51) into (3-49) will yield the profit maximising wage, where the derivation is shown in the section-end appendix 3.7.9.

\[
w = \left[ r_{1i} - \frac{n \cdot s_i^b}{S_i} \right] \frac{\gamma}{\left[ 1-n \right] \frac{1}{l_b}} \cdot S
\]

(3-52)

\[
= \left[ r_{1i} - \frac{n \cdot s_i^b}{S_i} \right] \frac{\mu}{\left[ 1-n \right] \frac{1}{l_b}} \cdot S
\]

\[
= \left[ r_{1i} - \frac{n \cdot s_i^b}{S_i} \right] \frac{f'(\varepsilon, v_j)}{\left[ (1-n) \cdot f(\varepsilon, v_j) - f'(\varepsilon, v_j) \cdot v_j \right]} \frac{S}{J}
\]

(3-48) to (3-52) implies the optimal wage will increase when

- Saving in each bank \(\frac{S}{J}\) increases;
- The elasticity of the financial technology function with respect to the per unit bank employment level, \(\mu\), increases;
- The financial technology \(f(\varepsilon, v_j)\), that determines the efficiency of bank in channel saving into investment, decreases;

\[
\frac{f'(\varepsilon, v_j)}{f(\varepsilon, v_j)} \cdot v_j = \frac{\partial f(\varepsilon, v_j)}{\partial (\varepsilon, v_j)} \frac{v_j}{f(\varepsilon, v_j)} = \frac{\partial f(\varepsilon, v_j)}{\partial (\varepsilon, v_j)} \frac{v_j}{f(\varepsilon, v_j)} \frac{\partial f(\varepsilon, v_j)}{\partial (\varepsilon, v_j)}
\]
Theoretical Model

- The elasticity aggregate saving with respect to the interest rate $\frac{1}{\gamma}$ decreases.

- The excess of interest payment over storage return at early age, $r_l - \frac{n s^b}{S_l}$, increases.

These effects are channelled directly and indirectly through the corresponding increase in interest margin of lending $(1+i)$.

3.4.4 Equilibrium

3.4.4.1 Labour Market Equilibrium

Recall the following equations in the above section:

- (3-39): Marginal Productivity of labour in final good sector
  \[ w = (1 - \alpha)B \left( \frac{x_l}{I_y} \right) = (1 - \alpha)B \left( \frac{x_l}{1 - l_b} \right) \]

- (3-52): Optimal wage in the banking sector
  \[ w = \left[ r_l - \frac{n \cdot s^b}{S_l} \right] \cdot \frac{\gamma}{1 - \gamma} \cdot S \]
  \[ = \left[ r_l - \frac{n \cdot s^b}{S_l} \right] \cdot \frac{f'(\varepsilon, v_j)}{(1 - n) \cdot f(\varepsilon, v_j) - f'(\varepsilon, v_j) \cdot v_j} \cdot S \]
Equalising the optimal wage rate in the final good sector (3-39) and the financial sector (3-52) gives the following \(^{109}\).

\[ S \bigg/ x_t = \frac{(1-\alpha)B}{r_t - \frac{n \cdot s_t^b}{S_t}} \left[ \frac{1 - \gamma}{\gamma} \right] \cdot \frac{l_b}{1-l_b} \quad (3-53) \]

### 3.4.4.2 Equilibrium Growth Rate

#### 3.4.4.2.1 Capital Growth Path

Recall the following specification from the above section

- **(3-1)** Production Function for Intermediate Goods

\[ x_t = A_k_t \]

- **(3-2):** Production Function for Final Goods

\[ y_t = B \left( E_l y \right)^{\gamma a} \left[ \frac{1}{0} \left[ l_i \right] \right]^{\gamma a} = c_t + \frac{K_{t+1}}{R} \]

- **(3-12):** Production Function in symmetric equilibrium

\[ y_t = B x_t^\alpha \left( E_l y \right)^{\gamma a} = B A^\alpha k_t^\alpha \left( E_l y \right)^{\gamma a} \quad (3-26) \]

\(^{109}\) The proof of (3-53) is as follows:

\[
w = (1-\alpha)B(\frac{x_t}{l_t}) = \left[ r_t - \frac{n \cdot s_t^b}{S_t} \right] \frac{f'(\varepsilon, v_j)}{f(\varepsilon, v_j) - f'(\varepsilon, v_j) \cdot v_j} S_j\]

\[
\Rightarrow S \bigg/ x_t = \frac{(1-\alpha)B}{r_t - \frac{n \cdot s_t^b}{S_t}} \left[ \frac{1 - \gamma}{\gamma} \right] \cdot \frac{J}{l_t} \frac{f'(\varepsilon, v_j)}{f(\varepsilon, v_j) - f'(\varepsilon, v_j) \cdot v_j} \cdot J \]

\[
= \frac{(1-\alpha)B}{r_t - \frac{n \cdot s_t^b}{S_t}} \left[ \frac{1 - \gamma}{\gamma} \right] \cdot \frac{J}{l_t} \frac{f'(\varepsilon, v_j)}{f(\varepsilon, v_j) - f'(\varepsilon, v_j) \cdot v_j} \cdot J \]

\[
= \frac{(1-\alpha)B}{r_t - \frac{n \cdot s_t^b}{S_t}} \left[ \frac{1 - \gamma}{\gamma} \right] \cdot \frac{l_b}{1-l_b} \]
• (3-28) Capital Accumulation Equation for each individual Banks

\[ K^b_{t+1} = S_q^b f(\varepsilon, v) \]

From (3-28), aggregate capital accumulation (investment) in the intermediate good sector with the presence of bank in symmetric equilibrium is given as follows:

\[ \Delta x_t = I = JK^b_t = JS_q^b f(\varepsilon, v) = S \cdot q^b f(\varepsilon, v) \]  

Using the fact that \( K_i(i) = K^b_i \) in symmetric equilibrium, the equilibrium growth rate is given as follows\(^\text{110}\)

\[ g_k = \alpha \cdot S \cdot q^b f(\varepsilon, v) \]

Therefore, combining (3-53) with (3-55) yields the following equilibrium capital growth rate that describes the labour market equilibrium.

\[ g_k = \alpha \cdot S \cdot q^b f(\varepsilon, v) \]

\[ = \left[ \alpha \cdot (1-\alpha)B \left( \frac{1-\gamma}{\gamma} \right) \frac{l_b}{S_i} \right] \cdot q^b f(\varepsilon, v) \]

\(^\text{110}\) The proof of (3-54) is as follows:

\[ g_k = \frac{y_{t+1} - y_t}{y_t} = \frac{\Delta y_t}{\Delta t} = \frac{\alpha B x^a (E_x)^{-a}}{B x^a (E_x)^{-a}} \cdot \frac{dx_t}{dt} = \alpha \cdot \frac{dx_t}{dt} = \alpha \cdot \frac{I}{x_t} = \alpha \cdot \frac{J \cdot K^b_{t+1}}{x_t} = \alpha \cdot \frac{S \cdot q^b f(\varepsilon, v)}{x_t} \]
3.4.4.2.2 Consumption Growth Path

Recall the following optimising conditions from the above section

- (3-37) Optimal Consumption Growth equation

\[
\frac{c_{z_{z+1}}}{c_{z_k}} - 1 = \left[ \left( \frac{\pi}{1 - \pi} \right) \cdot \frac{r_{z_k}}{r_{z_k}} \right]^{\frac{1}{\gamma}} - 1
\]

- (3-40) Factor Market Equilibrium Condition, which state that marginal product of using intermediate input is equal to the real rental price of capital in the bank credit market

\[ p_{z_{z+1}} = \alpha \beta = \left( 1 + i \right)^\frac{r_{z_k}}{r_{z_k}} \]

- (3-46) Financial Intermediation Margin equation

\[
1 + i = \frac{r_{z_k} - \frac{n \cdot s_{i_{k}}^b}{\gamma}}{q_i^b \cdot f(\varepsilon, v_j) \cdot \left[ 1 - \gamma \right]} = \frac{r_{z_k} - \frac{n \cdot s_{i_{k}}^b}{\gamma}}{\frac{q_i^b \cdot f(\varepsilon, v_j)}{\gamma} \cdot \left[ 1 - \gamma \right]}
\]

- (3-51) Optimal Conditions governing Interest-elasticity of Savings $\frac{1}{\gamma}$ and Labour elasticity of Financial Technology $\mu$.

\[
\frac{1}{\gamma} = \frac{1 - n \cdot f(\varepsilon, v_j)}{\mu} = \frac{f(\varepsilon, v_j) \cdot 1 - n}{f'(\varepsilon, v_j)} = \frac{f(\varepsilon, v_j) - f'(\varepsilon, v_j) \cdot 1 - n}{f'(\varepsilon, v_j) \cdot 1 - n}
\]
Theoretical Model

Drawing them together can yield the following equilibrium consumption growth path\textsuperscript{111}.

\begin{equation}
 g_{c} = \left( \frac{\pi}{1 - \pi} \right) \alpha \cdot \beta \cdot q_{i}^{b} \cdot f(\varepsilon, v_{j}) \cdot \left( \frac{1 - \frac{1}{\gamma}}{r_{ix} - \frac{n \cdot s_{i}^{b}}{S_{i}}} \right) \right)^{1/\sigma} - 1
\end{equation}

\textbf{3.4.5 Discussion}

\textbf{3.4.5.1 First Stage: Financial Development Promotes Economic Growth}

Financial Development in this model can be thought of as follows:

- The improvement of financial technology that governs the efficiency of bank in channelling saving into investment. i.e. $f(\varepsilon, v_{j})$ increases.

- The increase in the proportion of workforce employed in the financial sector. i.e. $l_{b}$ increases.

Financial development occurs when financial instruments, markets, and intermediaries ameliorate the effects of information, enforcement and transaction costs and result in a higher efficiency of channelling and mobilising savings into productive investment. Hence the improvement of financial technology function, $f(\varepsilon, v_{j})$, can be thought of as financial development. Whereas $l_{b}$ can serve as a proxy to quantify the depth and the overall importance of financial sector in the economy. The higher the

\textsuperscript{111} The proof of (3-57) is as follows:

\begin{align*}
 g_{c} = \frac{c_{2r+1}}{c_{r}} - 1 &= \left( \frac{\pi}{1 - \pi} \right) \cdot \frac{r_{2r}}{r_{r}} \right)^{1/\sigma} - 1 = \left( \frac{\pi}{1 - \pi} \right) \left( \frac{\alpha \beta}{1 + i} \right)^{1/\sigma} - 1 \\
 &= \left( \frac{\pi}{1 - \pi} \right) \alpha \cdot \beta \cdot q_{i}^{b} \cdot f(\varepsilon, v_{j}) \cdot \left( \frac{1 - \frac{1}{\gamma}}{r_{ix} - \frac{n \cdot s_{i}^{b}}{S_{i}}} \right) \right)^{1/\sigma} - 1 \\
 &= \left( \frac{\pi}{1 - \pi} \right) \alpha \cdot \beta \cdot q_{i}^{b} \cdot f(\varepsilon, v_{j}) \cdot \left( \frac{1 - \frac{f'(\varepsilon, v_{j}) \cdot v_{j}}{f(\varepsilon, v_{j}) \cdot 1 - n}}{r_{ix} - \frac{n \cdot s_{i}^{b} \cdot f'(\varepsilon, v_{j}) \cdot v_{j}}{S_{i} \cdot f(\varepsilon, v_{j}) \cdot 1 - n}} \right) \right)^{1/\sigma} - 1
\end{align*}

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proportion of workforce employed in the financial sector, the greater significance of the impact of financial sector towards the development of the economy. One point to note is that the effect of $l_b$ is increasing at an increasing rate. The implication is that the effect of financial development on economic growth is larger for developed countries compared with the developing world.

The McKinnon-Shaw School on financial liberalisation and the real world observation suggested that countries with a repressed financial sector usually have a highly oligopolistic banking systems and a low interest-rate elasticity of saving because of the usage of non-price resources allocation means, while in a highly financially developed countries, the banking system is more competitive and the responsiveness of saving toward interest-rate change will be higher\footnote{Readers can refer to the literature review in the previous chapter (Fry 1995; McKinnon 1973; Shaw 1973)}. Therefore, similar to the Berthelemy and Varoudakis (1996) model, it is assumed that financial development, as represented by $v_j = \frac{l_b}{j}$, is positively related to the interest-rate elasticity of saving $\frac{1}{\gamma}$. According to (3-51), the interest-rate elasticity of saving $\frac{1}{\gamma}$ is negatively related to the labour elasticity of financial technology $\mu$. This implies that financial development is negatively related to $\mu$. This further justifies the assumption, as the financial sector is more developed, that the responsiveness of improvement financial technology with respect to labour increase will be lower due to the diminishing marginal return. Whereas, for an underdeveloped financial sector, there will be a significant improvement on the financial sector when there is a small incremental of labour because the marginal return is higher.

Therefore, financial development will raise the interest-rate elasticity of saving $\frac{1}{\gamma}$ and the financial technology $f(\varepsilon, v_j)$, and lower the labour elasticity of financial technology $\mu$. Both effects will lower the financial intermediation margin $1+i$ according to (3-46) and (3-49).

Recall in (3-40), in factor market equilibrium the marginal cost of using capital (intermediate input) at the optimal condition depends on the capital (intermediate input) income shares, $a$, and the total factor productivity, $B$, which is equal to the real rental price of capital in the bank credit market i.e., the intermediation margin $1+i$ times the

\footnote{Readers can refer to the literature review in the previous chapter (Fry 1995; McKinnon 1973; Shaw 1973)}
interest rate \( \frac{r_{2t}}{r_{1t}} \). Therefore, lowering the financial intermediation margin \( 1 + i \) will lead the bank to raise their interest rate \( \frac{r_{2t}}{r_{1t}} \), so as to level the real rental price of capital in the financial market with the marginal cost of using capital in the real sector at factor market equilibrium, holding \( \alpha \) and \( B \) constant.

Raising the interest rate \( \frac{r_{2t}}{r_{1t}} \) will result in a higher consumption growth in equilibrium according to (3-37). Therefore, the above describes the mechanism where financial development can exert a positive effect on long-run economic growth through the interest-rate channel by increasing efficiency of channelling savings into productive investment. This analysis also provides indirect support for the financial liberalisation thesis, where liberalising interest rates will exert a beneficial effect on the country economic growth.

### 3.4.5.2 Second Stage: Growth Promote Financial Development

#### 3.4.5.2.1 Growth Effects on Marginal Productivity of Labour in Banking Sector

Recall the following equation in above sections

- (3-52) Marginal Productivity of Labour in Banking Sector (\( MPL_B \))

\[
\begin{align*}
    w &= \left[ r_{1t} - \frac{n \cdot s^b}{S_t} \right] \cdot \frac{\gamma}{1 - \gamma} \cdot \frac{S}{J} \\
\end{align*}
\]

- (3-53): Saving at Labour Market Equilibrium

\[
\begin{align*}
    S &= \frac{(1 - \alpha)B}{r_{1t} - \frac{n \cdot s^b}{S_t}} \cdot \left( \frac{1}{\gamma} - 1 \right) \cdot \frac{l_b}{1 - l_b} \\
\end{align*}
\]

According to (3-53), equilibrium aggregate saving is positively related to the interest-rate elasticity of saving \( \frac{1}{\gamma} \) and financial development measured by per bank employment in
Theoretical Model

financial sector \( v_j = \frac{l_b}{f} \). Hence financial development raises aggregate level of saving in

the economy directly and indirectly through raising interest-rate elasticity of saving \( \frac{1}{\gamma} \),

holding the other factors constant. Besides, higher interest rate will also increase the
incentives for people to save. According to \( (3-52) \), higher saving will lead to a higher
profitability of bank and raise the marginal productivity of labour in equilibrium.

Recall the following equation in above sections

- \( (3-46) \): Equation for Bank Intermediation Margin

\[
1 + i = \frac{r_{it} - n \cdot s_t^b}{S_t} \cdot \frac{q_t^b \cdot f(\varepsilon, v_f)}{1 - \frac{1}{\gamma}}
\]

- \( (3-55) \): Optimal Growth in terms of Savings.

\[
g_k = \frac{\alpha \cdot S \cdot q_t^b \cdot f(\varepsilon, v_f)}{x_t}
\]

Combining the above 2 equations with \( (3-48) \) and \( (3-53) \) yields the marginal
productivity of labour in banking \( MPL_B \) sector as a function of economic growth rate\(^{113} \).

\[
w = \left[ r_{it} - \frac{n \cdot s_t^b}{S_t} \right] \cdot \frac{1}{\left( \frac{1}{1 - \frac{1}{\gamma}} \right)} \cdot \frac{g_k \cdot x_t}{\alpha \cdot q_t^b \cdot f(\varepsilon, v_f)} \cdot \frac{1}{l_b}
\]

According to \( (3-58) \), marginal productivity of labour in banking sector \( MPL_B \) is
negatively related to the fraction of employment in banking \( l_b \). Hence a standard
downward sloping labour demand curve can be obtained.

Financial development affects the \( MPL_B \) through the following channel:

\(^{113}\) The derivation of \( (3-58) \) is as follows:

\[
w = \left[ 1 + i \right] q_t^b \cdot f'(\varepsilon, v_f) - \frac{n \cdot s_t^b}{S_t} \cdot \frac{f'(\varepsilon, v_f)}{f(\varepsilon, v_f)} \cdot S_t \cdot \frac{r_{it} - n \cdot s_t^b}{S_t} \cdot \frac{1}{\left( \frac{1}{1 - \frac{1}{\gamma}} \right)} \cdot \frac{g_k \cdot x_t}{\alpha \cdot q_t^b \cdot f(\varepsilon, v_f)} \cdot \frac{1}{l_b}
\]

\[
= \left[ r_{it} - \frac{n \cdot s_t^b}{S_t} \right] \cdot \frac{1}{\left( \frac{1}{1 - \frac{1}{\gamma}} \right)} \cdot \frac{g_k \cdot x_t}{\alpha \cdot q_t^b \cdot f(\varepsilon, v_f)} \cdot \frac{1}{l_b}
\]
• Financial development that raises the financial technology $f(\varepsilon,v_j)$ and interest-rate elasticity of saving $\frac{1}{\gamma}$ will bring down the bank intermediation margin (3-49), and thereby exerting a negative effect on $MPL_B$.

• However, the accompanied economic growth $g_k$ brought by an increase in financial technology $f(\varepsilon,v_j)$ will exert a positive impact on the $MPL_B$ through the saving channels, holding others constant (3-58).

It is reasonable to assume that in the early stages of development with a less developed financial market, the positive external effect exerted on bank productivity on saving generated by the growth in real sector will outweigh the negative effect of lower bank intermediation margin, so that overall there is an increasing return to scale of production in the banking sector. It is because according to the financial liberalisation thesis that a repressed financial sector usually has a highly oligopolistic banking systems and a low interest-rate elasticity of saving because of the usage of non-price resources allocation means, and therefore bank intermediation margin tend to be less sensitive to the change in financial structure. While at the later stage of development with highly financial market, the positive external effect exerted by saving generated by the real sector growth will tend to diminish, while bank intermediation margin will tend to be more sensitive to competition and to the change in financial structure. Therefore the overall effect will be ambiguous and marginal productivity ($MPL_B$) may lower if the negative effect outweighs the positive influence.

### 3.4.5.2.2 Dynamics of Change in Banking Sector Employment due to Growth

The marginal productivity of labour in real sector and in banking sector is represented by the following equations:

• (3-39) Marginal Productivity of Labour in Real (Final Good) Sector ($MPL_R$)

$$w = (1 - \alpha)B\left(\frac{x}{l_y}\right) = (1 - \alpha)B\left(\frac{x}{1 - l_b}\right)$$
• (3-58) Marginal Productivity of Labour in Banking Sector (MPL$_R$)

\[
w = \left[ r_t - \frac{n \cdot s_i^b}{S_t} \right] \cdot \frac{1}{1 - \frac{1}{\gamma}} \cdot \frac{g_k \cdot x_t}{\alpha \cdot q_i^b \cdot f(\varepsilon, \nu_j)} \cdot \frac{1}{l_b}
\]

In the final good (real) sector, there is a diminishing marginal productivity of labour (MPL$_R$) with respect to the fraction of workforce employed in the final good sector. Whereas in the banking sector, the marginal productivity of labour (MPL$_B$) is constant and it is independent on the fraction of workforce employed in the banking sector. Recall the proportion of workforce can be employed in either the final good sector or in the banking sector. Hence one can yield the following equilibrium labour force in banking sector$^{114}$.

\[
(3-59)
\]

\[
\cdot l_b = \frac{g_k}{g_k + \left[ \alpha \cdot (1 - \alpha) \cdot B \cdot \left( \frac{1}{\gamma} - 1 \right) \cdot q_i^b \cdot f(\varepsilon, \nu_j) \right] / \left( r_t - \frac{n \cdot s_i^b}{S_t} \right)}
\]

(3-59) implies that holding all other factor constant, economic growth (g) will raise the fraction of workforce in banking sector ($l_b = 1 - l_f$) in equilibrium. Hence financial sector

$^{114}$ The derivation of (3-59) is as follows:

\[
w = (1 - \alpha)B \left( \frac{x_t}{1 - l_b} \right) = \left[ r_t - \frac{n \cdot s_i^b}{S_t} \right] \cdot \frac{1}{1 - \frac{1}{\gamma}} \cdot \frac{g_k \cdot x_t}{\alpha \cdot q_i^b \cdot f(\varepsilon, \nu_j)} \cdot \frac{1}{l_b}
\]

\[
\alpha \cdot (1 - \alpha) \cdot B \cdot \left( \frac{1}{\gamma} - 1 \right) \cdot q_i^b \cdot f(\varepsilon, \nu_j)
\]

\[
\Rightarrow \frac{r_t - \frac{n \cdot s_i^b}{S_t}}{g_k + \left[ \alpha \cdot (1 - \alpha) \cdot B \cdot \left( \frac{1}{\gamma} - 1 \right) \cdot q_i^b \cdot f(\varepsilon, \nu_j) \right] / \left( r_t - \frac{n \cdot s_i^b}{S_t} \right)} \cdot l_b = (1 - l_b) \cdot g_k
\]

\[
\Rightarrow l_b = \frac{g_k}{g_k + \left[ \alpha \cdot (1 - \alpha) \cdot B \cdot \left( \frac{1}{\gamma} - 1 \right) \cdot q_i^b \cdot f(\varepsilon, \nu_j) \right] / \left( r_t - \frac{n \cdot s_i^b}{S_t} \right)}
\]
will expand and lead to financial development. Figure 3-5 depict the graphical illustration of the above results.

**Figure 3-5** Growth rate increase will shift up MPLR curve, and therefore the fraction of workforce in banking sector with increase from point X to point Y.

3.4.5.3 Explanation

At the early stage of development, the financial sector is still in an infant stage, and most of the workforce in the economy is employed in the real sector. When financial development starts to take off, workers will migrate to the financial sector from the real sector, because wages (marginal productivity of labour) will be relatively higher in the financial sector. This will lead to expansion in the financial sector (as more labour is employed) and result in economic growth as explained in section 3.4.5.1. Economic growth in the real sector will generate more saving, which will exert a positive effect on banking productivity and raise the wage rate for the bank. This in turn will attract more...
labour to migrate to the financial sector because of higher wage. Hence, this will result in further expansion of financial sector (and hence financial development). Therefore, a virtuous cycle is formed.

In the meantime, as the fraction of workforce in the real sector decreases, the wage rate in the real sector will increase, while at the later stage of development with a highly financial market, the positive external effect exerted by saving generated by the real sector growth will tend to diminish, and the marginal productivity of labour in the bank will be less responsive to economic growth, as explained in section 3.4.5.2.1. Therefore, a steady-state will arise where the marginal productivity of labour will be equal across the real sector and the financial sector, and the long-run growth rate is described by (3-56) and (3-57).

3.5 Difference between the result of the new model with previous models

While the fundamental idea of the new model in this study is similar to the original Greenword and Smith (1997) and Berthelemy and Varoudakis (1996) models, the result differs. Greenwood and Smith (1997) result suggests that banks are always justified to exist, as capital accumulation in the society will always be greater in the presence of banks. However, by introducing the intermediation (wage) cost and labour market dynamics, this study is able to yield a different result, showing that banks are justified to exist only if the intermediation (wage) cost is sufficiently low. The new result seems to be more consistent with the microeconomic theory and the observation of the evolution pattern of the financial system in the world, where higher intermediary costs will lead to inefficiency of the intermediation process that inhibit capital accumulation. Thus the result here is also able to yield a new testable hypothesis for researchers to test in the future.

By specifying the bank's production, this study is able to examine the effect of different economic parameters on the capital accumulation path. Hence capital accumulation can be affected not only by the risk aversion factor, the relative return on capital investment over storage and the probability for agents to have late withdrawal of deposits at the old age, as in Greenwood and Smith (1997) model, but also by the ratio of the wage cost to the total deposits for the bank and the efficiency for banks to channel saving into productive investment. Hence this represent another difference in results the new model with the original one.
The original Berthelemy and Varaoudakis model defines financial development as an expansion of employment in banking sector. This study further include the improvement of financial technology (financial innovation), and thereby is able to yield a new result that is different from the original one. While the previous result focus on the expansion of financial sector as a growth determinant factor, the new result in this study show that improvement of the quality of legal infrastructure that raises the financial technology function will exert a positive impact on economic growth.

In sum, by introducing the labour market dynamics and by specifying the bank’s production function, this new model is able to provide new results that are different from the original framework.

3.6 Conclusion

The analysis shows that the proportion of saving that is channelled to productive investment is greater in the presence of financial intermediation. Accordingly, by preventing premature liquidation of capital and improvement of risk sharing through inter-mediation, the banking system will result in a larger capital investment in the portfolio through the provision of liquidity. This justifies the existence of the financial system.

The profit-maximising motives of the bank entrepreneur will result in the starting off of bank system. At the infant stage of development, less people are employed in the financial sector relative to the real sector. This result in a higher marginal labour productivity (and hence wage) in the bank relative to the real sector. Workers will therefore migrate to the financial sector, which therefore lead to an expansion of financial sector.

Financial development can facilitate capital accumulation through liquidity provision and lowering risk in the system. It will also exert a positive influence on long-run economic growth through interest-rate channel by increasing bank competition and by increasing the efficiency of financial intermediation. Hence, financial development encourages growth and lead to an expansion of real sector.

Economic growth in the real sector will generate more saving and thereby a positive external effect on banking productivity. Because of the less developed financial system and the monopolistic or oligopolistic nature of banking system at the early stage, bank intermediation margins tend to be less sensitive to the change in financial structure,
and therefore the negative effect of financial development on marginal labour productivity through the lowering bank margin will be significantly less than the positive external effect by growth. Therefore the marginal productivity, and hence the wage rate, for the bank will rise. This in turn will attract more labour to migrate to the financial sector because of higher wage. Hence, this will result in further expansion of the financial sector (and hence financial development).

The process will continue and the country will reach their later stage of development with a highly developed financial system. At this stage, marginal labour productivity will be significant higher due to the migration of workers away from this sector. Besides, as there is a continued development of financial sector, bank margins will be more sensitive to these changes because there is more competition and a more efficient use of resources, and bank margins will continue to fall. The negative effect of bank intermediation margin on wage will therefore counteract the positive external effect by growth. With a rising wage rate in real sector and a constant falling wage rate in the financial sector, the economy will reach the steady-state where marginal productivity of labour become equal across the real sector and the financial sector. Expansion of the financial system will cease, and the steady-state of economic growth rate is governed by the total factor productivity and the capital share of income in the final good sector, as well as the financial technology, the time preference and magnitude of the elasticity of marginal utility of consumption.
3.7 Appendix: Mathematical Proofs

The appendix shows the derivations of some equations in this chapter.

3.7.1 The Derivation of (3-23)

Let $\Omega$ denote the utility function in equation (3-22).

\[
\Omega = \frac{S^{1-\sigma} \left[ (1-\pi) \left( n \left( 1-q_i^* \right) \right)^{1-\sigma} + \pi \left( n \left( 1-q_i^* \right) + (R\theta B)q_i^* \right)^{1-\sigma} \right]}{1-\sigma} - 1
\]

Maximising $\Omega$ with respect to $q_i^*$ (i.e. the fraction of capital held in financial autarky agent's portfolio) yields the optimal level of $q_i^*$. The following shows the step by step derivations of this first order condition.

\[
\frac{d\Omega}{dq_i^*} = 0
\]

\[
\Rightarrow \frac{S^{1-\sigma} \left[ (1-\pi) \left( n \left( 1-q_i^* \right) \right)^{1-\sigma} + \pi \left( n \left( 1-q_i^* \right) + (R\theta B)q_i^* \right)^{1-\sigma} \right]}{1-\sigma} = 0
\]

\[
\Rightarrow (1-\pi) \left[ n \left( 1-q_i^* \right) \right]^{\sigma} \left( -n \right) + \pi \left[ n \left( 1-q_i^* \right) + (R\theta B)q_i^* \right]^{\sigma} \left( (R\theta B) - n \right) = 0
\]

\[
\Rightarrow \frac{\pi (R\theta B - n)}{n(1-f^*) + R\theta B q_i^*} = \frac{n(1-\pi)}{n(1-q_i^*)} \Rightarrow \frac{\pi (R\theta B - n)}{n(1-\pi)} = \frac{n(1-f^*) + R\theta B q_i^*}{n(1-q_i^*)}
\]

\[
\Rightarrow n(1-q_i^*) \cdot \left[ \frac{\pi (R\theta B - n)}{n(1-\pi)} \right]^{1/\sigma} = n(1-q_i^*) + R\theta B q_i^*
\]

\[
\Rightarrow n \left[ \frac{\pi (R\theta B - n)}{n(1-\pi)} \right]^{1/\sigma} - n = \left[ \frac{\pi (R\theta B - n)}{n(1-\pi)} \right]^{1/\sigma} - n + R\theta B q_i^*
\]

\[
\Rightarrow q_i^* = \frac{\left[ \frac{\pi (R\theta B - n)}{n(1-\pi)} \right]^{1/\sigma} - 1}{1 + \frac{R\theta B}{n}} = \frac{\left[ \frac{\pi (R\theta B - n)}{(1-\pi)} \right]^{1/\sigma} - 1}{1 + \frac{R\theta B}{n}}
\]

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3.7.2 The Derivation of (3-33)

The utility function of a representative agent is
\[
(1 - \pi)(c_{11})^{1-\sigma} - 1 + \pi(c_{21})^{1-\sigma} - 1
\]
according to equation (3-32), which is
\[
(1 - \pi)[(S_1 r_{11})^{1-\sigma} - 1] + \pi[(S_2 r_{21})^{1-\sigma} - 1]
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3.7.3 The Derivation of (3-34)

Maximising equation (3-33) with respect to $q^b_i$ (i.e. the fraction of capital investment by a bank) yields the optimal level of $q^b_i$. The following shows the step by step derivations of this first order condition.

\[
\frac{d}{d(q^b_i)} \left[ S_i^{-\sigma} (1-\pi)^{\sigma} \left[ n^{1-\sigma} \left( 1 - q^b_i - \frac{w \cdot v_j}{S_i} \right)^{1-\sigma} \right] + \frac{1}{S_i^{1-\sigma}} \left[ RA \theta B \cdot f(\varepsilon, v_j) \right]^{1-\sigma} \left( q^b_i \right)^{1-\sigma} \left( 1 - \frac{1}{S_i} \right)^{1-\sigma} \right] = 0
\]

\[
S_i^{-\sigma} \left\{ - (1-\pi)^{\sigma} n^{1-\sigma} \left( 1 - q^b_i - \frac{w \cdot v_j}{S_i} \right)^{-\sigma} + \pi^\sigma (1-\sigma) \left[ RA \theta B \cdot f(\varepsilon, v_j) \right]^{-\sigma} (q^b_i)^\sigma \right\}
\]

\[
\Rightarrow \frac{\pi^\sigma \left[ RA \theta B \cdot f(\varepsilon, v_j) \right]^{1-\sigma} (q^b_i)^\sigma}{(1-\pi)^{\sigma} n^{1-\sigma} \left( 1 - q^b_i - \frac{w \cdot v_j}{S_i} \right)^{-\sigma}} = 0
\]

\[
\Rightarrow \pi = \frac{1}{(1-\pi)} \left( \frac{n}{RA \theta B \cdot f(\varepsilon, v_j)} \right)^{\sigma} \cdot \frac{q^b_i}{1 - q^b_i - \left( \frac{w \cdot v_j}{S_i} \right)}
\]

\[
\Rightarrow \eta = \frac{1}{1 - \pi} \left( 1 - q^b_i - \left( \frac{w \cdot v_j}{S_i} \right) \right) = q^b_i (1 + \eta)
\]

\[
\Rightarrow q^b_i = \frac{\eta \left( 1 - \frac{w \cdot v_j}{S_i} \right)}{(1 + \eta)} \text{ where } \eta = \frac{n}{(1-\pi)} \left( \frac{RA \theta B \cdot f(\varepsilon, v_j)}{\pi} \right)^{\sigma}
\]

This gives the optimal $q^b_i$ in equation (3-34).
3.7.4 Proofs of first order conditions in section 3.3.3.2.4

Recall the optimal fraction of capital investment by a bank $q_i^b$ is given by equation (3-34)

$$q_i^b = \frac{\eta \left(1 - \frac{w \cdot v_j}{S_i}\right)}{(1 + \eta)} \pi \left(\frac{\eta \left(1 - \frac{\theta \cdot B \cdot f(\epsilon, v_j)}{n}\right)}{(1 - \pi)}\right)^{\frac{1-\sigma}{\alpha}}$$

where $\eta = \frac{\pi}{1 - \pi}$.

Differentiate $q_i^b$ with respect to $\left(\frac{w \cdot v_j}{S_i}\right)$ (the ratio of wage cost to the total deposit for the bank) gives the followings, which implies that $q_i^b$ is negatively related to $\left(\frac{w \cdot v_j}{S_i}\right)$

$$\frac{d(q_i^b)}{d \left(\frac{w \cdot v_j}{S_i}\right)} = -\frac{\eta}{(1 + \eta)} < 0$$

Differentiate $q_i^b$ with respect to $\pi$ (the probability for agents $t$ have late withdrawal of deposits at the old age) gives the followings, which implies that $q_i^b$ is positively related to $\pi$.

$$\frac{d(q_i^b)}{d \pi} = \frac{(1 + \eta) \left(1 - \frac{w \cdot v_j}{S_i}\right) \left(1 - \pi\right)^2 \left(\frac{\eta \left(1 - \frac{\theta \cdot B \cdot f(\epsilon, v_j)}{n}\right)}{(1 - \pi)}\right)^{\frac{1-\sigma}{\alpha}} - \eta \left(1 - \frac{w \cdot v_j}{S_i}\right) \left(1 - \pi\right)^2 \left(\frac{\eta \left(1 - \frac{\theta \cdot B \cdot f(\epsilon, v_j)}{n}\right)}{(1 - \pi)}\right)^{\frac{1-\sigma}{\alpha}}}{(1 + \eta)^2}$$

$$= \frac{1}{(1 + \eta)^2} > 0$$

Differentiate $q_i^b$ with respect to $\sigma$ (the level of risk-averseness) gives the followings, which implies that $q_i^b$ is negatively related to $\sigma$.

$$\frac{d(q_i^b)}{d \sigma} = \frac{(1 + \eta) \left(1 - \frac{w \cdot v_j}{S_i}\right) \left(1 - \pi\right)^2 \left(\frac{\eta \left(1 - \frac{\theta \cdot B \cdot f(\epsilon, v_j)}{n}\right)}{(1 - \pi)}\right)^{\frac{1-\sigma}{\alpha}} - \eta \left(1 - \frac{w \cdot v_j}{S_i}\right) \left(1 - \pi\right)^2 \left(\frac{\eta \left(1 - \frac{\theta \cdot B \cdot f(\epsilon, v_j)}{n}\right)}{(1 - \pi)}\right)^{\frac{1-\sigma}{\alpha}}}{(1 + \eta)^2}$$

$$= \frac{-1}{(1 + \eta)^2} < 0$$

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Differentiate $q_i^b$ with respect to $\left(\frac{RA\theta B}{n}\right)$ (the relative return of capital investment over storage) gives the followings, which implies that $q_i^b$ is positively related to $\left(\frac{RA\theta B}{n}\right)$.

\[
\frac{d(q_i^b)}{d\left(\frac{RA\theta B}{n}\right)} = \frac{\eta \left(1 - \frac{w \cdot v_j}{S_i}\right) \left(1 - \frac{\pi}{1 - \sigma}\right) \cdot \frac{f(\sigma)}{\left(\frac{R\theta B \cdot f(\sigma)}{n}\right)^{\frac{1 - \sigma}{\sigma}}}}{(1 + \eta)^2} = \frac{1}{(1 + \eta)^2} > 0
\]

Differentiate $q_i^b$ with respect to $f(\sigma)$ (the efficiency for banks to channel saving into productive investment) gives the followings, which implies that $q_i^b$ is positively related to $f(\sigma)$.

\[
\frac{d(q_i^b)}{d(f(\sigma))} = \frac{\eta \left(1 - \frac{w \cdot v_j}{S_i}\right) \left(1 - \frac{\pi}{1 - \sigma}\right) \cdot \frac{f(\sigma)}{\left(\frac{R\theta B \cdot f(\sigma)}{n}\right)^{\frac{1 - \sigma}{\sigma}}}}{(1 + \eta)^2} = \frac{1}{(1 + \eta)^2} > 0
\]
3.7.5 The Proof of Proposition 1A

The capital accumulation with the existence of the bank, \( K'_{it, b} \), is larger than that without banks, \( K'_{it, w} \), if \( \frac{K'_{it, b}}{K'_{it, w}} > 1 \). Recall from (3-21) and (3-26), 
\( K'_{it, w} = S_i q^*_i \) and \( K'_{it, b} = S_i \cdot q^*_i \cdot f(e, v_j) = K^*_b \cdot f(e, v_j) \). Therefore,

\[
\frac{K^*_b}{K^*_w} = \frac{q^*_i \cdot f(v_j)}{q^*_i} = \frac{\left(1 - \frac{w \cdot v_j}{S_i}\right) \cdot f(e, v_j) \cdot \left(1 + \frac{\lambda}{1 - \eta} \right)}{\left(1 + \eta\right) (\lambda - 1)} = \left(1 - \frac{w \cdot v_j}{S_i}\right) \cdot f(e, v_j) \cdot \left(\frac{\lambda}{1 - \eta} + \frac{\lambda \eta - \eta - 1}{n} \right)
\]

\[
\left(1 - \frac{w \cdot v_j}{S_i}\right) \cdot f(e, v_j) \cdot \left(\frac{\lambda}{1 - \eta} + \frac{\lambda \eta - \eta - 1}{n} \right) = \left[\left(\frac{\pi}{1 - \eta}\right) \left(\frac{RAOB - n}{n}\right)\right]^{\frac{1}{\pi}} + \left[\left(\frac{\pi}{1 - \eta}\right) \left(\frac{RAOB - n}{n}\right)\right]^{\frac{1}{\pi}} - 1
\]

It is because \( q^*_i = \frac{1 - \eta}{\lambda - 1 + \frac{RAOB}{n}} \) according to (3-22), and \( q^*_i = \frac{\left(1 - \frac{w \cdot v_j}{S_i}\right)}{n} \) according to (3-33). Rearrange and simplify the above expression will yield the followings:
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\[
\begin{align*}
\frac{K_{nl}^+}{K_{nl}^-} &= \left(1 - \frac{w \cdot v}{S_{l}}\right) f(e, v) \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} + \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} - \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \\
&= \left(1 - \frac{w \cdot v}{S_{l}}\right) f(e, v) \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} + \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} - \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \\
&= \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} + \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} - \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \\
&= \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} + \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} - \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \\
&= \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} + \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} - \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \\
&= \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} + \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} - \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \\
&= \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} + \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} - \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \\
&= \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} + \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} - \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \\
&= \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}} \left(\frac{\pi}{1 - \pi}\right) \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} + \left(\frac{RAOB \cdot f(e, v)}{n}\right)^{\frac{1}{2}} - \left(\frac{RAOB - n}{n}\right)^{\frac{1}{2}}
\end{align*}
\]
Therefore \( K_{r_{ii}}^b > 1 \) if and only if

\[
K_{r_{ii}}^b = \left( 1 - \frac{w \cdot v_i}{S_i} \right) f(e, v_i) \left( \frac{\pi}{1 - \pi} \frac{RABB - n}{n} \right)^{n - 1} \left( RABB - n \right) > 1
\]

This holds if and only if

\[
1 - \frac{w \cdot v_i}{S_i} \left( \frac{\pi}{1 - \pi} \frac{RABB - n}{n} \right)^{n - 1} \left( RABB - n \right) > f(e, v_i) \left( \frac{\pi}{1 - \pi} \frac{RABB - n}{n} \right)^{n - 1} \left( RABB - n \right) \]

if and only if

\[
1 - \frac{w \cdot v_i}{S_i} \left( \frac{\pi}{1 - \pi} \frac{RABB - n}{n} \right)^{n - 1} \left( RABB - n \right) > 0
\]
\[
\begin{array}{c}
\left\{ \begin{array}{c}
f(\varepsilon, v)^{\frac{1}{2}} \left( \frac{\pi}{1-\pi} \right)^{\frac{1}{2}} \left( \frac{RAOB - n}{n} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1} + \left( \frac{RAOB - n}{RAOB} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1} \\
\left( \frac{\pi}{1-\pi} \right)^{\frac{1}{2}} \left( \frac{RAOB - n}{n} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1} - f(\varepsilon, v) \left( \frac{1-\pi}{\pi} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1} \\
f(\varepsilon, v)^{\frac{1}{2}} \left( \frac{\pi}{1-\pi} \right)^{\frac{1}{2}} \left( \frac{RAOB - n}{n} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1} + \left( \frac{RAOB - n}{RAOB} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1}
\end{array} \right\} > \frac{w \cdot v}{S_i}
\end{array}
\]

if and only if

\[
\left\{ \begin{array}{c}
f(\varepsilon, v)^{\frac{1}{2}} - f(\varepsilon, v) \left( \frac{1-\pi}{\pi} \right)^{\frac{1}{2}} \left( \frac{RAOB - n}{n} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1} + f(\varepsilon, v) \left( \frac{RAOB - n}{RAOB} \right)^{\frac{1}{2}} \\
\left( \frac{\pi}{1-\pi} \right)^{\frac{1}{2}} \left( \frac{RAOB - n}{n} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1} + f(\varepsilon, v) \left( \frac{1-\pi}{\pi} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1} \\
f(\varepsilon, v)^{\frac{1}{2}} \left( \frac{\pi}{1-\pi} \right)^{\frac{1}{2}} \left( \frac{RAOB - n}{n} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1} + \left( \frac{RAOB - n}{RAOB} \right)^{\frac{1}{2}} \left( \frac{RAOB}{n} \right)^{1}
\end{array} \right\} > \frac{w \cdot v}{S_i}
\]

if and only if

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\[
\frac{w \cdot v}{S_i} < \begin{cases} 
\left[ \frac{f(e, v_i) - 1}{f(e, v_i)} \right]^{\frac{1}{2}} (RAOB - n)^{\frac{1}{2}} \left( n \frac{1}{RAOB} \right)^{\frac{1}{2}} + \left( RAOB - n \right)^{\frac{1}{2}} \left( RAOB - n \right)^{\frac{1}{2}} f(e, v_i)^{\frac{1}{2}} \\
+ \left( n \frac{1}{RAOB} \right)^{\frac{1}{2}} f(v_i)^{\frac{1}{2}} + \left( 1 - \pi \right) \left( n \frac{1}{RAOB} \right)^{\frac{1}{2}} f(e, v_i)^{\frac{1}{2}} \\
\left( \frac{\pi}{1 - \pi} \right) \left( RAOB - n \right)^{\frac{1}{2}} \left( n \frac{1}{RAOB} \right)^{\frac{1}{2}} + \left( RAOB - n \right)^{\frac{1}{2}} \left( RAOB - n \right)^{\frac{1}{2}} f(e, v_i)^{\frac{1}{2}} \\
\right] 
\end{cases}
\]

if and only if

\[
\frac{w \cdot v}{S_i} < \begin{cases} 
\left[ \frac{f(e, v_i) - 1}{f(e, v_i)} \right]^{\frac{1}{2}} (RAOB - n)^{\frac{1}{2}} \left( n \frac{1}{RAOB} \right)^{\frac{1}{2}} + \left( RAOB - n \right)^{\frac{1}{2}} \left( RAOB - n \right)^{\frac{1}{2}} f(e, v_i)^{\frac{1}{2}} \\
+ \left( n \frac{1}{RAOB} \right)^{\frac{1}{2}} f(v_i)^{\frac{1}{2}} + \left( 1 - \pi \right) \left( n \frac{1}{RAOB} \right)^{\frac{1}{2}} f(e, v_i)^{\frac{1}{2}} \\
\left( \frac{\pi}{1 - \pi} \right) \left( RAOB - n \right)^{\frac{1}{2}} \left( n \frac{1}{RAOB} \right)^{\frac{1}{2}} + \left( RAOB - n \right)^{\frac{1}{2}} \left( RAOB - n \right)^{\frac{1}{2}} f(e, v_i)^{\frac{1}{2}} \\
\right] 
\end{cases}
\]

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Therefore, the above shows that $\frac{K_{A1}^k}{K_{n1}^k} > 1$ if and only if

$$\frac{w \cdot v_j}{S_j} < \left\{ \left[ \frac{f(\varepsilon, v_j) - 1}{f(\varepsilon, v_j)} \right] \left[ \frac{n}{RAOB} \right]^{\frac{1}{\pi}} - \left[ \frac{1 - \pi}{\pi} f(\varepsilon, v_j) \right] \right\} \pi \left[ \frac{1}{1 - \pi} \right] \left( RAOB - n \right) \frac{1}{\pi} \left( RAOB \right)^{-\frac{1}{\alpha}} + \left( RAOB - n \right) + \left[ \frac{1 - \pi}{\pi} f(\varepsilon, v_j) \right] \right\} \left[ \frac{n}{f(\varepsilon, v_j)} \right] \left[ \frac{n}{f(\varepsilon, v_j)} \right]^{\frac{1}{\alpha}}$$

This proof Proposition 1A, which shows the condition where the capital accumulation with the existence of the bank, $K_{n1}^k$, is larger than that without banks, $K_{n1}^k$. 

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3.7.6 The Derivation of (3-46)

The profit function is given by (3-45)

\[
\Pi_j = \psi_j - w \cdot v_j = \left[1 + i\right] q^b_i \cdot f(\varepsilon, v_j) \cdot S_i - S_i r_u - w \cdot v_j
\]

Maximise \(\Pi_j\) with respect to bank’s savings \(S_i\) will give the following condition:

\[
\frac{d\Pi_j}{dS_i} = \left[1 + i\right] q^b_i \cdot f(\varepsilon, v_j) + q^b_i \cdot f(\varepsilon, v_j) \cdot S_i \cdot \frac{\partial [1 + i]}{\partial S_i} - r_u = 0
\]

Rearrange and simplify the above expressions will give the following results:

\[
\left[1 + i\right] q^b_i \cdot f(\varepsilon, v_j) + q^b_i \cdot f(\varepsilon, v_j) \cdot S \cdot \frac{\partial \left[1 + i\right]}{\partial (r_{2t}/r_{1t})} \cdot \frac{\partial (r_{2t}/r_{1t})}{\partial S} \cdot J = r_u
\]

\[
\Rightarrow \left[1 + i\right] q^b_i \cdot f(\varepsilon, v_j) - q^b_i \cdot f(\varepsilon, v_j) \cdot S \cdot (RA\Theta B) \cdot \frac{\partial (r_{2t}/r_{1t})}{\partial S} = r_u
\]

\[
\Rightarrow \left[1 + i\right] q^b_i \cdot f(\varepsilon, v_j) - q^b_i \cdot f(\varepsilon, v_j) \cdot \left[1 + i - \frac{n \cdot s^b_i}{S_i \cdot q^b_i \cdot f(\varepsilon, v_j)} \right] \cdot \frac{\partial (r_{2t}/r_{1t})}{\partial S} = r_u
\]

\[
\Rightarrow \left[1 + i\right] q^b_i \cdot f(\varepsilon, v_j) \cdot \left[1 - \gamma\right] = r_u - n(1 - q^b_i - w \cdot v_j) \cdot \gamma
\]

\[
\Rightarrow \left[1 + i\right] = \frac{r_u - n \cdot s^b_i}{q^b_i \cdot f(\varepsilon, v_j) \cdot [1 - \gamma]}
\]

This yields the optimal banking intermediation margin condition (3-46) when savings are optimised.
3.7.7 The Derivation of (3-48)

The profit function is given by (3-45)

$$\Pi_j = \psi_j - w \cdot v_j = \left[1 + \bar{i}\right] q_i^b \cdot f(\varepsilon, v_j) \cdot S_i - S_i r_{it} - w \cdot v_j$$

Maximise $\Pi_j$ with respect to bank’s employment $v_j$ will give the following condition:

$$\frac{\partial \Pi_j}{\partial v_j} = \left[1 + \bar{i}\right] q_i^b \cdot f'(\varepsilon, v_j) \cdot S_i + \frac{\partial}{\partial v_j} \left[1 + \bar{i}\right] q_i^b \cdot f(\varepsilon, v_j) \cdot S_i - w = 0$$

Rearrange and simplify the above expressions will give the following results:

$$\left[1 + \bar{i}\right] q_i^b \cdot f'(\varepsilon, v_j) \cdot S_i - \left[1 - q_i^b \cdot \frac{w \cdot v_j}{S_i} \cdot f'(\varepsilon, v_j) \cdot S_i \cdot q_i^b \cdot f(\varepsilon, v_j) \cdot S_i \right] q_i^b \cdot f(\varepsilon, v_j) \cdot S_i = w$$

$$\Rightarrow (1-n)w = \left[1 + \bar{i}\right] q_i^b \cdot f'(\varepsilon, v_j) \cdot S_i \cdot \left[1 - q_i^b \cdot \frac{w \cdot v_j}{S_i} \cdot f'(\varepsilon, v_j) \cdot S_i \right] q_i^b \cdot f(\varepsilon, v_j) \cdot S_i,$$

$$\Rightarrow w = \left[1 + \bar{i}\right] q_i^b \cdot f'(\varepsilon, v_j) \cdot \frac{n \cdot s_i^b \cdot f'(\varepsilon, v_j)}{f(\varepsilon, v_j)} \cdot S_i \cdot \frac{S_i}{1-n}$$

This yields the optimal wage (marginal productivity of labour) in (3-48).
3.7.8 The Derivation of (3-49)

The profit function is given by (3-45)

$$\Pi_j = \psi_j - w \cdot v_j = [1 + i] q^b_i \cdot f(\varepsilon, v_j) \cdot S_i - S_i r_u - w \cdot v_j$$

The optimal wage is given by (3-48)

$$w = \left[ [1 + i] q^b_i \cdot f'(\varepsilon, v_j) - \frac{n \cdot s^b_i \cdot f'(\varepsilon, v_j)}{S_i} \right] \cdot \frac{S_i}{1-n}$$

Substitute the optimal wage in the profit function yields the following result:

$$\Pi_j = [1 + i] q^b_i \cdot f(\varepsilon, v_j) \cdot S_i - S_i r_u$$

$$- \left[ [1 + i] q^b_i \cdot f'(\varepsilon, v_j) - \frac{n \cdot s^b_i \cdot f'(\varepsilon, v_j)}{S_i} \right] \cdot \frac{S_i}{1-n} \cdot v_j = 0$$

$$\Rightarrow [1 + i] q^b_i \cdot f(\varepsilon, v_j) - \left[ [1 + i] q^b_i \cdot f'(\varepsilon, v_j) - \frac{n \cdot s^b_i \cdot f'(\varepsilon, v_j)}{S_i} \right] \cdot \frac{v_j}{1-n} = r_u$$

$$\Rightarrow [1 + i] q^b_i \left[ f(\varepsilon, v_j) - f'(\varepsilon, v_j) \cdot \frac{v_j}{1-n} \right] = r_u - \frac{n \cdot s^b_i \cdot f'(\varepsilon, v_j)}{S_i} \cdot \frac{v_j}{1-n}$$

$$\Rightarrow 1 + i = \frac{r_u - \frac{n \cdot s^b_i \cdot f'(\varepsilon, v_j)}{S_i} \cdot \frac{v_j}{1-n}}{q^b_i \left[ 1 - \frac{f'(\varepsilon, v_j)}{f(\varepsilon, v_j) - 1-n} \right] f(\varepsilon, v_j)}$$

This yields the optimal banking intermediation margin condition (3-49) when bank's employment is optimised.
3.7.9 The Derivation of (3-52)

The optimal wage is given by (3-48)

\[ w = \left[ 1 + \frac{n \cdot s_i^b}{S_i} \cdot f'(v_j) \right] \cdot \frac{S_i}{1-n} \]

\[ = \left[ \frac{r_{it} - \frac{n \cdot s_i^b}{S_i} \cdot \gamma}{q_t^b \cdot f(e, v_j)[1-\gamma]} \cdot \frac{n \cdot s_i^b}{S_i} \cdot f'(v_j) \right] \cdot \frac{S}{J \cdot (1-n)} \]

\{because \( [1+i] = \frac{r_{it} - \frac{n \cdot s_i^b}{S_i} \cdot \gamma}{q_t^b \cdot f(e, v_j)[1-\gamma]}\) according to (3-46)\}

\[ = \left[ \frac{r_{it} - \frac{n \cdot s_i^b}{S_i} \cdot \gamma}{[1-\gamma]} \cdot \frac{n \cdot s_i^b}{S_i} \cdot f'(v_j) \right] \cdot \frac{S}{J \cdot (1-n)} \cdot \frac{\gamma}{v_j} \cdot (1-n) \]

\{because \( \gamma = \frac{\mu}{1-n} = \frac{f'(e, v_j)}{f(e, v_j)} \cdot \frac{v_j}{1-n} \) according to (3-51)\}

\[ = \left[ \frac{r_{it} - \frac{n \cdot s_i^b}{S_i}}{[1-\gamma]} \cdot \frac{\gamma}{v_j} \cdot \frac{S}{J} = \left[ \frac{r_{it} - \frac{n \cdot s_i^b}{S_i}}{[1-\gamma]} \right] \cdot \frac{\gamma}{v_j} \cdot \frac{S}{J} \right. \]

\{simplify and rearrange the equation\}

\[ = \left[ \frac{r_{it} - \frac{n \cdot s_i^b}{S_i}}{[1-\gamma]} \right] \cdot \frac{f'(e, v_j)}{f(e, v_j)} \cdot \frac{S}{J} \cdot \frac{v_j}{1-n} \]

\[ = \left[ \frac{r_{it} - \frac{n \cdot s_i^b}{S_i}}{[1-\gamma]} \right] \cdot \frac{f'(e, v_j)}{f(e, v_j)} \cdot \frac{S}{J} \cdot \left( \frac{1}{1-n} \cdot f(e, v_j) - f'(e, v_j) \cdot v_j \right) \]

This gives the results in (3-52).
4 Reviews of the Empirical Literature and Data Description

4.1 Introduction

The theoretical analysis in Chapter 3 is able to yield a testable implication that there is a bi-directional casual relationship between financial development and economic growth, and thereby forming the theoretical underpinning of the empirical analysis in the following three chapters. The current chapter presents a survey of previous empirical studies of the finance-growth nexus, and discusses the datasets that are to be used for the empirical analysis in later chapters. This chapter is organised as follows. Section 4.2 reviews the literature concerning the empirical studies of cross-country economic growth. Section 4.3 reviews the empirical studies of the finance-growth nexus in the literature. Section 4.4 provides a detailed description and correlation analysis about the dataset that are to be used for the empirical work in chapter 5 and 6.

4.2 Growth Econometrics

This section provides a survey of the cross-country empirical studies on economic growth. Most of the empirical studies of the finance-growth nexus are based on the cross-country economic growth framework. Therefore, this section forms the background knowledge to understand the tools that are used to investigate the finance-growth nexus. It also yields valuable insight on the methodology that is going to be used in the empirical works in chapter 6.

4.2.1 Evidence for growth: Cross Countries Empirical Works

Temple (1999) reviews cross-country empirical work on economic growth. With the advance of the new growth theory, and with the availability of the Summers-Heston data set, there is a vast amount of empirical work aimed to explain the post-1960 growth evidence (Heston, Summers, and Aten 2002; Temple 1999).

Critics challenge the method of cross-section growth regression. They argue that growth in each country is distinctive that one-size-fit all approach cannot explain
the growth experience across countries. In response, one may argue that statistical work using cross-section analysis is often necessary to quantify the importance of the 'potentially relevant' factor. Econometrics is needed to test for the validity of generalizations, and this can serve as the starting point to explore the idiosyncratic elements in some particular countries. Therefore, careful growth regressions can play a valuable role in explaining growth pattern across countries (Temple 1999).

4.2.1.1 Growth Accounting

Growth accounting refers to allocation of economic growth rates among the determinants of output that influence growth. It estimates the size of the effect upon output of a given change in each input determinants. In estimation, growth accounting assumes that the technical progress is Hicks-neutral (or Total Factor Productivity augmenting) rather than Harrod-neutral (labour augmenting)\(^{115}\) (Denison 1987).

One form of cross-country regression is growth accounting. By specifying the production function, output growth can be decomposed into growth of capital inputs and total factor productivity (TFP). Instead of estimation, growth accounting imposes parameters of the production function based on factor shares or micro evidence, and assumptions have to be made about the production function, such as perfect competition, constant return to scale and the absence of externality. However, the new growth theorists question the validity of these assumptions. One may also question the usefulness to decompose output growth into contribution of inputs and TFP, as it depends on the research question. Therefore, one argues for the use of a sufficiently general cross country regression model that account for most influences on factor accumulation and of TFP, and which simply relates growth to policy outcome, as a complement to conventional growth accounting approach to understand the difference in productivity growth (Temple 1999).

\(^{115}\) The technical progress function \(A(t)\) is lies outside the production function, i.e. \(Y=A(t)F(K,L)\). It is possible for technical progress to be both Hicks-neutral and Harrod-neutral if the production function has constant unit of elasticity of substitutions. Economists tend to use Cobb-Douglas form of production function, as this is the only functional form that fulfills this criteria (The History of Economic Thought Website 2006a).
4.2.1.2 Conditional Convergence Regression

One conventional framework for cross country regression is by Mankiw, Romer and Weil (MRW, 1992), which provides a framework for conditional convergence regression. For the following constant returns to scale Cobb-Douglas production function with 3 inputs (i.e. capital input, labour input and the technology level),

\[ Y_t = K_t^\alpha H_t^\beta (A_t L_t)^{1-\alpha-\beta} \]  

(4-1)

where \( K_t = sK_t - \delta K_t \), \( H_t = sH_t - \delta H_t \), \( L_t = L_t e^t \) and \( A_t = A_t e^t \) are the physical capital, human capital, Labour input and the technology level at time t respectively. \( Y_t \) is the Output and \( y_t = \frac{Y_t}{A_t L_t} \) is output per efficient unit of labour force. Solving this model yield the following economic growth rate \( g_t \):

\[
g_t = \gamma + \theta \ln y_t - \theta \ln A_t - \theta \frac{\alpha}{1-\alpha-\beta} \ln s + \theta \frac{\beta}{1-\alpha-\beta} \ln s_k + \theta \left[ \frac{\alpha + \beta}{1-\alpha-\beta} \ln(n + \gamma + \delta) + \epsilon_t \right]
\]

(4-2)

The implication is that growth regression has to control for the steady state level of income, where it will be in negative sign if there is conditional convergence. The framework also implies that the initial level of technology should also be included in the regression, though it is difficult to find a suitable proxy of technology as it is unobserved. Omitting this unobserved factor will results in bias of estimated parameters (Mankiw, Romer, and Weil 1992; Temple 1999).

4.2.1.3 Informal Growth Regression

Barro (1991) provides a common approach for growth regression. The regression model simply relates growth to policy outcome. The specification of the regression is mainly by the previous results in the literature, and it is \textit{ad hoc} in nature. The model is given as follows:

\[
g_t = \theta \ln y_t + \phi X_t + \phi Z_t + \epsilon_t
\]

(4-3)
$X$, represents the vector of growth determinants that are suggested by Solow's growth model, such as investment, initial technology and rate of technological growth, etc. Whereas $Z$, is the vector of growth determinants lies outside Solow’s model that measures policy outcomes like school enrolment rate, investment ratio, and etc. The informal growth regression can be seen as an extension of MRW framework as they attempt to account simultaneously the input growth and variation in TFP growth. However, critics point out that the extension is not perfect due to the following reasons:

- It is difficult to estimate the technology parameter and some explanatory variable is correlated to initial efficiency.
- Some important insights will be lost, as this approach lack theoretical foundation;
- When a variable enter the informal regression, it is not clear if it affects the long-run growth rate or the steady-state level of income, or both. (Barro 1991; Durlauf, Johnson, and Temple 2005; Temple 1999).

### 4.2.1.4 Cross Country Growth Accounting with Externality

The central idea of Cross-Country Growth Accounting with externality is to infer whether the growth determinant variable act through factor accumulation or TFP growth. The specification of the model, by Benhabib and Spiegel (1994) is as follows:

$$g_t = \frac{dA_t}{dt} + \rho \frac{dK_t}{dt} + \omega \frac{dH_t}{dt} + \tau \frac{dL_t}{dt} \varepsilon_t$$

The difference of this method compared with the traditional one is that output elasticity is estimated rather than imposed, and the cross-country variation in TFP growth can be captured with the need of approximation. The advantage of this framework lies in the fact that there is no longer a danger of spurious correlations driven by the omission of initial efficiency (Benhabib and Spiegel 1994; Temple 1999).
4.2.2 Hypothesis Testing, Model specification, Econometrics issue that arise in the estimation of growth model

There are different econometric techniques to estimate different types of data structures\(^{116}\) that appear in growth analysis. The following provides comparison and evaluation.

4.2.2.1 Time-Series Approach

Growth varies over time, and countries are distinctive in nature. Therefore, one way to understand growth pattern is by examining the time series data for each country in isolation, to capture the variation over time (Durlauf, Johnson, and Temple 2005).

This approach faces several problems. First, the quality of data is in question. In many countries, data that span across time are not available, and there are missing data in between dates. Another problem is that most analyses are based on secondary data, in which it is difficult to examine whether data interpolation is being used to fill in the missing data of the key variables\(^{117}\). The results will be misleading when interpolated data are used (Durlauf, Johnson, and Temple 2005).

Second, some key growth determinants that are significant across section, such as the incident of political revolutions (Barros 1991), display relative little time variation. Thus, they will only exhibit effect in a short horizon, and the use of time-series approach is therefore inappropriate (Durlauf, Johnson, and Temple 2005).

Third, growth economists are interested in the evolution of potential output, but not their deviations from potential output such as business cycle and output collapse. It is easy for the econometric modelling of a growth process to be contaminated by business cycle dynamics. The problem of short-run output instability makes it difficult to isolate the effect of growth determinants (such as inflation) on potential output, as the difference between observed and potential output are

\(^{116}\) Whether data are observed in cross-section, time series \& panel, and whether the series are classified as exogenous or endogenous.

\(^{117}\) Some variables, like education attainment and income distribution, are measured less frequent and based primarily on census data (usually in 5-years time). Sometimes interpolation between census periods is used to transform the data into annual basis.
correlated with variables that fluctuate at high frequency (Durlauf, Johnson, and Temple 2005).

Despite all these problems, the time series approach can yield several valuable insights. This approach can be used to discriminate between different growth theories. The development of the statistical test of growth model based on Jones (1995) and the Granger-Causality Testing provide the evidence of temporal precedence\textsuperscript{118}, which helps to build a case that growth is influenced by other variables over a long horizon (Durlauf, Johnson, and Temple 2005; Jones 1995).

4.2.2.2 Panel data

There is a trade-off between robustness and efficiency when comparing panel data estimation with single country time series regressions. Panel data method allows richer models to be estimated and is likely to increase efficiency as there is more observation. However, the estimation will be biased if the assumption of parameter homogeneity across section is violated (Durlauf, Johnson, and Temple 2005).

The vast majority of panel data growth studies use a fixed effects (within group) estimator\textsuperscript{119} rather than the random effect estimators for estimating models with unobserved country effects. The advantage is that it can address the problem of heterogeneity bias\textsuperscript{120}. However, the fixed-effects identification strategy cannot apply in all contexts\textsuperscript{121}. Besides, this approach faces several problems. Often researchers do not pay enough attention to the dynamics of adjustment, to differentiate the short-run variation turn to the long run effect. The method to eliminate the country-specific intercepts by either within group transformation or first differencing will tend to aggravate the measurement errors. There is a trade-off between bias and efficiency in deciding if fixed effect estimation is to be used. Furthermore, growth episodes within

\textsuperscript{118} Jones (1995) model regress growth on lagged growth and lagged policy variable, which is similar to Granger Causality test (Durlauf, Johnson, and Temple 2005; Jones 1995).

\textsuperscript{119} Between-group estimator is not used, because it is biased when the unobserved specific effect is correlated with the X-variables.

\textsuperscript{120} Bias cause from omitting a time constant-variable in the panel data model.

\textsuperscript{121} Some explanatory variables, like geographical characteristic, are fixed in nature. Therefore, variation is 'between-countries', and empirical work should based on cross-section instead.
countries look more alike than growth episodes across countries, and therefore offering less identifying variation (Durlauf, Johnson, and Temple 2005).

A natural alternative to the within-country estimator is to devote more attention to model the heterogeneity, rather than treating it unobserved and to try to eliminate its effect. One way is to include a complete set of regional dummies to alleviate the bias associated with omitted variables. When estimating dynamic models, the alternative strategy is to difference the model to eliminate the fixed effects, and then use the instrumental procedures to address the correlation between the differenced lagged dependent variable and the induced MA(1) error term. The most widely used General Method-of-Moment Approach, developed by Arellano and Bond (1991) and being first applied in growth context by Caselli, Esquivel, and Lefort (1996), is based on using lagged levels of series as instruments for lagged first differences. It could alleviate biases due to measurement error and problem of endogeneity. However, many researchers are sceptical that lags are a suitable instrument (Arellano and Bond 1991; Caselli, Esquivel, and Lefort 1996; Durlauf, Johnson, and Temple 2005).

Another issue for dynamic panel estimation is parameter heterogeneity. If a slope parameter varies across countries, and the explanatory variable is serial correlated, this will induce serial correlation in the error term. The panel estimator will be inconsistent. A solution is to split the sample into groups that are more likely to share similar parameter values. Another is to allow for heterogeneity over time (Durlauf, Johnson, and Temple 2005).

The empirical growth literature has not fully addressed the question of the appropriate time horizons over which growth model should be assessed. The construction of the time series observations (5 or 10 years) can appear arbitrary, and it is less clear that employing 5 year averages are genuinely informative about the medium-run growth dynamics (Durlauf, Johnson, and Temple 2005).

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122 As explanatory variables maybe highly persistent, using lagged levels as the instruments for first difference will likely lead to bias of the GMM panel data estimator in short panels. One way to counteract this is to make more restrictive assumption about the initial condition.
4.2.2.3 Event Study Approaches

Event study is an econometrics analysis of the effects of an event on an outcome variable. This approach is a commonly used empirical tool in research into security prices, whose objective is to assess if equity holders are able to earn abnormal returns in response to the arrival of information on a specific returns\textsuperscript{123}. Once it is established that there are statistically significant abnormal returns, a common approach is to regress the abnormal returns for the event period against a set of variables that is believed to explain the event period response (Peterson 1989a).

Rather than solely using panel or dummy approach, growth literature has borrowed the event study approach to examine growth impact of major historical events and policy changes, such as financial and trade liberalisation, waves of democratisation, regime change, etc., in order to provide a useful complement to regression-based method. The approach is to study the time paths of growth variables examined before and after such events (Durlauf, Johnson, and Temple 2005).

To a certain extent, the approach is a complement to the structural approach of the causal inquiry. Simon (1953) suggests that the invariance of a relationship under interventions to an input variable provides an operational notion of cause, and Hoover (1990) and Cartwright (1989) discuss the general issues in an econometric context. The idea is that where experiment is possible, holding particular variables constant while varying others provides a powerful way to discover valid empirical assertions to identify prior independent knowledge for the system. Hence, rather than relying on causal inference, experiments that allow interventions to the system provides an operational notion of cause which avoid the problem of spurious correlation. Hoover (2001) develops feasible methods for investigating large scale causal questions\textsuperscript{124}. Applied in growth context, Intervention in the case can refer to the historical event or policy change that might affect growth (Cartwright 1989; Hendry 1995; Hoover 1990; Hoover 2001; Simon 1953; Simon 1998).

\textsuperscript{123} An abnormal or excess return is the difference between observed return and that appropriate given a particular return generating model. The expected return is a forecasted return for the event period, where the forecast is developed using data from a benchmark period, which is not contaminated by the arrival of information concerning the particular event (Peterson 1989b)

\textsuperscript{124} Please refer to the previous chapter on the study of causality
While the advantage of this approach is that it can incorporate the historical event and provide a richer analysis, there are several issues that has to be noted when performing an event study include:

- One has to be cautious about inferring a causal effect, as event may sometimes arise endogenously rather than exogenously assigned;
- The choice of benchmark model has to be carefully specified;
- There are statistical problems relating to the independence of observation when events are clustered in time (Durlauf, Johnson, and Temple 2005; Peterson 1989a).

4.2.2.4 Endogeneity and instrumental variable

It is difficult to establish the directions of causation in growth regression. There is a standard problem that two variables may be correlated but jointly determined by a third variable. There are many instances of explanatory variables that are endogenously determined in economic sense as well as in technical sense\textsuperscript{125} (Durlauf, Johnson, and Temple 2005).

One approach is to model as many as possible of the variables that are endogenously determined.\textsuperscript{126} Another response is to apply instrumental procedures to a single structural equation, with growth as the dependent variable. Current growth literature did indeed identify instruments for some particular endogenous variable. However, the validity of these instruments is in question. Critics argue that these studies failure to address the question that the instrument may correlated with the error term in the growth regression. Besides, it requires that the proposed instrument cannot be a direct growth determinant or correlated with an omitted growth determinants, which is clearly not the case in the literature (Durlauf, Johnson, and Temple 2005).

\textsuperscript{125} In econometric analysis, the problem of endogeneity arise when the explanatory variable is corrected with the disturbances in the growth regression.

\textsuperscript{126} A leading example is by Tavares & Wacziarg (2001), which they examine how democracy affect growth through the channel on human capital accumulation, physical capital accumulation, inequality and government expenditure.
4.2.3 Remarks

The growth econometrics literature has provided tools for economists to test for the relationship between financial development and economic growth. The next section will review how economists apply the growth regression techniques in examining the finance-growth nexus.

4.3 Review of Empirical Studies of Finance-Growth Nexus

The following provides the literature review of the empirical studies of the Finance-Growth Nexus. This section is borrowed heavily from the review paper published by Levine (2005) (Levine 2005).

4.3.1 King and Levine (1993)

Goldsmith was the first to provide significant empirical evidence about the correlation of finance and growth for a cross-section of countries\(^\text{127}\). The next important work of the cross-country studies of finance-growth nexus come from King and Levine (1993). They extend the cross-country growth framework introduced by Barro (1991) by adding variables that proxy for financial development. The measure is as follows:

- Liquid liabilities (M2) of the financial system divided by GDP - which measure the financial depth (overall size) of the financial system as expounded by McKinnon-Shaw framework;
- Ratio of bank credit divided by bank credit plus central bank domestic assets,- which measures the relative degree to which the central bank and commercial bank allocate credit;
- Credit to private sector divided by GDP; the rationale is that the higher the credit ratio, the better the financial system in channelling saving into investment.

King and Levine (1993) found a robust, positive and statistically significant relationship between the financial development indicators and economic growth (King and Levine 1993b; Levine 2005; Rousseau and Wachtel 2005).

\(^{127}\) Readers can refer to section 2.4.5 in chapter 2 for the survey of Goldsmith's work.
4.3.2 Time Series Approach

One of the criticisms associated with inferring causation from cross-countries correlations is that many cross-country studies ignored the non-stationary aspect of the variable and the problem of mis-specification. A number of studies make use the time-series techniques of Engle-Granger ECM mechanism, Johansen approach and the Multi-Variate Vector Auto-regressive Model to examine the nature links and causality test between financial development and economic growth. Among these studies are Demetriades and Hussein (1996), Arestis and Demetriades (1997), Rousseau and Wachtel (1998), Luintel and Khan (1999), Arestis, Demetriades and Luintel (2001), Wachtel (2003) and Rioja and Valev (2004). These studies express scepticism for the robustness of the finance-growth nexus, and show that the relationship exhibits considerable variation among the level of economic development of countries (Arestis and Demetriades 1997; Arestis, Demetriades, and Luintel 2001; Demetriades and Hussein 1996; Felix and Valev 2004; Rousseau and Wachtel 1998; Rousseau and Wachtel 2005; Wachtel 2003).

4.3.3 Growth Accounting

Recall in section 4.2.1.4, the central idea of Cross-Country Growth Accounting with externality is to infer whether the growth determinant variable act through factor accumulation or TFP growth. Benhabib and Spiegel (2000), apply these techniques originated by Benhabib and Spiegel (1994), to examine whether financial development affects growth solely through its contribution to physical and human capital accumulation, or whether if also has a positive impact on total factor productivity growth. The results suggest that indicators of financial development are auto-correlated with both total factor productivity growth and investment. However, their results are not robust, as some financial development indicators exhibit positive impact while others show negative (Benhabib and Spiegel 1994; Benhabib and Spiegel 2000).
4.3.4 Instrumental Variable Techniques

As mentioned at section 4.2.2.4, it is difficult to establish the directions of causation in growth regression. There is a standard problem that two variables may be correlated but jointly determined by a third variable. There are many instances that explanatory variables are endogenously determined in an economic sense as well as in a technical sense. Therefore, subsequent empirical studies in the finance-growth nexus have applied instrumental variable techniques to tackle the problems of simultaneity bias.

4.3.4.1 Legal Origin Instruments

The development of the legal view of finance that is pioneered by La Porta et al. (1997, 98), who stress that that the historically determined differences in legal tradition help explain international differences in financial development today (La Porta et al. 1997; La Porta et al. 1998). Levine (1998, 1999) and Levine, Loayza and Beck (2000) incorporate their idea in their study. They treat the legal origin variables, which state whether a country’s commercial and company law derives from British, French, German or Scandinavian law, as the exogenous component of financial development, and use them as instrumental variables in order to tackle the problems of simultaneity bias and provide a richer analysis for the finance-growth nexus. Their results suggest the legal origin instruments are highly correlated with financial development, and provide a statistical significant impact from financial development on economic growth (Levine 1998; Levine 1999; Levine 2005; Levine, Loayza, and Beck 2000).

4.3.4.2 Financial Structure: Market-Based vs. Bank-Based Financial System

The issue of how financial structure – the mix of financial markets and intermediaries operating in an economy – affect economic performance. International comparison was between the market-based system (represented by US and UK), and bank-based system (represented by Germany and Japan) has long been studied in the finance
literature\textsuperscript{128}. Though this line of research has shed light into the functioning of the financial system in these economies, several works, such as Mayor et al. (1988) and Rajan and Zingales (1995), argue that the distinction between bank-based and market-based system is fragile (Allen and Gale 2000; Demirguc-Kunt and Levine 2001; Edwards and Fischer 1994; Mayer, Mankiw, and Barroux 1988; Mayer and Sussman 2001; Rajan and Zingales 1995).

Levine (2002), based on the dataset of Beck, Demirguc-Kunt, and Levine (2001)\textsuperscript{129}, treat the financial structure as the exogenous component of financial development, and use as an instrumental variable to control simultaneous bias. The results suggest that information of financial structure does not help in explaining cross-country differences in financial development and the process of economic growth. Yet in another study, Tadesse (2002) shows that while market-based systems outperform bank-based system among countries with developed financial sectors, it is inferior to bank-based system among countries with underdeveloped financial sector (Beck, Demirguc-Kunt, and Levine 2001b; Demirguc-Kunt and Levine 2001; Levine 2005; Levine 2002; Tadesse 2002).

4.3.4.3 Other Instrumental Variables

Several studies use the initial values and lagged version of explanatory variable as an instrument for financial development. These instruments are listed as follows:

- Lagged versions of all explanatory variables (Levine, Loayza, and Beck 2000, Loayza and Ranciere 2002);
- Consumption and GDP (Levine and Zervos 1998);
- Initial inflation (Rousseau and Sylla 2001, Rousseau and Wachtel 2002)
- Initial value of explanatory variables (King and Levine 1993, Rousseau and Sylla 2001, Rousseau and Wachtel 2002)


\textsuperscript{129} Beck, Demirguc-Kunt, and Levine (2001) has constructed a large cross-country, time series database on the mixture for financial system across 150 countries, which classifies countries according to which they are bank-based or market-based.
• Initial Income (Demetriades and Law 2004);

Their results suggested that the above economic factors are statistically significant, which implies that they form the exogenous components of financial development (Demetriades and Law 2004; Durlauf, Johnson, and Temple 2005; King and Levine 1993b; Levine, Loayza, and Beck 2000; Levine and Zervos 1998b; Loayza and Ranciere 2002; Rousseau and Sylla 2001; Rousseau and Wachtel 2002).

4.3.5 Remarks

The review of the empirical literatures has suggested that finance-growth nexus do hold through various form of econometric analysis. However, most studies mainly focus on the impact of financial development on economic growth without studying the reverse or simultaneous impact of economic growth on financial development. Therefore, the analysis in later chapters can fill the gap in the current literature by studying the bi-directional relationship of financial development and economic growth.

4.4 Data

4.4.1 Countries and Time Span

The present enquiry concerns whether there is a bi-directional causal relationship between financial development and economic growth, a maximum of 161 countries are included in the analysis with a maximum time span ranging from 1965 to 2004\textsuperscript{130}. The main source of the data are from World Development Indicators from World Bank (World Bank 2006). The countries are classified according to their income level using World Bank Classification. Accordingly, economies are divided among income groups according to 2001 Gross Nation Income (GNI) per capita, calculated using the World Bank Atlas method. The range of income (in US$) for each category is as follows:

- High Income: $9206 or more;
- Upper Middle Income: $2976-$9205;
- Lower Middle Income: $746-$2975;

\textsuperscript{130} It is noted that due to number of missing observations, the number of economies included in the analysis in Chapter 6 will be reduced to the maximum of 118.
Lower Income: $745 or less.

The 161 counties examined are classified as follows, where the numbers in the bracket shows the total number of economies in each group.

**High Income OECD Economies (23):**

- Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, South Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States;

**High Income Non-OECD Economies (11):**

- The Bahamas, Cyprus, Guam, Hong Kong, Israel, Kuwait, Macao, Malta, Singapore, Slovenia, United Arab Emirates;

**Upper Middle Income Economies (29):**

- Antigua and Barbuda, Argentina, Barbados, Belize, Chile, Costa Rica, Croatia, Dominica, Estonia, Gabon, Grenada, Hungary, Latvia, Lithuania, Malaysia, Mauritius, Mexico, Oman, Panama, Poland, Saudi Arabia, Seychelles, Slovak Republic, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, Uruguay, Venezuela;

**Lower Middle Income Economies (46):**

- Albania, Algeria, Armenia, Azerbaijan, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Cape Verde, China, Colombia, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Georgia, Guatemala, Honduras, Indonesia, Iran, Jamaica, Jordan, Kazakhstan, Macedonia, Maldives, Federal States of Micronesia, Morocco, Namibia, Paraguay, Peru, Philippines, Romania, Russian Federation, South Africa, Sri Lanka, Suriname, Swaziland, Syrian Arab Republic, Thailand, Tonga, Tunisia, Turkey, Ukraine, Vanuatu;

**Low Income Economies (52):**

4.4.2 Proxies for Economic Growth

GDP per capita growth is used as a proxy for economic growth. It is defined as the annual percentage growth rate of GDP per capita based on constant local currency. GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources (World Bank 2006). It is used widely as a proxy for economic growth in the cross-country growth literatures.

4.4.3 Proxies for Financial Development

Four different measures of financial development indicators are used as proxies for financial development in this study.

4.4.3.1 Domestic Credit provided by the private sector as a percentage of GDP (Domestic Credit)

The first proxy for financial development is Domestic Credit provided by the private sector as a percentage of GDP. This variable includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. The banking sector includes monetary authorities and deposit money banks, as well as other banking institutions where data are available (including institutions that do not accept transferable deposits but do incur such liabilities as time and savings deposits). Examples of other banking institutions are savings and mortgage loan institutions and building and loan associations (World Bank 2006). The underlying assumption is that the more developed the financial system, the better the financial sector is able to channel savings into credit, and the higher ability for the private sector to provide credit to the domestic firm, and therefore the higher ratio of domestic credit provided.
by the private sector to the overall economic activities. The idea is drawn from Levine, Loayza and Beck (2000).

4.4.3.2 Quasi-Liquid Liabilities as a percentage of GDP (Financial Depth)

The second proxy for financial development is Quasi-Liquid Liabilities (M3-M1) as a percentage of GDP. Quasi-liquid liabilities are the sum of currency and deposits in the central bank (M0), plus time and savings deposits, foreign currency transferable deposits, certificates of deposit, and securities repurchase agreements, plus travellers' checks, foreign currency time deposits, commercial paper, and shares of mutual funds or market funds held by residents. They equal the M3 money supply less transferable deposits and electronic currency (M1) (World Bank 2006). The ratio of money over GDP is a standard measure of financial depth and it is widely used by many authors, such as King and Levine (1993), Demetriades and Hussein (1996) and Levine, Loayza and Beck (2000). The idea is drawn from the McKinnon-Shaw financial liberalisation framework, where the more developed the financial system is, the higher the level of saving, credit availability and investment, and the higher level of money balances and demand for financial assets in terms of the overall level of economic activities, and hence the higher the ratio of M3 over GDP. The measure used in this analysis, Quasi-Liquid Liabilities (M3-M1) over GDP, which is used by Rousseau and Wachtel (2005) improves the measure of financial depth by removing the financial assets that are solely for transaction purpose, and the resulting residual form a better measure for the oversize of financial intermediaries. Hence, Quasi-Liquid Liabilities as a percentage of GDP is used as the proxy for financial development in this thesis.

4.4.3.3 Stock Market Capitalisation of listed companies as a percentage of GDP (Stock Market Capitalisation)

The third proxy for financial development is Stock Market Capitalisation of listed companies as a percentage of GDP. Stock Market Capitalisation is defined as the share price times the number of shares outstanding and the listed domestic companies are the domestically incorporated companies listed on the country’s stock exchanges at the end of the year (World Bank 2004). This is the measurement of the oversize of
stock markets and is used by Levine and Zervos (1998). The larger the ratio, the better the stock market is in saving mobilisation and resource allocation.

4.4.3.4 Stocks traded as a percentage of GDP (Stocks Traded)

The forth proxy for financial development is Stocks traded as a percentage of GDP respectively. Stocks traded refers to the total value of shares traded during the period as a percentage of GDP (World Bank 2004). These two variables are the measurements of the liquidity of the stock markets (Levine and Zervos 1998a), the higher the liquidity of the stock market, the better the stock market is in allocating resource and facilitating trading, diversification and management of risk.

4.4.4 Correlation Analysis

Table 4-1 reports the correlation matrix for Economic Growth and four Financial Development measures.

Table 4-1: Correlations between Economic Growth and 4 Different Measures of Financial Development using annual observations.

<table>
<thead>
<tr>
<th></th>
<th>Growth</th>
<th>Domestic Credit</th>
<th>Financial Depth</th>
<th>Stock Market Capitalisation</th>
<th>Stocks Traded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
<td>1</td>
<td>0.016</td>
<td>0.042</td>
<td>0.093</td>
<td>0.169</td>
</tr>
<tr>
<td>Domestic Credit</td>
<td></td>
<td>1</td>
<td>0.719</td>
<td>0.538</td>
<td>0.508</td>
</tr>
<tr>
<td>Financial Depth</td>
<td></td>
<td></td>
<td>1</td>
<td>0.488</td>
<td>0.459</td>
</tr>
<tr>
<td>Stock Market Capitalisation</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.806</td>
</tr>
<tr>
<td>Stocks Traded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

The first row in Table 4-1 correlates growth with the 4 financial development measures. The signs of these correlations are consistent with our priors where growth and financial development are positively related. The second to fifth row corresponds to the correlations between different financial development measurements. The results show positive and reasonably strong correlations among the financial development measures. The correlations are strongest between Domestic Credit and Financial Depth and between Stock Market Capitalisation and Stock Traded, which is expected
as the former two financial development measures focus on financial intermediary development while the latter two focus on the stock market development. Table 4-2 and Table 4-3 show the correlation matrix using 5-year average observation and average value of the series respectively, where the correlation matrix results are similar to the result using annual observation in Table 4-1: Correlations between Economic Growth and 4 Different Measures of Financial Development using annual observations.

Table 4-2: Correlations between Economic Growth and 4 Different Measures of Financial Development using 5-year average observations.

<table>
<thead>
<tr>
<th></th>
<th>Growth</th>
<th>Domestic Credit</th>
<th>Financial Depth</th>
<th>Stock Market Capitalisation</th>
<th>Stocks Traded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
<td>1</td>
<td>0.045</td>
<td>0.037</td>
<td>0.050</td>
<td>0.176</td>
</tr>
<tr>
<td>Domestic Credit</td>
<td></td>
<td>1</td>
<td>0.716</td>
<td>0.662</td>
<td>0.606</td>
</tr>
<tr>
<td>Financial Depth</td>
<td></td>
<td>1</td>
<td>0.504</td>
<td>0.459</td>
<td></td>
</tr>
<tr>
<td>Stock Market Capitalisation</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>0.820</td>
</tr>
<tr>
<td>Stocks Traded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4-3: Correlations between Economic Growth and 4 Different Measures of Financial Development using average value of the series

<table>
<thead>
<tr>
<th></th>
<th>Growth</th>
<th>Domestic Credit</th>
<th>Financial Depth</th>
<th>Stock Market Capitalisation</th>
<th>Stocks Traded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
<td>1</td>
<td>0.213</td>
<td>0.379</td>
<td>0.360</td>
<td>0.392</td>
</tr>
<tr>
<td>Domestic Credit</td>
<td></td>
<td>1</td>
<td>0.627</td>
<td>0.415</td>
<td>0.492</td>
</tr>
<tr>
<td>Financial Depth</td>
<td></td>
<td>1</td>
<td>0.401</td>
<td>0.431</td>
<td></td>
</tr>
<tr>
<td>Stock Market Capitalisation</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>0.776</td>
</tr>
<tr>
<td>Stocks Traded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

4.5 Summary

This chapter reviews the empirical studies of the finance-growth nexus, the cross-country economic growth framework, and summarises the nature and characteristic of
the dataset that are to be used for the empirical work in chapter 5 and 6. The correlations analysis suggests that there is a positive linear association between financial development and economic growth. The next 2 attempts to further explore the relationship by use two different econometrics frameworks in order to identify the causal relationship in the finance-growth nexus.
5 Analysis of the Causal Relationship between Financial Development and Economic Growth

5.1 Introduction

The analysis in Chapter 3 sets the theoretical foundation of the empirical analysis for the thesis. The motivation of this chapter is to understand the meaning of causality, and how to apply the analytical framework developed according to this line of thought to study the causal relationship between financial development and economic growth. Though there are papers, such as Sen (2000)\textsuperscript{131}, which uses Granger-Causality tests to examine the finance-growth nexus, applications of this approach to examine the causal relationship between financial development and economic growth has remained scant. Therefore, this chapter is able to fill this gap in the existing literature by applying Granger-Causality test in this area.

The original Granger-Causality Test (1969) assumes equal lag orders on each variable each equation specification within the system. The weakness is that it will lead to a loss of degrees of freedom and inefficient estimation of parameter. Choosing optimal lag orders is therefore important to obtain a robust result. This study is able to contribute to the literature by applying two optimal lag-length selection criteria in the Granger-Causality test to examine the causal relationship between financial development and economic growth.

The Chapter is organised as follows. Section 5.2 reviews the historical review of philosophical enquiry of the study of causality. Section 5.2 describes the application of causal analysis in the study of the realm of economics. Section 5.4 specifies the methodology, namely Granger-Causality Test with two information lag-length selection approach, to examine causality problem, and to apply it to test for the causal relationship between financial development and economic growth. Section 5.5 discusses the result of the analysis. Section 5.6 concludes.

\textsuperscript{131} Sen (2000) applies a set of Granger-Causality tests, showing that financial development Granger-caused GDP growth for 19 out of 24 developing countries for the period 1970-90 ((Sen 2000).
5.2 Causality and Economics

5.2.1 Philosophical Enquiry of Causal Effect

The notion of Causality – namely, the awareness of what causes what in the world and why it matters, is central to human thought. According to Hausman (2003), many important generalisations in economics are causal claims For example; the law of demand asserts a price increase will reduce the quantity demanded for a normal good. In the financial field, central banks are concerned with the effect of altering interest rate on the macroeconomic variables such as inflation and house prices. Economists and policymakers are therefore concerned with the consequences of alternative policies to the society, and econometricians are therefore concerned with the possibilities of determining causal relations from statistical evidence and with the relevance of casual relations to the possibility of consistent estimation of parameter values. (Hausman 2003).

The study of causation is much wider than economics; it is what science is about, and what much of history is about (Hicks 1979). The following is a preliminary sketch of the historical development on the notion of causality in human history. The present author is neither a philosopher nor historian, and therefore no attempt is made for a complete survey or the making of any contributions to the philosophical inquiry in this area.

The first full expression of the principles of causation can be found in the writings of Plato and Aristotle. Plato put across the necessity of causation in several of his writings in the theory of Forms. The most important single contribution on the elaboration of the theory of causality in Ancient Greek thought is to be found in

132 According to Plato, ‘Forms’ are conceived of as separate existents which are responsible for particulars being of the kind they are. They are the abstract representation of the universals of things we see around us. The material world as it seems to us is not a real word, but is only a shadow of the real world (Forms). ‘Forms’ are sometimes translated into English as ‘Ideas’ (Honderich 2005). Plato asserts that “whatever becomes must necessarily become, owing to some cause; without a cause it is impossible for anything to achieve becoming.” Accordingly, Forms are eternal and unchangeable, they require no causal explanation. But the material world (such as physical objects and organisms) requires a cause of change. It is because they are copies of Forms and are always changing and not eternal, and therefore require causes for their generation. However, Plato did not explain what is meant by the necessity of causation (Weinberg 2003).
Aristotle. He distinguished 4 major kinds of causes, which are 1, the Material Cause; 2, The Formal Cause; 3. The Efficient Cause; and 4, The Final Cause. According to Aristotle, every change requires a cause that resembles the change and such causal relationships occur with regularity if there is no interference, and it is necessary for a cause to exist for every change. Another important feature of Aristotle's views is that causal connection is simultaneous determination (Metaphysics, Book 5, Ch.2, 1014a, lines 20f.) (Weinberg 2003). At first, it is not easy to see how this doctrine, that cause and effect are mutually simultaneous, can be made consistent with any temporal succession of events in the world. Yet economists seem to be happy with this notion and to construct simultaneous equation system to explain dynamics in economic behaviour.

The Aristotelian works on causality remain influential on the dominant thought in the Medieval Ages. The medieval period was dominated by Christendom. The created universe was seen as a rational manifestation of God and the study of causality and the rational investigation of the universe were seen as a way of approaching God. The translations of the major works of Aristotle into Latin during the 12th and 13th centuries as well as translations from Jewish and Arabic philosophers made at the same time provided a new impetus to philosophical discussion on Christian teachings and the study of causal nexus. A detailed analysis of causality is to be found on the writings of Aquinas, who in his lifetime tried to synthesise the Aristotelian systems into Christian teachings. (Weinberg 2003; White 2001).

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133 The Material Cause is the material substance out of which things come into existences, such as atoms. The Formal Cause is the form which things eventually have when they are perfected. It identifies the intrinsic natures of things, i.e. its essence or definition. It embraces the account of causes in terms of fundamental principles or general law. In nowadays language, it simply corresponds to 'explanation of things in general'. The Efficient Cause brings changes so as to move things into completion of its 'forms'. It is the moving cause that constitute to the source of changes. This definition corresponds to what we would now simply call 'causes' nowadays. The Final Cause – the purpose or function for the existence of things. It is the end that things are supposed to serve. Among the four causes, the efficient cause argument was mostly picked up by later philosopher to investigate the notion of causality. (Lepper 1971b; Weinberg 2003; White 2001).

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134 Aquinas maintains all of the familiar Aristotelian doctrines and expounds them with logic. Accordingly, every change requires a cause that resembles the change. This requirement is logically conceived as absolute necessity by Thomas' proof of God, in which He argues to the necessity of a cause of every change from the
The medieval thoughts on causality have come under dramatic change during the Modern Period, and the breakthrough started with the work of Galileo, which has contributed to the rejection of the Aristotelian system and led to the separation of science from the field of religion and philosophy. The publication of Galileo for his work ‘Two New Sciences’ in 1638 suggested that it is unhelpful for scientific inquiry to argue about cause and effect because description should come first and explanation second. Besides, the law of nature is mathematical, and mathematics, not logic, should be seen as the basic intellectual tool of science. Therefore, attention should be focused on correctly predicting and describing the observations in mathematical relationship and experiments (Pearl 2000). Besides, the new conception of inertia introduced by Galileo in his further development of the Copernican model suggested the it is no longer necessary to assume a cause in order to explain continuation of motion or rest, as in the Aristotelian system (Marinchev 2003; Weinberg 2003).

Although there is a breakthrough of Galilean works on scientific inquiry, philosophers and scientist are reluctant to give up the idea of causal explanation. They continue to maintain the necessity of cause for every new event, and to search for the origin and justification of those established scientific mathematical relationships.

Aristotelian definition of change. Accordingly, 1. everything except God must be created and is finite; 2. Since change is the actualisation of a capacity, anything that undergoes change must be induced by something; 3. Since nothing except God can actualise itself, the change must be induced by something other than the object itself that undergoes change.

From there, Thomas insists that all finite things have their own capacities both to undergo change itself and to induce change for other things. This doctrine is consistent with the view that ‘God cooperates with His creatures whenever any of them exercise its own proper causal efficiency’ (Weinberg 2003).

135 The new concept reinstates the Aristotelian description of motion as a basic physical principle. The principle state that a body moving on a level surface will continue in the same direction at a constant speed unless further interference, and implicitly therefore it is impossible to distinguish a moving object with a stationary one without some outside reference for comparison.

136 For example, the French philosopher Descartes found the assertion that everything which exists requires a cause and he ascribes the cause to eternal truth and uses it as a main proof of the existence of God. 17th century continental rationalist Baruch Spinoza conceives that God – the infinite substance – is the natural world. God itself is a part of the deterministic system of which everything in nature is a part. In his deterministic world, every finite chain of events that constitutes regularities of nature in the universe is a necessary consequence of the divine nature so that cause and logical ground are identified. Another 17th century continental rationalist Leibniz made causal connection as a self-evident logical law in which the deity is the ultimate...
At the same time when Galileo’s methods were published, Francis Bacon in Britain proposed an empirical method that could discover causal connection. Inductive reasoning from fact to axiom to law should be used to interpret the nature. The discovery of the ways in which nature phenomena occurs should be based on observation and experience rather than certain presuppose notion that distort the truth. The developments of inductive philosophy has introduced a way to understand causal relationship and form the basis of scientific inquiry (Honderich 2005; Weinberg 2003).

The most important contribution to the subject of causal connection in modern philosophy was made by David Hume. His great claim lies in the fact that reason and experience together cannot produce the belief in a particular causal reasoning, and thus challenges these two long-standing pillars in understanding causal relationships base on his scepticism on logical and inductive reasoning. He asserted that it was impossible to know universality of the causal relations through our observations and experiences. To infer universality from our confined observations, one needs to assume that nature is uniform and that the future will always resemble the past base on reasoning. However, reasoning alone is incapable of providing a foundation in reason for these perceived universal claims concerning causal connection137. Hence he concluded that the belief in causal connection has an entirely different foundation other than reasoning (Honderich 2005; Weinberg 2003).

For Hume, all human perceptions derive from sense impressions, and the foundation of causal account lies on the fundamental non-rational processes – customs and habit, rather than reasons or observations138. Causation is nothing but the constant cause of every change by his theory of monads (Honderich 2005; Pearl 2000; Weinberg 2003).

137 Hume claims that there are only two kinds of reasoning, ‘demonstrative’ and ‘probable’, which neither can provide the required justifications: demonstrative reasoning – such as logical deduction – cannot establish the uniformity of nature, for non-uniformity is conceivable, and therefore possible. Probable reasoning – causal reasoning from the observed to the unobserved – cannot establish uniformity either. Probable reasoning itself presupposes the uniformity of nature, so to employ it to justify that uniformity would be circular. As explained by the 20th British philosopher Russell, even if experience has told us that past futures resemble the past, we cannot conclude that future futures will resemble future pasts, unless we already assume that the future resembles the past (Honderich 2005).

138 Hume argues that humans observe nothing but the regular succession of events. This repetition in our experience produces a sense impression and felt expectation. This impression is projected onto the objects revealed by sensation and so we derive
conjunction of two events that happen to be contiguous in time and space, the event that is prior in time being labelled the 'cause' of the later event labelled 'effect', although there is actually no necessary connection between them. Causation considered as a natural relation has therefore that feature of habitually felt expectation that is contributed by the mind of the observer and is in no way a constituent of the objective situation. In other words, all knowledge comes from experience encoded in the mind is correlation, but observation of correlation does equal to causation, and the necessary connection of cause to effect is always dependent of our mind. (Blaug 1980; Hoover 2001; Pearl 2000; Weinberg 2003).

Hume's sceptism on experiences and reasons constitutes a threat to the foundations of natural science, as the rational order of the world could never be fully explained by the accumulation of sense perceptions. Immanuel Kant gave another account of causal connection and our experience of physical objects through his account in the original constitution of human recognition. According to Kant, the rational order of the world was the product of a rule-based activity of 'synthesis'. This consisted of conceptual unification and integration carried out by the mind through concept (categories of the understanding) operating within space and time. This 'synthesis' is not a concept but is a priori necessary condition for any possible function of the human mind. The principle of causality is valid for all human experience because the human mind interprets experiences in causal ways. The principle of causality has absolute and objective validity as applied to the entire range of experience. The objectivity can be explained only in terms of the way all human minds interpret the succession of events in times revealed in sensation. Hence form Kant, a method of causal state can be stated as 'on observation of A we predict an observation of B will follow'. Causal link is not substantial but is a result of testing procedure (Lepper 1971a; Weinberg 2003).

The central notion of causal relationship is therefore the repeatability of succession. However, the development of natural science since the 17th century onwards has tended to emphasise the functional determination generalised by the exact science (such as equations of physics and chemistry) rather than the regularities of succession that is probabilistic in nature and cannot establish uniformity by logical

the feeling of expectancy for a connection of objects with one another. The idea of necessary connection is thus derived from custom and habitually felt expectation, rather than being founded on reasons or observation
consideration. Causal concepts have gradually became less important, and the have been replaced by mathematical relationships and experiments (Weinberg 2003).

5.2.2 Causation in Economics in Early Twentieth Century

Before the 1930s, economists were generally willing to use causal language explicitly and literally, despite some concerns that there might be a conflict between causal analysis of economic changes and “comparative static” treatments of equilibrium states. Some economists were also worried that thinking in terms of causes was not compatible with recognizing the multiplicity and mutuality of determination in economic equilibrium. In the anti-metaphysical intellectual environment of the 1930s and 1940s where logical positivism was dominant thought in the field, any mention of causation became highly suspicious, and economists commonly tended to avoid causal concepts. The consequence was that causal concepts have become redundant and economists tend not to mention it in their analysis. For example, rather than formulating the law of demand in terms of the causal consequences of price changes for quantity demanded, economists tried to confine themselves to discussing the mathematical function relating price and quantity demanded (Hausman 2003).

5.2.3 Post-War Development of Causation in Economics

Post-war economists who have attempted to discuss the meaning of causation in economics include Herbert Simon (1953), Herman Wold (1954), Julian Simon (1970), John Hicks (1979) and Arnold Zellner (1979). Most of the writers emphasise the difference between a mere association and the deeper sub-class of association that might be called causal relationships. Rather than focusing on the abstract philosophical question of causality, economists and econometricians focus on the causal testing situation to determine whether it is possible to test for causation using data available. (Granger 1998;Hicks 1979;Simon 1953;Simon 1970;Wold 1954;Zellner 1979). There are basically two types of causal testing: Cross-Sectional Causality and Temporal Causality.
5.2.3.1 Cross Sectional Causality Question

A population of economic agents is observed and some variable measured for each, for example, the GDP of a country. The totality (i.e. the summation of all country in the world) of these measurements gives a distribution. A question then can be asked – why is GDP in one country higher than another country. This is a cross-sectional causality question. Although many important economic questions can be phrased in the cross-sectional (also called instantaneous or contemporaneous) causal situation, they have received little causal testing in this context (Granger 1998).

5.2.3.2 Temporal Causality Question

It is also possible to measure parameters of the distribution, such as the mean or the variance, and to ask why these parameters are changing through time. Thus the question is asked, why is world GDP higher this year than last? This is the temporal causality question. Many causal tests have been conducted for economic questions and can be stated as temporal causation (Granger 1998).

5.2.3.3 Probabilistic Causation

Following the Humean tradition, it is convenient to assume the existence of a quantity called the ‘degree of belief’ held by an individual about the correctness of some causal theory or proposition, and to assume further that this quantity can be represented as a probability. The objective of any causal analysis, such as a statistical test, is the attempt to influence the degree of oneself or of others. For this purpose, the analysis need not be complete or perfect, but merely to have enough value to make one reconsider one’s belief. Therefore, modern probabilistic theory of causation can be inferred as a regularity account. It begins with the assumption that exception-less constant conjunction is too strong a condition to be useful. They look for relationships that tend to hold on average and for the most part. For example, financial development causes economic growth on the probabilistic if

\[ P(\text{Growth} \mid \text{Financial Development}) > P(\text{Growth}) \]
That means according to this account, financial development will cause economic growth if probability of experiencing economic growth conditional on financial development is larger than probability of experiencing economic growth without financial development (Granger 1998; Hoover 2001).

5.2.3.4 Asymmetry of Causation

The essential characteristic of causality is asymmetry. A mere association between a pair of economic variables, such as a correlation or a non-independent joint distribution, is insufficient to determine a causal relation, partly because such associations are symmetric between variables. This means that the extent to which X is correlated to Y or can be explained by Y, is exactly the same as Y is correlated or explained by X. Therefore, it is generally thought that causation is a non-symmetric relationship, and there are various ways in which asymmetry can be introduced. The most important of which are as follows, according to Granger (Granger 1998).

- Controllability;
- a relevant theory;
- outside knowledge
- temporal priority

5.2.3.4.1 Controllability

According to Strotz and Wold (1960), "z is a cause of y if it would be possible by controlling z indirectly to control y, at least stochastically. But it may or may not be possible by controlling y indirectly to control z this way." This refers to controllability. Essentially this idea is based on hypothetical experiment. For example, if holding all other factors, by controlling the proxy of financial development, it would be possible to control the proxy for economic growth, but not the reverse, one can introduce the causal asymmetry in the finance-growth nexus. Many current growth regressions in the literature are based on this idea to identify the causal relationship. Yet Simon (1970) disagrees with the equivalence of causation and controllability due to the identification problems within the system (Granger 1998; Simon 1970; Strotz and Wold 1960)
5.2.3.4.2 Relevant Theory

Relevant economic theory can serve to identify the causal asymmetric association. The philosopher H. Feigl suggests that "The clarified (or purified) concept of causation is defined in terms of predictability according to a set of law", and several economists such as Simon (1970) and Zellner (1979) lean on this view. They generally believe that causal analysis should be based on some generally acceptable economic theory, where a sound theory will raise the degree of belief on causal relationships (Granger 1998; Simon 1970; Zellner 1979).

5.2.3.4.3 Outside Knowledge - Exogeneity

A variable that is outside the economic system can be used to identify the asymmetry of causal relationship. This is the concept of exogeneity. A variable is exogenous if it is determined outside the system under analysis. For example, the legal theory of finance state that a country's legal system is determined by historical tradition and thereby an exogenous variable to the financial development and economic growth. Hence causation can only flow from legal system to financial development and economic growth, but not vice versa. Therefore, outside knowledge and exogeneity can break the symmetric of association between variables. (Beck, Demirguc-Kunt, and Levine 2001a; Granger 1998; Hendry 1995; Koopmans 1950).

5.2.3.4.4 Temporal Priority

It is generally accepted that cause cannot occur after the effect. Therefore, the temporal priority assumption, which assumes that cause will occur before the effect, will provide a reasonable method to identify causal asymmetry. Although certain economists such as Hicks (1979) also maintain that instantaneous and contemporaneous causality are the characteristic forms of the causal relation in modern economics, it is difficult to identify a sensible mechanism in which there is an instantaneous relationship between the observed inputs and decisions (causes) and the observed output (effects), as all economic variables are the temporal accumulations of the outcomes of economic decision. Besides, missing common causes will also lead to the possibility of apparent instantaneous causality. Therefore, temporal priority
assumption is regarded as reasonable for statistical testing purpose to identify causal asymmetry (Granger 1998; Hicks 1979)

5.2.3.5 Structural Approach

Economists are aware of the fallacy of inferring causes from correlations or simultaneous observation. The issue of present concern is deciding when the empirical evidence is sufficiently strong to support claims that any predicted causality has been observed. The problem of identification is the problem of finding a sufficient number of prior assumptions to determine a unique set of equations, each corresponding to a mechanism, which fits the observation. The equation thus determined is called structural equations, while algebraically equivalent equations derived from them by linear combination are called reduced form equation. These independent prior assumptions or knowledge concerning the system constitute a mechanism that identifies causal ordering (Hendry 1995; Simon 1998).

5.2.3.5.1 Identification of Causal Ordering

Simon (1953) suggests that the invariance of a relationship under interventions to an input variable provides an operational notion of cause, and Hoover (1990) and Cartwright (1989) discuss the general issues in an econometric context. The idea is that where experiment is possible, holding particular variables constant while varying others provide a powerful way to discover valid empirical assertion to identify prior independent knowledge for the system. Hence, rather than relying causal inference, experiment that allow interventions to the system provides an operational notion of cause which avoid the problem of spurious correlation (Cartwright 1989; Hendry 1995; Hoover 1990; Simon 1953; Simon 1998).

5.2.3.5.2 Invariance under Intervention

Hoover (2001) develops feasible methods for investigating large scale causal questions, such as whether changes in the money supply (M) cause changes in the relate of inflation P or accommodates changes in P that are otherwise caused. If changes in M causes changes in P, then the conditional distribution of P on M should remain stable with exogenous changes in M, but should change with exogenous
changes in $P$. Hoover argues that historical investigation, backed by statistical inquiry, can justify the conclusion that some particular changes in $M$ or $P$ have been exogenous. One can then determine the causal direction by examining the stability of the conditional distributions (Hausman 2003; Hoover 2001).

The algorithm for causal inference is illustrated by the following two stages. Consider a bivariate model of money supply ($M$) and Inflation ($P$), there is a genuine intervention in the $M$ process if

- there is a narrative evidence of an intervention in the $M$ process; and
- Both $M$ conditional (on $P$) and marginal distribution break statistically;

By the same token, there is a genuine intervention in the $P$ process if

- there is a narrative evidence of an intervention in the $P$ process; and
- Both $P$ conditional (on $M$) and marginal distribution break statistically;

Once the intervention process is being identified, one can discriminate the causal direction by the following tables

<table>
<thead>
<tr>
<th>Table 5-1: Intervention in the $M$ process</th>
<th>Marginal Distribution of $P$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stable</td>
</tr>
<tr>
<td><strong>Conditional Distribution of $P$ on $M$</strong></td>
<td>Stable</td>
</tr>
<tr>
<td></td>
<td>Unstable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5-2 Intervention in the $G$ process</th>
<th>Marginal Distribution of $M$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stable</td>
</tr>
<tr>
<td><strong>Conditional Distribution of $M$ on $P$</strong></td>
<td>Stable</td>
</tr>
<tr>
<td></td>
<td>Unstable</td>
</tr>
</tbody>
</table>

If one identifies intervention in both $G$ and $M$ processes, then it is impossible to discriminate causal direction using this approach (Hoover 2001).
5.3 *Granger Causality Test*

Many tests for temporal causation economic questions in the literature are conducted using the methodology known as Granger Causation pioneered by Granger in 1969. This approach is based on the following two axioms:

- The cause will occur before the effect (strict temporal priority), i.e. the future cannot cause the past;
- The cause contains unique information about the fact. (Granger 1969; Granger 1998).

5.3.1 Formal Representation

The formal representation of the second axioms can be stated as follows. Let $A_t$ represent all the observable information available at time $t$, and $(A_t - Y_t)$ represent all this information except that contained in the series $Y_{t+j}, j \geq 0$. Then, for any region $C$, $Y_t$ will be said to cause $X_{t+1}$ if

$$\Pr ob(X_{t+1} \cdot in \cdot C|A_t) \neq \Pr ob(X_{t+1} \cdot in \cdot C|A_t - Y_t)$$

In this extent, the Granger causality test is a method based on forecastability. It is related to the question of how useful one variable (or set of variables) $Y_t$ is for forecasting another variable (or set of variables) $X_t$ (Granger 1998).

5.3.2 Prima Facie Causality

Prima facie causality is the case when one has a belief about a temporal causation. If a test is based on the above definition, but replaces the un-useful universal information-set with a restricted but practical time-series information set $I_t$, and if the test finds evidence for causation, then the relationship remains a prima facie cause. The larger and more relevant $I_t$ is, the more rigorous will be the test and the more likely that degrees of belief will change. In practice, tests are normally based but on parameters of the distributions such as means, rarely on distributions. $Y_t$ is a prima facie cause in mean of $X_{t+1}$ with respect to $I_t$ if

$$E(X_{t+1}|I_t) \neq E(X_{t+1}|I_t - Y_t)$$

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and it will follow that $X_{t+j}$ is better forecast if $Y_t$ is used than if it is not used. Standard time-series modelling techniques will provide models $X_t$ based on $I_t$ and $I_t - Y_t$ and the post-sample forecasting ability of the two models can then be used to test this particular form of causation (Granger 1998).

### 5.3.3 Econometric Test for Granger Non-Causality

The appeal of Granger-causality is that it can be reduced to a simple econometric test. The specification of the regression can be illustrated as follows. Let $X_t$, $Y_t$ be two stationary time series with zero means. The simple causal model is represented as

\[
X_t = \sum_{j=1}^{m} \alpha_j X_{t-j} + \sum_{j=1}^{m} \beta_j Y_{t-j} + \varepsilon_t
\]

\[
Y_t = \sum_{j=1}^{m} \delta_j X_{t-j} + \sum_{j=1}^{m} \gamma_j Y_{t-j} + \eta_t
\]

$Y_t$ causes $X_t$ if some $\beta_j$ is not zero. Similarly, $X_t$ causes $Y_t$ if some $\delta_j$ is not zero. A joint test of Granger non-causality can be based on a test of hypothesis that

\[
H_0 : \beta_j = 0, \delta_j = 0, j = 1, \ldots, m
\]

This is the most common form of Granger-Causality Test (Granger 1969)

### 5.3.4 Granger-Causality: Formal Discussion using Spectral Analysis

#### 5.3.4.1 Definition

Granger-Causality approaches are discussed formally through the use of spectral analysis by Granger (1969). The formal definition of the concept that is relevant to Causality in the original Granger (1969) paper is as followings

1. **Causality** - If $\sigma^2(X[I]) < \sigma^2(X[I] - Y)$, one can say that $Y$ is causing $X$, denoted by $Y \Rightarrow X$. In this case, $Y$, is causing $X$, if one can better predict $X$, using all available information, $I$, than if the information apart from $Y_t$ had been used.
II. Feedback - Feedback is said to occur if \( X_t \) is causing \( Y_t \) and also \( Y_t \) is causing \( X_t \), i.e.

\[
\sigma^2(X|I) < \sigma^2(X|I - Y), \\
\sigma^2(Y|I) < \sigma^2(X|I - X),
\]

Feedback is denoted by \( Y_t \Leftrightarrow X_t \).

III. Instantaneous Causality - If \( \sigma^2(X|I, Y) < \sigma^2(X|I) \), one can say that instantaneous causality \( Y_t \Rightarrow X_t \) is occurring. In other words, the current vale of \( X_t \) is better 'predicted' if the present value of \( Y_t \) is included in the 'prediction' than if it is not.

IV. Causality lag - If \( Y_t = X_t \), one define the (integer) causality lag \( m \) to be the least value of \( k \) such that \( \sigma^2(X|I - Y(k)) < \sigma^2(X|I - Y(k + 1)) \). Thus knowing the values \( Y_{t-j} \) where \( j = 0, 1, ..., m - 1 \) will be of no help in improving the prediction of \( X_t \).

5.3.4.2 Formal Derivations using Spectral Analysis

5.3.4.2.1 A Simple Casual Model

This section describes the formal derivation of Granger Causality using spectral analysis by Granger (1969). Consider the causal model in (5-4). In terms of the time shift operator \( U \), where \( UX_t = X_{t-1} \), the system can be written as follows:

\[
\begin{align*}
X_t &= a(U)X_t + b(U)Y_t + \varepsilon_t, \\
Y_t &= c(U)X_t + d(U)Y_t + \eta_t,
\end{align*}
\]

where \( a(U) \), \( b(U) \), \( c(U) \) and \( d(U) \) are power series in \( U \) with the coefficient of \( U^0 \) zero i.e. \( a(U) = \sum_{j=1}^{m} a_j U^j \).
Using the Cramer representation of the series\(^{139}\), expression such as \(a(U)X_t\) can be written as \(a(U)X_t = \int_{-\pi}^{\pi} e^{i\omega t} \cdot a(e^{-i\omega}) \cdot dZ_x(w)\). Thus equation (5-6) can be written as follows:

\[
\int_{-\pi}^{\pi} e^{i\omega t} \cdot \{[1 - a(e^{-i\omega})] \cdot dZ_x(w) - b(e^{-i\omega}) \cdot dZ_y(w) - dZ_z(w)\} = 0
\]

\[
\int_{-\pi}^{\pi} -a(e^{-i\omega}) \cdot dZ_x(w) + [1 - b(e^{-i\omega})] \cdot dZ_y(w) - dZ_z(w)\} = 0
\]

from which it follows that

\[
A \begin{bmatrix} dZ_x \\ dZ_y \end{bmatrix} = \begin{bmatrix} dZ_z \\ dZ_{\eta} \end{bmatrix}
\]

where \(A = \begin{bmatrix} 1-a & -b \\ -c & 1-d \end{bmatrix}\) and where \(a\) is written for \(a(e^{-i\omega})\), etc., and \(dZ_z\) for \(dZ_x(w)\), etc. Thus, provided the inverse of \(A\) exists,

\[
A^{-1} \begin{bmatrix} dZ_x \\ dZ_y \end{bmatrix} = \begin{bmatrix} dZ_z \\ dZ_{\eta} \end{bmatrix}
\]

As the spectral, cross-spectral matrix for \(X_t\), \(Y_t\) is directly obtainable from \(E\left[\frac{dZ_x}{dZ_y} \cdot dZ_x \cdot dZ_y\right]\), these functions can quickly be found from (5-9) using the known properties of \(dZ_x\) and \(dZ_{\eta}\). One finds that the power spectra are given by

\[
f_x(w) = \frac{1}{2\pi\Delta} \left(1 - d\right)^2 \sigma_e^2 + \left|b\right|^2 \sigma_{\eta}^2 \right) \quad \text{where} \quad \Delta = \left|\left(1-a\right)(1-d) - bc\right|^2.
\]

\[
f_y(w) = \frac{1}{2\pi\Delta} \left(1 - d\right)^2 \sigma_e^2 + \left|1 - d\right|^2 \sigma_{\eta}^2 \right)
\]

Of more interest is the cross spectrum which has the form

\[
C_r(w) = \frac{1}{2\pi\Delta} \left|\bar{c} \cdot \sigma_e^2 + \left|\bar{d}\right|^2 b \cdot \sigma_{\eta}^2 \right|
\]

Thus, the cross spectrum may be written as the sum of two components

\[\text{(5-12)}\]

\(^{139}\) Cramer representation is a basic spectral representation associated a series. If \(X_t\) is a stationary time series with mean zero, it can be represented as \(X_t = \int_{-\pi}^{\pi} e^{i\omega t} dZ_x(w)\) where, where \(z_w(w)\) is a complex random process with uncorrelated increments.
Analysis of the Causal Relationship between Financial Development and Economic Growth

\[ Cr(w) = C_1(w) + C_2(w) \]

where \( C_1(w) = \frac{\sigma_\varepsilon^2}{2\pi\Delta} (1 - d)c \) and \( C_2(w) = \frac{\sigma_\eta^2}{2\pi\Delta} (1 - a)b \)

If \( Y_t \) is not causing \( X_t \), then \( b = 0 \) and so \( C_2(w) \) vanishes. Similarly, \( C_1(w) \) vanishes if \( X_t \) is not causing \( Y_t \) (because in this case \( c = 0 \)). Therefore, the cross spectrum can be decomposed into the sum of two components, one which depends upon the causality \( X \) by \( Y \) and the other on the causality of \( Y \) by \( X \).

If, for example, \( Y \) is not causing \( X \) so that \( C_2(w) \) vanishes, then \( C_r(w) = C_1(w) \) and the resulting coherence and phase diagrams will be interpreted in the usual manner. This suggests that in general \( C_1(w) \) and \( C_2(w) \) can be treated separately as cross spectra connected with the arms of the feedback mechanism. Thus, coherence and phase diagrams can be defined for \( X \Rightarrow Y \) and \( Y \Rightarrow X \). For example,

\[ C_{xy}^{-1}(w) = \frac{|C_1(w)|^2}{f_x(w)f_y(w)} \]

may be considered to be a measure of the strength of the causality \( X \Rightarrow Y \) plotted against frequency and is a direction generalisation of coherence. One can call \( C_{xy}^{-1}(w) \) the causality coherence. Further,

\[ \phi_{xy}^{-1}(w) = \tan^{-1} \left( \frac{\text{imaginary part of } C_1(w)}{\text{real part of } C_1(w)} \right) \]

will measure the phase lag against frequency of \( X \Rightarrow Y \) and will be called the causality phase diagram.

By the same token, the causality coherence function and causality phase diagram function can be defined for \( Y \Rightarrow X \) using \( C_2(w) \). These functions can also be expressed in terms of \( a, b, c, \) and \( d \).

\[ C_{xy}^{-1}(w) = \frac{\sigma_\varepsilon^4(1 - d)c^2}{\left(\sigma_\varepsilon^2|1 - d|^2 + \sigma_\eta^2|b|^2\right)\left(\sigma_\varepsilon^2|c|^2 + \sigma_\eta^2|1 - a|^2\right)} \]

It should be noted that \( 0 < C_{xy}^{-1}(w) < 1 \) and similar for \( C_{yx}(w) \).

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5.3.4.2.2 An Example

To illustrate these definitions, consider the following feedback system

\[ X_t = bY_{t-1} + \varepsilon_t \]
\[ Y_t = cX_{t-2} + \eta_t \]

where \( \sigma^2_{\varepsilon} = \sigma^2_{\eta} = 1 \). In this case, \( a(w) = 0, b(w) = be^{-iw}, c(w) = ce^{-2iw}, d(w) = 0 \). The spectra of the series \( \{X_t\}, \{Y_t\} \) are

\[ f_x(w) = \frac{1 + b^2}{2\pi|1 - b \cdot c \cdot e^{-3iw}|^2} \]
\[ f_y(w) = \frac{1 + c^2}{2\pi|1 - b \cdot c \cdot e^{-3iw}|^2} \]

and thus are of similar shape.

The usual coherence and phase diagrams derived from the cross spectrum between these two series are

\[ C(w) = \frac{c^2 + b^2 + 2 \cdot b \cdot c \cdot \cos(w)}{(1 + b^2)(1 + c^2)} \]

and

\[ \phi(w) = \tan^{-1} \frac{c \cdot \sin(2w) - b \cdot \sin(w)}{c \cdot \cos(2w) + b \cdot \cos(w)} \]

These diagrams according to Granger are of little use in characterising the feedback relationship between the two series. However, when the causality-coherence and phase diagrams are considered, one get

\[ C_{xy}(w) = \frac{c^2}{(1 + b^2)(1 + c^2)}, \quad C_{yx}(w) = \frac{b^2}{(1 + b^2)(1 + c^2)} \]

Both are constant for all \( w \), and if \( b \neq 0, c \neq 0 \), \( \phi_{xy}(w) = 2w \) (time-lag of two unit), \( \phi_{yx}(w) = w \) (time-lag of one unit).

The causality lag are thus seen to be correct and the causality coherences to be reasonable. In particular, if \( b=0 \), then \( C_{xy}(w) = 0 \), which means that no causality is found when none is present.

Other particular cases are also found to give correct results. If, for example, the same sample model in (5-16) is considered but with \( \sigma^2_{\varepsilon} = 1, \sigma^2_{\eta} = 0 \), i.e. \( \eta_t \equiv 0 \) for all \( t \), the one finds \( C_{xy}(w) = 1, C_{yx}(w) = 0 \), i.e. \( X \) is 'perfectly' causing \( Y \), as is in fact the case.
5.3.4.2.3 Case for Instantaneous Causality

If one considers a more general model with instantaneous causality

\[ X_t + b_0 Y_t = \sum_{j=1}^{m} a_j X_{t-j} + \sum_{j=1}^{m} b_j Y_{t-j} + \varepsilon_t \]

\[ Y_t + c_0 Y_t = \sum_{j=1}^{m} c_j X_{t-j} + \sum_{j=1}^{m} d_j Y_{t-j} + \eta_t \]

It is found that the cross spectrum is given by

\[ Cr(w) = \frac{1}{2\pi\Delta} \left[ (1-d) \cdot (c-c_0) \cdot \sigma^2_x + (1-a) \cdot (b-b_0) \cdot \sigma^2_y \right] \]

where \( \Delta = \sqrt{(1-a)(1-d) - (b-b_0)(c-c_0)} \).

Thus, once more, the spectral can be considered as the sum of two components, each of which can be associated with a ‘casualty’, provided that this includes instaniously causality. It is, however, probably more sensible to decompose \( Cr(w) \) into three parts, \( Cr(w) = C_1(w) + C_2(w) + C_3(w) \), where \( C_1(w) \) and \( C_2(w) \) are as in (5-12) but with \( \Delta \) replaced by \( \Delta' \), and

\[ C_3(w) = \frac{-1}{2\pi\Delta} \left[ c_0 (1-d) \sigma^2_x + b_0 (1-a) \sigma^2_y \right] \]

representing the influence of the instantaneous causality.

Such decomposition may be useful but it is clear that when instantaneous causality occurs, the measures of causal strength and phase lag will lose their meaning.

5.3.4.2.4 Case for No Causality

Returning to the simple model in (5-6), throughout the section it has been stated that \( Y_t \not\rightarrow X_t \) if \( b = 0 \). On intuitive grounds this seems to fit the definition of no causality. If \( b = 0 \), then \( X_t \) is determined from the first equation and the minimum variance of the predictive error of \( X_t \) using past \( X_t \) will be \( \sigma^2_x \). This variance cannot be reduced using past \( Y_t \). The proof is as follows. In the general case, it is clear that

\[ \sigma^2(X_t | X_t, Y_t) = \sigma^2_x \]

i.e., the variance of the predictive error of \( X_t \), if both past \( X_t \), and
past \(Y\) are used, will be \(\sigma^2_e\) from the topic equation in (5-6). If only past \(X\) is used to predict \(X\), the minimum variance of the predictive error is given by

\[
\sigma^2(X|\overline{X}) = e^{2\beta_1^2} \sum_{t=1}^{\infty} \frac{1}{t} \sigma_e(w) dw
\]  

(5-20)

From (5-10), \(f_s(w) = \frac{1}{2\pi \Delta} \left( |1 - d| \sigma^2_e + |b|^2 \sigma^2_y \right)\) where \(\Delta = (1-a)(1-d) - bc\). To simplify (5-20), it is noted that \(\int_{-\pi}^{\pi} \log(1 - \alpha \cdot e^{iw}) dw = 0\) by symmetry. Thus if \(f_s(w) = \frac{\pi |1 - \alpha \cdot e^{iw}|^2}{2\pi |1 - \beta \cdot e^{iw}|^2}\), then \(\sigma^2(X|\overline{X}) = \alpha_0\). For there to be no causality, one must have \(\alpha_0 = \sigma^2_e\). It is clear from the form of \(f_s(w)\) that in general this could only occur if \(|b| = 0\), in which case \(2\pi f_s(w) = \frac{\sigma^2_e}{|1 - \alpha|^2}\) and the required result follows.

5.3.4.3 Summary

Granger (1969) shows that causality can be studied by using spectral analysis. The cross spectrum between two variables can be decomposed into 2 parts, each relating to a single causal arm of a feedback situation. The strength and length of causality can be measured using causality phase diagram and causality coherence. Hence, the derivation of this section can be served as the formal foundation of Granger-Causality test.

5.3.5 Vector Autoregressive Representation

The concept of Granger-Causality can also be represented using the Vector-Autoregressive (VAR). Assume that autoregressive representations exist for both \(X_t\) and \(Y_t\), one can yield the following VAR expression:

\[
\begin{bmatrix}
X_t \\
Y_t
\end{bmatrix} = A(L) \begin{bmatrix}
X_{t-1} \\
Y_{t-1}
\end{bmatrix} + \begin{bmatrix}
\varepsilon_t \\
\eta_t
\end{bmatrix}
\]

(5-21)

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where

\[ A(L) = \begin{bmatrix} a_{11}(L) & a_{12}(L) \\ a_{21}(L) & a_{22}(L) \end{bmatrix} \]

The time series \( Y_t \) is said to Granger-cause \( X_t \) if \( a_{12}(L) \) is not equal to zero.

### 5.3.6 Sims Causality

Based on the concept of causality developed by Granger, Sims (1972) formulated another notion of causality. The use of the moving average representation of set of time series is the basis for Sims' notion of causality. While Granger-Causality can be understood in terms of forecasting and prediction, Sims approach focus on examining what sorts of shocks affect a process (Sims 1972; Wold 1938).

Using the Wold (1938) representation theorem, given the covariance stationary stochastic process of \( X_t \) and \( Y_t \), the VAR system in (5-21) can be expressed in the following moving average representation.

\[
\begin{bmatrix} X_t \\ Y_t \end{bmatrix} = \Pi(L) \begin{bmatrix} \epsilon_t \\ \eta_t \end{bmatrix}
\]

where

\[
\Pi(L) = \begin{bmatrix} \pi_{11}(L) & \pi_{12}(L) \\ \pi_{21}(L) & \pi_{22}(L) \end{bmatrix}
\]

The time series \( Y_t \) is said to Sims-cause \( X_t \) if \( \pi_{12}(L) \) is not equal to zero.

One can show that Granger and Sims causality are equivalent in the bivariate case. However, the two approaches may yield different results at the multivariate level.
5.3.7 Shortcomings

The concepts of Granger causality start with the premise that the future cannot cause the past. If event A occurs after event B, then A cannot cause B. Granger (1969) applies this concept to economic series to determine whether one time series 'causes' in the sense of precedes another. However, merely because event A occurs before B does not mean that A causes B. A counter example is that Christmas shopping does not cause Christmas. This idea is first illustrated by Tobin (1970) in his examination of money-income nexus, where his model shows that 'timing sequence consistent with observations, and superficially favourable to hypothesis stressing the causal importance of money, can be generated by a structure in which money has no causal role.' i.e. money supply increases preceding income rise but money does not Granger-cause income in his model. The point is that Granger causality has nothing to do with the notion of causality in the common (or philosophical sense). It is related to the question of how useful one variable in forecasting another variable (Tobin 1970).

The development of the Rational Expectation Hypothesis in the 1970s also questions the relevancy of temporal ordering for causal distinction. Rational expectations theory was developed in response to the perceived flaws in theories based on adaptive expectations, where future expectation is based on the past information. The hypothesis of rational expectations addresses this by assuming that agents will take into account of all available information to form expectations. For example, if the government want to lower unemployment by expansionary monetary policy, economic agents will anticipate the effects of policy change and raise their expectations of inflation accordingly. This change in expectation will counteract the expansionary effect of increased money supply. In equilibrium, this will raise inflation without successfully lowering unemployment rate. Putting this concept in the field of finance-growth nexus, if a country expects to grow in the future, then financial institutions may develop now in anticipation even its development is 'caused' by the expectation of growth rather than growth itself. Hence the timing inconsistency, where agent preference changes overtime due to rational expectations, will render the temporal ordering for causal distinction irrelevant.

Cartwright (1989) argues that Granger Granger-causality requires holding fixed all causally relevant factors to the beginning of time and that, even if it were
possible, this would be an effective strategy only for determination of token-level causes (particular incident), but Granger’s aim is to discover type-level causes (general economic relationship). This line of thought suggests that the Granger-causality test is a pure test of association with no reference to economic structure (Cartwright 1989; Hoover 2001).

One drawback on the definition is the need to know the universal information to ascertain the effect of deleting the history of one variable. Most empirical tests have been performed in limited information sets where the relevancy of these variables cannot determine its actual relevancy in the whole population. Besides, most of the empirical tests have been conditional on a host of untested assumptions such as homoscedasticity, parameter constancy, linearity, and fixed lag lengths, and any violation of these assumptions will render the estimations invalid (Hendry 1995).

5.4 Data and Methodology

5.4.1 Data

The present enquiry concerns causal relationship between financial development and economic growth; 161 countries are examined with a time span ranging from 1965 to 2004. The data are from World Development Indicators from World Bank (World Bank 2006) and details about the data is explained in chapter 4. GDP per capita growth is used as the proxy for economic growth, whereas Domestic Credit provided by the private sector as a percentage of GDP is used as the proxy for financial development. The underlying assumption that Domestic Credit provided by the private sector as a percentage of GDP is a financial development indicator, is that the

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140 Type-level causal question is generic, which corresponds to identify the regularities, or the general relation between variables. Token-level causal question is singular, which corresponds to instantiations of variables and refer to a singular incident. For example, 'do financial development cause economic growth?' is a type-level causal question, and 'Did pegging the HK-dollar to the US dollar in 1983 result in a halt of capital outflow in that year?' is a token-level causal question. According to the structural approach by Hoover (2001), ‘Token causes are causes by virtue of their being realizations of type-level causes (i.e. of variables in a causal structure), and token-level causes do not stand in need of an independent analysis.’ (Hoover 2001).
more developed the financial system, the better the firm's ability to provide credit to the private sector.

5.4.2 Unit Root Tests

The augmented Dickey-Fuller (ADF) test was used to determine the order of integration and hence the stationarity of each univariate time-series in the model. The specification of ADF tests and the null hypothesis are as either one of the following 3 cases\(^{141}\) (Dickey and Fuller 1981; Patterson 2000):

a. When there is a deterministic trend and intercept in the series

\[
\Delta Y_t = \mu + \phi t + \gamma Y_{t-1} + \sum_{k=1}^{p} \delta_k \Delta Y_{t-k} + \eta_t
\]  \hspace{1cm} (5-23)

b. When there is an intercept but no deterministic trend in the series

\[
\Delta Y_t = \gamma Y_{t-1} + \sum_{k=1}^{p} \delta_k \Delta Y_{t-k} + \eta_t
\]  \hspace{1cm} (5-24)

c. When there is no deterministic trend and intercept in the series

\[
\Delta Y_t = \gamma Y_{t-1} + \sum_{k=1}^{p} \delta_k \Delta Y_{t-k} + \eta_t
\]  \hspace{1cm} (5-25)

The optimal lag length is chosen according to the Schwarz (1978) Bayesian Information Criteria. The idea is to choose the lag order, \(p\), to minimise a function of the form (SBIC) of the following:

\[
SBIC(p) = T \ln \hat{\sigma}^2 (p) + p(\ln T)
\]  \hspace{1cm} (5-26)

where \(\hat{\sigma}^2 (p)\) is the estimated regression variances, \(T\) is the sample size, and the second term serves as a penalty function for increasing the order of the model. (Patterson 2000; Schwarz 1978).

The results of the tests are given by the following tables.

\(^{141}\) Notice that the ADF test-statistics will be different under the three cases mentioned. Therefore, it is important to determine if the series contains an intercept and a deterministic trend before conducting any statistical inference.
Table 5-3: Stationary Test Results: Individual Country

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<td>I(0)</td>
</tr>
<tr>
<td>Antigua and Barbuda</td>
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</tr>
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</tbody>
</table>

142 For full results, please refer to appendix. 10% significance level was used as a critical level to determine if one can reject the testing null hypothesis. I(0) indicated that the series is of integrated order 0, i.e. there is no unit root and the series is stationary. I(1) and I(2) indicated that the series is of integrated order 1 and 2 respectively, i.e. there is more than 1 unit root and hence the series is non-stationary. n/a indicated that there is not enough observation for that particular series.
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Table 5-4 Stationary Test Results: Summary

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<td>I(2)</td>
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<tr>
<td>Total</td>
<td>161</td>
<td>161</td>
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</table>

From the above Table 5-3 & Table 5-4, we can yield the following conclusions:

- Growth series is stationary in 93% of the sample countries;
- Financial development series exhibit non-stationary trend in majority of countries (more than 78% of the sample);

It is well-known that the basic assumption of the Least Square Estimation is stationarity of the variable. Besides, much current literature on cross-country growth regression assumes homogeneity of the panel and stationarity of the financial development variable. The above results refute these assumptions. The results show that there is heterogeneity across countries regarding stationarity of the variables, and the financial development indicator exhibit non-stationary trend in more than 70% of whole sample countries. All these will lead to biased results if we use the
conventional cross-country panel estimation of granger-causality with assumed stationarity of the variables.

5.4.2.1 Basic Specification

The following equations will apply to those countries where both financial development and economic growth variable are stationary.

$$g_t = \lambda_1 + \sum_{i=1}^{m} \alpha_i g_{t-i} + \sum_{j=1}^{n} \beta_j \ln(FD)_{t-j} + \varepsilon_t$$ \hspace{1cm} (5-27)

$$\ln(FD)_t = \lambda_2 + \sum_{i=1}^{r} \rho_i g_{t-i} + \sum_{j=1}^{s} \theta_j \ln(FD)_{t-j} + \eta_t$$ \hspace{1cm} (5-28)

FD represents the financial development indicators, g represents the economic growth variable, and t denotes the time. $\lambda_1, \lambda_2$ are the constant term in each equation respectively. $\varepsilon_t, \eta_t$ are the error terms, and $m, n, r, s$ are the lag-orders.

A test of Granger non-causality can be based on a test of hypothesis that

$$H_0 : \beta_j = 0, \rho_i = 0; \hspace{1cm} j = 1, \ldots, n, \hspace{1cm} i = 1, \ldots, r$$ \hspace{1cm} (5-29)

5.4.2.2 If Financial Development Indicators are non-stationary

In section 5.4.2, the unit root test shows that 78% of financial development indicators are non-stationary (have one unit root), while economic growth is stationary across countries. The violation of the assumption of stationarity will render the results bias or lead to spurious regression. According to the conventional time-series approach, taking the first difference of I(1) series will reduce the integrated order of that series by one and make it a stationary [i.e. become an I(0)] series, thereby correcting the problems.
Hence, the following equations systems are applied to these countries for causality testing.

\[ g_t = \lambda_t + \sum_{i=1}^{m} \alpha_i g_{t-i} + \sum_{j=1}^{n} \beta_j \Delta \ln(FD)_{t-j} + \epsilon_t \]  

\[ \Delta \ln(FD)_t = \lambda_2 + \sum_{i=1}^{r} \rho_i g_{t-i} + \sum_{j=1}^{s} \theta_j \Delta(FD)_{t-j} + \eta_t \]  

A test of Granger non-causality can be based on a test of hypothesis that

\[ H_0 : \beta_j = 0, \rho_j = 0; \]
\[ j = 1, ..., n, \]
\[ i = 1, ..., r \]

5.4.2.3 When Both Series are Non-Stationary

Engle and Granger’s (1987) test of non-cointegration will be applied to those countries where both the series of economic growth and financial development are non-stationary and of the same integrated order. The two-step procedure of the test is as follows.

a. Estimate the static level of regression by OLS

\[ g_t = \lambda + \phi_t FD_t + \omega_t \]  

From the equation, test for the integrated order of the residual \( \omega_t \). If \( \omega_t \) is stationary, one can conclude that co-integration exists and there is long-run equilibrium relationship between financial development and economic growth.

b. Incorporate the Error Correction Mechanism (ECM) terms into the equation

If there is co-integration, the following ECM equation is being tests

\[ \Delta g_t = \pi_0 + \pi_1 \Delta \ln(FD)_t - \sum_{i=2}^{m} \alpha_i g_{t-i+1} - \sum_{j=2}^{n} \beta_j \ln(FD)_{t-j+1} + \pi_2 \hat{\omega}_{t-1} + \nu_t \]
\[
\Delta \ln(FD)_t = \kappa_0 + \kappa_1 \Delta g_t - \sum_{i=2}^{I} \rho_i g_{t-i+1} - \sum_{j=2}^{J} \theta_j \ln(FD)_{t-j+1} + \kappa_2 \omega_{t-1} + \zeta_t
\]  

(5-35)

A test of Granger non-causality can be based on a test of hypothesis that

\[
H_0 : \beta_j = 0, \rho_i = 0; \\
\quad j = 1, \ldots, n, \\
\quad i = 1, \ldots, r
\]  

(5-36)

5.4.3 Selecting the optimal lag lengths

The original Granger-Causality Test (1969) assumes equal lag orders on each variable each equation specification within the system. The weakness is that it will lead to a loss of degrees of freedom and inefficient estimation of parameter. Econometricians modified the original Granger-Causality Test, and incorporate the information criteria into the test to determine the optimal lag lengths, in order to provide a more parsimonious representation and more efficient estimates of parameters.

5.4.3.1 Akaike Final Prediction Error (FPE) and Hsiao-Granger Causality Test

Hsiao (1979) formulated a testing procedure based on Akaike's (1970) final prediction error (FPE) criterion and on Granger's (1969) definition of causality. Consider the following specification:

\[
g_t = \lambda_t + \sum_{i=1}^{m} \alpha_i g_{t-i} + \sum_{j=1}^{n} \beta_j \ln(FD)_{t-j} + \varepsilon_t
\]  

(5-27)

The definition of the final prediction error (FPE) defined by Akaike (1970) is as follows:

\[
FPE(m, n) = \left( \frac{T + n + m + 1}{T - n - m - 1} \right) \left( \frac{RSS}{T} \right)
\]  

(5-37)
where $n, m$ are the lag orders, $T$ is the sample size, and RSS is the residual-sum-of-squares of the regression.

The purpose is to specify the order of lag lengths that minimise the FPE. Hsiao (1979) suggests the following steps test for existence of causal relationship based on the Akaike's FPE criteria

I. Take $g$ (i.e. economic growth) as the only output in the system, and determine the order of the one-dimensional autoregressive progress for $g$ that minimises FPE criterion: this identifies $m^*$. 

II. Introduce the lags of $FD$ (i.e. financial development) over the best univariate model of $g$, and choose the model that minimise FPE. This identifies $n$. 

III. To check if the lagged value of $g$ might pick up the effect of lagged $FD$ when $g$ is treated as a univariate series, let the lagged order of $FD$ be fixed at $n$ (from step II), and let the lagged order of $g$ vary from 0 to $m^*$ (from step I). Compute the FPE, and choose the lagged order of $g$ that minimise FPE. This identify $m$; 

IV. $FD$ granger cause $y$ if the minimum FPE from the bivariate model [i.e. $FPE(m,n)$] is smaller than the best univariate model of $g$ [i.e. $FPE(m^*,0)$]. (Akaike 1970; Hsiao 1979) 

Kang (1989) further modified the model by suggesting the exclusion of any insignificant lags between lag 1 and the optimal lag order founded, so as to avoid the problem of over-parameterisation and inefficiency (Kang 1989). 

The Hsiao-Kang methodology will therefore be used to determine the optimal lag lengths when performing Granger-Causality Test.

5.4.3.2 Schwarz Bayesian Information Criteria (SBIC) 

The model selection criterion based on Schwarz's Bayesian Information Criteria (SBIC) and on Granger definition of causality is listed in this section. Accordingly, SBIC results from a Bayesian procedure of seeking the most probable (a posterior) model. The purpose is to specify the order of lag lengths that minimise the SBIC, which formula is specified as follows (Atukeren 2005; Schwarz 1978).

$$SBIC(m,n) = \left[ \frac{T(m + n + 1)}{T} \right] \left( \frac{RSS}{T} \right)$$

(5-38)
The 4-step testing procedure from the above section 5.4.3.1 will be used accordingly, and \( FD \) will Granger-cause \( y \) if the minimum SBIC from the bivariate model [i.e. \( SBIC(m,n) \)] is smaller than the best univariate model of \( g \) [i.e. \( SBIC(m^*,0) \)].

### 5.4.3.3 Rationale

Accordingly, in (5-37) and (5-38), the first term corresponds to the measurement of estimation error, while the second term is a measure of modelling error. The reason for using information criterion is to determine the optimal lags that can balance 'the risk resulting from the bias when a lower order is selected and the risk resulting from the increase of variance when a higher order is selected' (Hsiao 1979). By choosing the specification that gives the smallest FPE or SBIC, it is argued that the test will be equivalent to choosing the specification based on F test with varying significance level accordingly.

Several studies document that SBIC is the first choice among all the information criteria to be used in testing Akaike FPE criteria tends to overestimate the true order of autoregression with positive probability and is said to be consistent, whereas SBIC will give a consistent estimation. Yet, current research continues to use the Akaike FPE criteria because its finite sample performance in choosing the right lag-length specification is not necessarily inferior to SBIC. Therefore, both methods will be used in this study (Koreisha and Pukkila 1995; Mills and Prasad 1992; Patterson 2000).

Apart from using Hsiao-Kang and SBIC methodology, the present analysis will also use the basic F-test to conduct Granger-testing exercise.

### 5.5 Data Analysis

#### 5.5.1 Results

Table 5-5 and Table 5-6 summarise the results of the Granger-Causality test using the Akaike FPE Criteria and Schwarz Bayesian Information Criteria respectively. For full results, please refer to the appendix. According to the Hsiao-Kang methodology using the Akaike FPE Criteria, as shown in Table 5-5, the relationship between financial development and economic growth is significant for the majority (77.3%,
125 out of 162) of the sample countries. The relationship is bi-directional for 50 (31.1%) countries. Financial development Granger-causes growth unilaterally in 41 (25.4%) countries, whereas growth Granger-causes financial development unilaterally in 34 (21.1%) countries. The relationship is insignificant for 36 (22.4%) countries.

Table 5-6 also shows the results of the F-test based on the specification using the Akaike FPE Criteria. Accordingly, the relationship between financial development and economic growth is significant for the majority (62.7%, 101 out of 162) of the sample countries. The relationship is reciprocal for 27 (16.8%) countries. Financial development granger-causes growth unilaterally in 33 (20.4%) countries, whereas growth granger-causes financial development unilaterally in 41 (25.5%) countries. The relationship is insignificant for 60 (37.3%) countries.

Although there are variations between the Ksiao-Kang methodology and the more traditional approach of the F-test, both approaches suggest that there is evidence of existence of bi-direction, or a reciprocal relationship between financial development and economic growth. About one half of the country sample shows finance causes economic growth, whereas there is another one half demonstrating economic growth cause financial development.

---

143 One of the reason is due to the small sample size in some country will lower the robustness of the test and lead to variation.
Table 5-5: Summary of Results of Granger Causality Test using Akaike FPE Criteria.

<table>
<thead>
<tr>
<th>Information Criteria</th>
<th>Akaike's FPE Criteria</th>
<th>Reciprocal Relationship</th>
<th>Finance Cause Growth</th>
<th>Growth Cause Finance</th>
<th>Insignificant Relation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Case 1</td>
<td>19</td>
<td>5</td>
<td>3</td>
<td>7</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Case 2</td>
<td>24</td>
<td>35</td>
<td>31</td>
<td>27</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>Case 3</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>50 (31.1%)</td>
<td>41 (25.4%)</td>
<td>34 (21.1%)</td>
<td>36 (22.4%)</td>
<td>161</td>
</tr>
<tr>
<td>F-Test</td>
<td>Case 1</td>
<td>14</td>
<td>4</td>
<td>9</td>
<td>7</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Case 2</td>
<td>10</td>
<td>29</td>
<td>28</td>
<td>50</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>Case 3</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>27 (16.8%)</td>
<td>33 (20.4%)</td>
<td>41 (25.5%)</td>
<td>60 (37.3%)</td>
<td>161</td>
</tr>
</tbody>
</table>

Notes: Case 1 corresponds to the situation where both growth and financial development indicators are stationary. Case 2 corresponds to the situation where growth is stationary but financial development indicators are non-stationary. Case 3 corresponds to the situation where both growth and financial development indicators are non-stationary. 10% significant level is used for hypothesis testing.
### Table 5-6 Summary of Results of Granger Causality Test using Schwarz Bayesian Information Criteria.

<table>
<thead>
<tr>
<th>Schwarz Bayesian Information Criteria</th>
<th>Reciprocal Relationship</th>
<th>Finance Cause Growth</th>
<th>Growth Cause Finance</th>
<th>Insignificant Relation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information Criteria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case 1</td>
<td>12</td>
<td>1</td>
<td>5</td>
<td>16</td>
<td>34</td>
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<tr>
<td>Case 2</td>
<td>8</td>
<td>12</td>
<td>14</td>
<td>83</td>
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</tr>
<tr>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21 (13%)</td>
<td>15 (9.3%)</td>
<td>22 (13.7%)</td>
<td>103 (64%)</td>
<td>161</td>
</tr>
<tr>
<td><strong>F-Test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case 1</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>15</td>
<td>34</td>
</tr>
<tr>
<td>Case 2</td>
<td>9</td>
<td>23</td>
<td>24</td>
<td>61</td>
<td>117</td>
</tr>
<tr>
<td>Case 3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>19 (11.8%)</td>
<td>32 (19.9%)</td>
<td>32 (19.9%)</td>
<td>78 (48.4%)</td>
<td>161</td>
</tr>
</tbody>
</table>

Notes: Case 1 corresponds to the situation where both growth and financial development indicators are stationary. Case 2 corresponds to the situation where growth is stationary but financial development indicators are non-stationary. Case 3 corresponds to the situation where both growth and financial development indicators are non-stationary. 10% significant level is used for hypothesis.
Using the SBIC methodology, the results show that finance-growth link is less apparent. The SBIC shows that the relationship is insignificant in more than half of the countries sampled (64%). The traditional F-test yields more encouraging results, where more than half of countries (52.2%) show a significant relationship in the finance-growth nexus. One reason to account for the differences of SBIC approach with the Ksiao-Kang methodology, is that the SBIC tended to be more restrictive in choosing lag specification than Akaike FPE Criteria (Patterson 2000). The optimal lag length is significantly lower in the case of SBIC. Hence, there is a possibility that the criteria tends to be too restrictive and under-parameterised, that the optimal lag specification is too short to study the temporal problems of causality.

In sum, the following conclusions can be drawn from the results

- There is evidence of reverse-causality in the finance-growth nexus. Hence the results provide empirical foundations for the theoretical studies in the literature on the reciprocal effect of financial development, such as Patrick (1966), Greenwood and Jovanovic (1990), Berthelemy and Varoudakis (1996) and Greenwood and Smith (1997) (Berthelemy and Varoudakis 1996c;Greenwood and Jovanovic 1990;Greenwood and Smith 1997;Patrick 1966).

- Yet the linkage of financial development and economic growth is not robust. Only around one half of countries show significant linkage between these two macro-economic variables.

- There is evidence for demand-following patterns and supply leading pattern.144 Causality runs in both ways for growth and financial development.

---

144 According to Patrick, demand following pattern is the evolutionary development of financial systems is a continuous and spontaneous response to the rising demand of financial services established by the process of economic development. Finance is therefore passive and permissive in the growth process, and the causality runs from growth to finance. Whereas supply leading pattern is the creation of financial institutions and their supply of their financial assets, liabilities and related financial services induced economic growth, by channelling savings to productive investment in modern sectors and by stimulating entrepreneurial activities in these sectors. The causality runs from finance to growth. Please refer to the literature review in earlier chapters for further details (Eschenbach 2004;Patrick 1966).
In order to provide a better understanding for the process, the results will be further categorised according to the country’s income level in order to shed light on how the level of development of a country affects the finance-growth nexus.

5.5.2 Results Classification by Country Income Level

The results are further categorised according to the level of per-capital income of each country in order to shed light on how countries development affecting the linkage between financial development and economic growth.

An interesting scenario is observed from Table 5-7 and Table 5-8. Both Akaike FPE and SBIC information criteria show that there are more cases for the causal direction running from financial development to growth than the reverse for high income OECD and non-OECD countries. The trend is different for the low and lower middle income countries groups. Accordingly in these groups, there are more cases for the causal direction running from growth to financial development than the reverse. For the upper middle income, no clear conclusion can be drawn.

Hence, the results appear to refute the Patrick (1966) hypothesis for the pattern that in the early stage of development where there is inadequate provision of financial services, the supply leading pattern dominates (Patrick 1966). The result here suggest that rather than that the economies will shift from a supply-leading pattern in early stages towards the demand-following pattern during the later stage of development, the reverse process is happening. More countries show that in the early stages of development, economic growth will cause a rising demand in financial services, leading to the creation of financial system and financial development. In the later stage, the creation of a financial system and financial development will further induce economic growth.

---

145 The World Bank Classification method is used here. For operational and analytical purposes, economies are divided among income groups according to 2003 gross national income (GNI) per capita, calculated using the World Bank Atlas method. The groups are: low income, $765 or less; lower middle income,$766–3,035; upper middle income, $3,036–9,385; and high income, $9,386 or more (World Bank 2004).
### Analysis of the Causal Relationship between Financial Development and Economic Growth

<table>
<thead>
<tr>
<th>Information Criteria</th>
<th>High Income: NonOECD</th>
<th>High Income OECD</th>
<th>Upper Middle Income</th>
<th>Lower Middle Income</th>
<th>Low Income</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reciprocal Relationship</td>
<td>Akaike's FPE Criteria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finance Cause Growth</td>
<td>Growth Cause Finance</td>
<td>Insignificant Relation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 (27.2%)</td>
<td>4 (36.4%)</td>
<td>2 (18.2%)</td>
<td>2 (18.2%)</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 (34.8%)</td>
<td>9 (39.1%)</td>
<td>2 (8.7%)</td>
<td>4 (17.4%)</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 (10.3%)</td>
<td>10 (34.5%)</td>
<td>6 (20.7%)</td>
<td>10 (34.5%)</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18 (39.1%)</td>
<td>4 (8.7%)</td>
<td>11 (24%)</td>
<td>13 (28.2%)</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18 (34.6%)</td>
<td>14 (26.9%)</td>
<td>13 (25%)</td>
<td>7 (13.5%)</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50 (31.1%)</td>
<td>41 (25.4%)</td>
<td>34 (21.1%)</td>
<td>36 (22.4%)</td>
<td>161</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F-Test</th>
<th>High Income: NonOECD</th>
<th>High Income OECD</th>
<th>Upper Middle Income</th>
<th>Lower Middle Income</th>
<th>Low Income</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Reciprocal Relationship</td>
<td>Akaike's FPE Criteria</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finance Cause Growth</td>
<td>Growth Cause Finance</td>
<td>Insignificant Relation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 (18.2%)</td>
<td>2 (18.2%)</td>
<td>2 (18.2%)</td>
<td>5 (45.4%)</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 (13.1%)</td>
<td>9 (39.1%)</td>
<td>4 (17.4%)</td>
<td>7 (30.4%)</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 (7%)</td>
<td>7 (24.1%)</td>
<td>7 (24.1%)</td>
<td>13 (44.8)</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 (26.1%)</td>
<td>2 (4.3%)</td>
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<td>20 (43.5%)</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 (15.4%)</td>
<td>13 (25%)</td>
<td>16 (30.8%)</td>
<td>15 (28.8%)</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>27 (16.8%)</td>
<td>33 (20.4%)</td>
<td>41 (25.5%)</td>
<td>60 (37.3%)</td>
<td>161</td>
<td></td>
</tr>
</tbody>
</table>
### Table 5-8 Summary of Results of Granger Causality Test using SBIC; Classification by Income Level.

<table>
<thead>
<tr>
<th>Information Criteria</th>
<th>Reciprocal Relationship</th>
<th>Schwarz Bayesian Information Criteria</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Finance Cause Growth</td>
<td>Growth Cause Finance</td>
</tr>
<tr>
<td>High Income: NonOECD</td>
<td>3 (27.4%)</td>
<td>1 (9.1%)</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td>High Income OECD</td>
<td>3 (13%)</td>
<td>2 (8.7%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Upper Middle Income</td>
<td>1 (3.4%)</td>
<td>4 (13.8%)</td>
<td>4 (13.8%)</td>
</tr>
<tr>
<td>Lower Middle Income</td>
<td>6 (13.1%)</td>
<td>3 (6.5%)</td>
<td>7 (15.2%)</td>
</tr>
<tr>
<td>Low Income</td>
<td>8 (15.4%)</td>
<td>5 (9.6%)</td>
<td>10 (19.2%)</td>
</tr>
<tr>
<td>Total</td>
<td>21 (13%)</td>
<td>15 (9.3%)</td>
<td>22 (13.7%)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>F-Test</th>
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<th>Schwarz Bayesian Information Criteria</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
<td>Finance Cause Growth</td>
<td>Growth Cause Finance</td>
</tr>
<tr>
<td>High Income: NonOECD</td>
<td>2 (27.2%)</td>
<td>2 (27.2%)</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td>High Income OECD</td>
<td>0 (0%)</td>
<td>8 (34.8%)</td>
<td>2 (8.7%)</td>
</tr>
<tr>
<td>Upper Middle Income</td>
<td>2 (6.9%)</td>
<td>4 (13.8%)</td>
<td>5 (17.2%)</td>
</tr>
<tr>
<td>Lower Middle Income</td>
<td>7 (15.2%)</td>
<td>9 (19.6%)</td>
<td>10 (21.7%)</td>
</tr>
<tr>
<td>Low Income</td>
<td>8 (15.4%)</td>
<td>9 (17.3%)</td>
<td>14 (26.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>19 (11.8%)</td>
<td>32 (19.9%)</td>
<td>32 (19.9%)</td>
</tr>
</tbody>
</table>
5.5.3 Limitations

One of the limitations of the present analysis is the small number of observations for each country. The frequency of the data needs to be reasonably high in order to examine the temporal order and to determine what causes what. Annual data with a small time span therefore raises a question on the usefulness of the study. Yet at present the study is looking at the long-run relationship between financial development and economic growth, and therefore the usage of annual data is appropriate in this context. The limitation of small sample size problems can be partially overcome by a cross-country study of over 160 countries, which thereby is able to increase the number of overall observations. However, the different optimal lag length in each country shows the heterogeneity of model specification. Therefore, the panel data method of the Granger-Causality test is not used in this study, as one of the presumptions of panel data estimation is the homogeneity of parameters.

The present analysis consists of a bivariate system of 2 variables. However, there is always the possibility that there is missing variable within the system that serves as a common cause, which may screen out the causal effect from one variable to the others in the bivariate system.

Though the present analysis has tested for the assumption and corrected for the problems of non-stationarity and fixed lag lengths, it is conditional on a host of untested assumptions such as homoscedasticity and parameter constancy, and the violation of these assumptions will render the estimation invalid.

5.6 Conclusion

As mentioned in Section 0, the Granger-Causality is a test of forecastability and association with no reference to economic structure. The development of the Rational Expectation Hypothesis also questions the relevancy of temporal ordering for causal distinction. Besides, the drawback of the definition is the need to know the universal information set to ascertain the effect of deleting the history of one variable in order to determine causal direction. The next chapter of this thesis will counteract these problems by looking at the structural simultaneous equation system, with the test
carried out with limited information sets, in order to draw causal interpretation and form the basis for policy analysis.

Both the cross sectional causality and the temporal causality question of the finance-growth nexus are addressed in this chapter, by looking at the time-series data across countries. The following chapters will pool the data together by using the panel approach to estimate the simultaneous equation systems. The next chapter will also examine the outside knowledge approach by using the Instrumental Variable techniques in econometrics, to study the effect of how an exogenous variable break into the finance-growth nexus in order to identify causal structure.
5.7 Appendix (table of full results) for this chapter

The full results of section 5.5, the Granger-Causality analysis with optimal lag selection criteria, are shown in this appendix. Section 5.7.1 and 5.7.2 gives the results using the FPE and SBIC criteria respectively. Recall the basic specification

\[ g_t = \lambda_1 + \sum_{j=1}^{m} \alpha_j g_{t-j} + \sum_{j=1}^{n} \beta_j \ln(FD)_{t-j} + \varepsilon_t \]  \hspace{1cm} (5-27) 

\[ \ln(FD)_t = \lambda_2 + \sum_{j=1}^{s} \rho_j g_{t-j} + \sum_{j=1}^{s} \theta_j \ln(FD)_{t-j} + \eta_t \]  \hspace{1cm} (5-28) 

Refer to the table in this appendix, when testing the casual direction from financial development (FD) to economic growth (g)

- \( m^* \) corresponds to the order of the one-dimensional autoregressive progress for \( g \) that minimise the information criteria.
- \( n \) refers to the lags of \( FD \) from the bivariate model that minimise the information criteria once \( FD \) is introduced over the best univariate model of \( g \).
- \( m \) refers to the lagged order of \( g \) that minimise the information criteria once holding \( FD \) fixed in the bivariate model.
- \( FD \) granger causes \( g \) if \( FPE(m,n) < FPE(m^*,0) \) for the FPE criteria, or \( SBIC(m,n) < SBIC(m^*,0) \) for the SBIC criteria.

When testing the casual direction from financial development (FD) to economic growth (g)

- \( s^* \) corresponds to the order of the one-dimensional autoregressive progress for \( FD \) that minimise the information criteria.
- \( r \) refers to the lags of \( g \) from the bivariate model that minimise the information criteria once \( g \) is introduced over the best univariate model of \( FD \).
- \( s \) refers to the lagged order of \( FD \) that minimise the information criteria once holding \( g \) fixed in the bivariate model.
- \( g \) granger causes \( FD \) if \( FPE(s,r) < FPE(s^*,0) \) for the FPE criteria, or \( SBIC(s,r) < SBIC(s^*,0) \) for the SBIC criteria.
5.7.1 FPE Criteria

5.7.1.1 For Countries where Growth and Financial Development Indicators are stationary

Table 5-9 Test of Whether Finance Granger-Cause Growth using FPE Criterion and F-Test

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### Analysis of the Causal Relationship between Financial Development and Economic Growth

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### Analysis of the Causal Relationship between Financial Development and Economic Growth

#### 5.7.1.2 For Countries where Growth is stationary but Financial Development Indicators are Non-Stationary

Table 5-11 Test of Whether Finance Granger-Cause Growth using FPE Criterion and F-Test

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Analysis of the Causal Relationship between Financial Development and Economic Growth

Table 5-12 Test of Whether Growth Granger-Cause Finance using FPE Criterion and F-Test

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Table 5-13 Co-integration Results, and Test of Whether Finance Granger-Cause Growth using FPE Criterion and F-Test

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### 5.7.2 SBIC Criteria

#### 5.7.2.1 For Countries where Growth and Financial Development Indicators are stationary

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Table 5-17 Co-integration Results, and Test of Whether Finance Granger-Cause Growth using SBIC Criterion and F-Test

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## Table 5-20 Co-integration Results, and Test of Whether Growth Granger-Cause Finance using SBIC Criterion and F-Test

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6 Modelling Financial Development and Economic Growth using a Simultaneous Equation Model Approach

6.1 Introduction

Chapter 5 has looked at Granger-Causality to examine the causal relationship between financial development. Granger-Causality is a test of forecastability and association with no reference to economic structure. Besides, the drawback of the definition is the need to know the universal information set to ascertain the effect of deleting the history of one variable in order to determine causal direction. The current chapter will therefore look at the structural simultaneous equation system, with the test carried out with limited information sets, in order to counteract these problems and to draw causal interpretation and form the basis for policy analysis. The theoretical analysis in chapter 3 forms the theoretical underpinning of the empirical analysis in this chapter.

The two Causality testing approaches in Chapter 5 and 6 are different, in terms of the conceptual basis and timing structure. Chapter 5 is based on the concept of temporal causation, which looks at the knowledge of the current value of a series helps in predicting the future value of a second series. Causal direction is identified through temporal order, where the fundamental assumption is the temporal priority assumption that assumes cause will always occur before the effect. In contrast, this chapter is based on the concept of cross sectional (also called instantaneous or contemporaneous) causation, which explores the knowledge of the current value of a series helps in predicting the current value of a second series. Causal direction in this case is identified through the introduction of a sensible mechanism (simultaneous equation system with multi-variables), where the mechanism itself and the additional controlled variables chosen are supported by economic theory, in order to estimate the (instantaneous) relationship between the observed inputs and decisions (causes) and the observed output (effects).

Recent literature in the area of finance-growth nexus mainly focused on the impact of financial development on economic growth without studying the reverse or simultaneous impact of economic growth on financial development. Therefore, the analysis in this chapter can fill this gap by studying the bi-directional relationship of financial development and economic growth. The simultaneous equation model is this
chapter is consisted of 2 equations: the growth regression and the financial development regression. In order to draw the universal information set of each regression, the current study will review the current empirical work of the growth econometrics and the empirical studies of finance-growth nexus in the literature, in order to identify the appropriate testing method and specification for the system.

This chapter is organised as follows. Section 6.2 describes the methodology of the estimation techniques in this study; Section 6.3 examined simultaneous equation systems using different approach, and the results will be reported in this section. Section 6.5 discussed the policy implications.

6.2 Methodology

6.2.1 Two-Stage-Least-Square (2SLS) Estimation.

A fundamental assumption of regression analysis is that the right-hand side variables are uncorrelated with the disturbance term. If the right-hand side of the equation contains the endogenously determined variable, this assumption is violated and will render both OLS results biased and inconsistent. The standard approach take into the problem of simultaneous bias is to use instrumental variables regression. The idea behind instrumental variables is to find a set of variables that are both correlated with the explanatory variables in the equation, and uncorrelated with the disturbances. These instruments are used to eliminate the correlation between right-hand side variables and the disturbances.

The Two Stage Least Square (2SLS) Estimation method was invented by Theil (1958). It is a special case of instrumental variables regression, where there are multiple instruments for the endogenous variable. The first stage involves estimating an OLS regression of each endogenous variable in the model on the set of instruments. The second stage is a regression of the original equation, with all of the endogenous variables replaced by the fitted values from the first-stage regressions. The coefficients of this regression are the 2SLS estimates. The 2SLS estimators are consistent and asymptotically normally distributed. (Theil 1958; Verbeek 2000).

This method forms the basis for hypothesis testing in the simultaneous equation. The following will give the formal derivation, the interpretation and the properties of the

6.2.1.1 Formal Derivation of the 2SLS Estimator

Consider the model

\[ y_j = X_j \beta_j + u_j \quad j = 1, 2, \ldots, m. \]  

(6-1)

Where \( y_j \) is a \( T \times 1 \) vector of dependent variable, and \( X_j \) is a \( T \times k \) matrix of explanatory variable. There are \( m \) equations in the system, with \( k \) explanatory variable and the total number of observation equals \( T \).

Consider there is ready set of predetermined variables \( Z \) which serve as a valid set of instruments. \( Z \) is the \( T \times q \) matrix that comprise \( q \) lagged dependent variables plus exogenous variables with \( T \) observations, which by assumption satisfy the condition that

\[ E(Z'u_j) = 0 \quad \text{and} \quad p \lim_{T \to \infty} \frac{Z'u_j}{T} = 0, \quad j = 1, 2, \ldots, m. \]  

(6-2)

The relevant moment conditions are then given by following \( q \) restrictions

\[ E(Z'u_j) = E[Z'(y_j - X_j \beta_j)] = 0 \]  

(6-3)

If \( q \) (number of instruments) = \( k \) (numbers of explanatory variable. The resulting instrumental variable estimator \( \hat{\beta}_{ivj} \) is as follows,

\[ \hat{\beta}_{ivj} = (Z'X)^{-1}Z'y_j \]  

(6-4)

However, in general there are more instruments than explanatory variables (i.e. \( q > k \)). In this case, there would be more restrictions than unknowns. Instead of dropping instruments that results in efficiency lost, the standard method is to choose \( \hat{\beta}_j \) that the \( q \) sample moment conditions in (6-4) are as close as possible to zero. This is equivalent with minimisation of the following quadratic function:
Modelling Financial Development and Economic Growth using a Simultaneous Equation Model Approach

\[ Q_r(\beta_j) = \left[ \frac{1}{T} Z'(y_j - X_j\beta_j) \right] W_r \left[ \frac{1}{T} Z'(y_j - X_j\beta_j) \right] \]  \hfill (6-5)

\( W_r \) is an \( q \times q \) positive definite symmetric matrix, which tell us how much weight to attach to which linear combinations of the sample moment. It can be thought of a weighting matrix. Differentiate \( Q_r(\beta_j) \) with respect to \( \beta_j \) gives the following first order conditions:

\[ -2X'_jZW'_rZ'y_j + 2X'_jZW'_rZ'X\beta_{ivj} = 0 \]
\[ \Rightarrow X'_jZW'_rZ'y_j = X'_jZW'_rZ'X\beta_{ivj} \]  \hfill (6-6)

Solving (6-6) gives the following instrumental variable estimators

\[ \hat{\beta}_{ivj} = \left( X'_jZW'_rZ'X_j \right)^{-1} X'_jZW'_rZ'y_j \]  \hfill (6-7)

\( X'_jZ \) is a \( k \times q \) matrix. The idea behind the consistency result is that we are minimizing a quadratic loss function in a set of sample moments that asymptotically converge to the corresponding population moments, while these population moments are equal to zero for the true parameter values. Three cases will follow to determine if there exists consistent estimate of \( \beta_j \):

- If \( q = k \), the matrix \( X'_jZ \) is invertible. There (6-7) is reducible to (6-4) and \( W_r \), the choice weighting matrix, becomes irrelevant. This corresponds to the situation where the number of moment conditions (restrictions) is equal to the number of parameter to be estimated. In other words, \( \beta_j \) is exactly identified.
- If \( q < k \), where the number of moment conditions (restrictions) is smaller than the number of explanatory variables, \( \beta_j \) is under-identified. This corresponds to the case where the inverse (6-9) does not exists, and there is no consistent estimators of \( \beta_j \).
If $q > k$, where number of moment conditions (restrictions) is larger than the number of explanatory variables, $\beta_j$ is over-identified, and there is more information than is necessary to obtain a consistent estimators for $\beta_j$. The estimates is consistent when the weighting matrix $W_T$ is asymptotically positive definite.

It can be shown that the optimal weighting matrix ($W_T$) is proportional to the inverse of the covariance matrix of the sample moments, which is given by $\frac{1}{T} Z' \mu_j$. If the assumption that $\mu_j$ is $IID(0, \sigma^2)$ and independent of $Z$, the asymptotic covariance matrix of the sample moment is given by $\sigma^2 p \lim \frac{1}{T} Z' Z$. The optimal weighting matrix is therefore as follows

$$ W_{T}^{opt} = \left( \frac{1}{T} Z' Z \right)^{-1} $$(6-8)

The resulting instrumental variable estimator is known as the two-stage-least-square (2SLS) estimators:

$$ \hat{\beta}_j = \left( X' Z (Z' Z)^{-1} Z' X \right)^{-1} X' Z (Z' Z)^{-1} Z' y $$

**6.2.1.2 Interpretation of 2SLS**

The estimator can be interpreted as a two stage estimation procedure. In the first stage, the explanatory variables $X_j$ are regressed on the set of instrument $Z$. This is the estimation of the parameters of the $j$th equation of the following reduced form:

---

Intuitively, this means that sample moments with a small variance which provide accurate information about the parameters in $\beta_j$, will get more weight in estimation that the sample moments with a large variance.
Modelling Financial Development and Economic Growth using a Simultaneous Equation Model Approach

\[ X_j = \pi_j Z + \zeta_j \]  \hspace{1cm} (6-10)

Then the dependent variable, \( y_j \), is regressed on the fitted values from, as follows:

\[ \hat{X}_j = Z(Z'Z)^{-1} Z'X_j \]  \hspace{1cm} (6-11)

\( \hat{X}_j \) is called the constructed regressors. Therefore the second stage estimates is given as follows:

\[ \hat{\beta}_j = \left( \hat{X}_j' \hat{X}_j \right)^{-1} \hat{X}_j' y_j \]  \hspace{1cm} (6-12)

Notice that (6-12) is formally identical to (6-9). In this interpretation, the original explanatory variable \( X_j \) are replaces by the constructed regressors \( \hat{X}_j \). Yet it is generally more helpful to think of 2SLS as the following instrumental variables estimators where the original explanatory variables are not replaced but are instrumented by \( \hat{X}_j \).

\[ \hat{\beta}_j = \left( \hat{X}_j' X_j \right)^{-1} \hat{X}_j' y_j \]  \hspace{1cm} (6-13)

6.2.1.3 Properties

Assume that probability limits of the following moments exist and finite,

\[ p\lim \frac{Z'Z}{T} = Q_{zz} \quad \text{and} \quad p\lim \frac{X'Z}{T} = Q_{xz} \]  \hspace{1cm} (6-14)
It can be shown that the 2SLS estimator is consistent since

$$\hat{\beta}_j = \left( X'Z(Z'Z)^{-1}Z'X \right)^{-1} X'Z(Z'Z)^{-1} Z (X_j \beta_j + \mu_j)$$

and

$$\lim p \hat{\beta}_j = \beta_j + \left( \lim p \frac{X'Z\left(Z'Z\right)^{-1}Z'X}{T} \right)^{-1} X'Z\left(Z'Z\right)^{-1} Z'\mu_j$$

Using the central limit theorem

$$T^{-\frac{1}{2}} Z'u_j \sim_a N\left(0, \sigma_{jj}Q_{zz}\right)$$

One can show that $\hat{\beta}_j$ is asymptotically normally distributed with

$$\sqrt{T}\left(\hat{\beta}_j - \beta_j\right) \sim_a N\left(0, \sigma_{jj}\left(Q_{xz}Q_{zz}Q_{zx}\right)^{-1}\right)$$

This result therefore forms the basis for hypothesis testing in the simultaneous equation.

### 6.2.2 Model of Estimation

The present enquiry concerns how financial development and economic growth simultaneously determine one another. The following linear simultaneous equations model is being tested.

$$Growth_{it} = \alpha + \beta FD_{it} + \gamma X_{it} + \epsilon_{it}$$

$$FD_{it} = \mu + \delta Growth_{it} + \lambda Z_{it} + \nu_{it}$$

$Growth_{it}$ is the variable for economic growth, and $FD_{it}$ is the logarithm of the financial development indicator. The index $i$ and $t$ represent the cross section and time period respectively.
The vast majority of panel data growth studies use a fixed effects (within group) estimator\textsuperscript{147} rather than the random effect estimators for estimating model with unobserved country effects. The advantage is that it can address the problem of heterogeneity bias\textsuperscript{148}. However, the fixed-effects identification strategy cannot apply in all contexts\textsuperscript{149}. Besides, this approach faces several problems. Often researchers do not pay enough attention to the dynamics of adjustment, to differentiate the short-run variation to the long run effect. The method to eliminate the country-specific intercepts by either within group transformation or first differencing will tend to aggravate the measurement errors. There is a trade-off between bias and efficiency in deciding if fixed effect estimation is to be used. Furthermore, growth episodes within countries look more alike than growth episodes across countries, and therefore offering less identifying variation (Durlauf, Johnson, and Temple 2005)

A natural alternative to the within-country estimator is to devote more attention to model the heterogeneity, rather than treating it unobserved and try to eliminate its effect. One way is to include a complete set of regional dummies to alleviate the biased associated with omitted variables. When estimating dynamic models, the alternative strategy is to difference the model to eliminate the fixed effects, and then use the instrumental procedures to address the correlation between the differenced lagged dependent variable and the induced MA(1) error term. The most widely used General Method-of-Moment Approach, developed by Arellano and Bond (1991) and being first applied in growth context by Caselli, Esquivel, and Lefort (1996), is based on using lagged levels of series as instruments for lagged first differences. It could alleviate biases due to measurement error and problem of endogeneity. However, many researchers are sceptical that lags are suitable instruments.

The approach that this study has adopted is to devote more attention to model the heterogeneity, rather than treating it unobserved and try to eliminate its effect. This is done by including a complete set of regional dummies and the proxies for legal origin, credit rights and market structure, and which can reflect between country-variations. The

\textsuperscript{147} Between-group estimator is not used, because it is biased when the unobserved specific effect is correlated with the X-variables.
\textsuperscript{148} Bias causes from omitting a time constant-variable in the panel data model.
\textsuperscript{149} Some explanatory variables, like geographical characteristic, are fixed in nature. Therefore, variation is ‘between-countries’, and empirical work should based on cross-section instead.
source of these data is from the (Beck, Demirguc-Kunt, and Levine 2001b) financial structure dataset, and full description of these variables will be given in the next section.

6.3 Data and Results

6.3.1 Data

The present enquiry concerns how financial development and economic growth simultaneously determining one another. 161 countries are examined with a maximum time span ranging from 1970 to 2002. The data are from World Development Indicators from the World Bank (World Bank 2006).

The following growth indicator is used.

- GDP per capita growth

Four different measures of financial development indicators are used, and each will be tested accordingly in the equation as a proxy for financial development (logarithm value is taken).

- Domestic Credit provided by the private sector as a percentage of GDP;
- Financial Depth: Quasi-Liquid Liabilities (M3-M1) as a percentage of GDP;
- Stock Market Capitalisation of listed companies as a percentage of GDP;
- Stocks traded as a percentage of GDP.

6.3.2 Preliminary Analysis

Scatter plots are a useful diagnostic tool for determining association between variables. However, even though such association exists, the plot may or may not suggest an underlying cause-and-effect mechanism. Yet the plot can present the reader with a preliminary association between financial development and economic growth.
Figure 6-1: Scatter plot of the Average Value (1960-2002) of Financial Development (logarithm of Domestic Credit over GDP) and Economic Growth.
Figure 6-2: Scatter plot of the Average Value (1906-2002) of Financial Development (logarithm of Quasi-Liquidity over GDP) and Economic Growth
Figure 6-1 shows the scatter-plot for the average value of Financial Development (logarithm of Domestic Credit over GDP) and Economic Growth between 1960 and 2002. The plot generally shows a positive association between financial development and economic growth, and the majority of the data is scattered around the upward sloping line. The most notable countries to demonstrate this positive association, on the one hand, are Hong Kong (HKG) and Japan (JPN). Their economy has taken off during the post-war period and their economic success has transformed them into highly industrialised economies, and the financial industry has become one of the pillars of their economies. Hence, they illustrate this positive association at one end of the spectrum. On the other hand, the Democratic Republic of Congo (ZAR) demonstrates the extreme case where low growth is associated with low financial development. Though the majority of the countries demonstrated this positive association, there are several counter-examples. For example, both Botswana (BWA) and Oman (OMN) experience high economic growth with relatively low levels of financial development. This maybe due to the fact that they possess abundant natural resources (such as diamond and oil), and growth is primarily driven by the primary sector in these economies. Another counter example is Switzerland, where growth is relatively low but it is highly financially developed. This may due to the fact that Switzerland was already a prosperous country during the post-war period and the convergent hypothesis suggest that growth will tend to be lower for a highly developed country.

Figure 6-2 shows the scatter-plot for the average value of another proxy for Financial Development (Financial Depth) and Economic Growth. The pattern is similar to Figure 6-1, which shows a positive association between financial development and economic growth, and the majority of the data scattered around the upward sloping line. The pattern seems to suggest that larger overall sizes of financial intermediaries with respect to level of economic activities are associated with higher economic growth.

In sum, although one can identify several outliers' countries from the Figure 6-1, the pattern seems to suggest financial development is positively associated with economic growth.
Modelling Financial Development and Economic Growth using a Simultaneous Equation Model Approach

Figure 6-3 Scatter plot of the Average Value (1975-2002) of Financial Development (logarithm of Stock Market Capitalisation over GDP) and Economic Growth

Log Stock Market Capitalisation over GDP
Figure 6-4 Scatter plot of the Average Value (1975-2002) of Financial Development (logarithm of Stock-Traded Value over GDP) and Economic Growth
Figure 6-3 shows the scatter-plot for the average value of Financial Development (logarithm of stock market capitalisation over GDP) and Economic Growth. An upward sloping line can still be drawn, though the data seems to be dispersedly scattered with variations. The relative importance of stock market varies across countries. Economies like Hong Kong (HKG) and Singapore (SGP) are at the high end spectrum of high growth and high stock market capitalisation ratio while Uruguay (URY) and Romania (ROM) are at the other low-end spectrum. The disperse pattern suggests that positive association between stock market capitalisation over the level of economic activities and economic growth in this context is not clear.

Figure 6-4 shows the scatter-plot for the average value of Financial Development (logarithm of total stock traded value over GDP) and Economic Growth. The pattern is similar to Figure 6-3, where the data seems to be dispersedly scattered with variations. Hong Kong (HKG) and Singapore (SGP) appear to have a liquid stock market accompanied with high growth, while Bolivia (BOL) and Uruguay (URY) are associated with illiquid stock market with low growth. The disperse pattern suggests that positive association between total value of stock traded over the level of economic activities and economic growth in this context is not clear.

In sum, the scatter plot seems to suggest that the development of a financial intermediary seems to have a linear positive association with economic growth, whereas the association between stock market development and economic growth is not apparent. In order to further understand the cause-and-effect mechanism as well as the interaction between these macroeconomic factors, next section will use the formal method to analysis their relationship.

6.3.3 Equation Specification

The present enquiry concerns how financial development and economic growth simultaneously determine one another. The following linear simultaneous equations model is being tested.

\[
\text{Growth}_{it} = \alpha + \beta \text{FD}_{it} + \gamma X_{it} + \epsilon_{it} \quad (6-18)
\]

\[
\text{FD}_{it} = \mu + \theta \text{Growth}_{it} + \lambda Z_{it} + \nu_{it} \quad (6-19)
\]
Modelling Financial Development and Economic Growth using a Simultaneous Equation Model Approach

$Growth_n$ is the variable for economic growth, and $FD_n$ is the logarithm of the financial development indicator. $X_n$ and $Z_n$ are the set of control variable that affect economic growth and financial development respectively. The index $i$ and $t$ represent the cross section and time period respectively.

Two-Stage-Least-Square (2SLS) Estimation will be used to estimate each single equation in the system to tackle the problem of simultaneous bias. Panel time series techniques will also be used in order to provide a richer model to be estimated, as it is likely to increase efficiency as there are more observations.

6.3.3.1 Growth Regression

Recall that (6-18) is the informal growth regression initiated by Barro (1991) that accounts simultaneously the input growth and the variation growth in total factor productivity. Though a critic has pointed out the method is not perfect as it lack theoretical foundation, this approach can yield applicable insights that can relate growth to policy outcome, and is able to provide a simple and direct way to estimate the effect of financial development on economic growth through the channels of capital accumulation and technological progress simultaneously. In terms of specification of the regression, it is ad hoc in nature and is driven by previous results in the literature. Yet the literature generally agrees on a common set of control variables that have been shown empirically to be robust determinants of growth. The set of control variables $X_n$ includes:

a) Trade Openness$^{150}$ - This measures the degree of international openness for a country. The idea is that the larger the ratio, the higher the ability for the country to specialise according to its comparative advantage, which in turn will improve the efficiency of resources allocation and thereby economic growth. Levine and Renelt (1992), Dollar and Kraay (2003), Rodrik et. al. (2004), Frankel and Romer (1999), and Alcala and Ciccone (2004) report a positive size of trade openness in their growth regression, though only the last two studies claim that the result is robust and statistically significant (Alcala and Ciccone 2004; Dollar and Kraay 2003; Frankel and Romer 1999; Levine and Renelt 1992; Rodrik, Subramanian, and Trebbi 2004);

$^{150}$ Total volume of trade over GDP is used. Total volume of trade is the sum of exports and imports of goods and services. Logarithm value is taken (World Bank 2004).

c) *Investment*\(^{152}\) - Though the neoclassical growth model suggests that long run economic growth is independent of investment rate, the traditional Harrod-Domar growth model of a Keynesian type suggests that investment is the driving force of economic growth as it leads to capital accumulation and increases the productive capacity of an economy. The empirical evidence by Barro (1991), Barro and Lee (1994), Sachs and Warner (1995), Caselli, et al. (1996) suggest that the investment ratio will exert a positive and statistically significant effect on economic growth (Barro 1991; Barro and Lee 1994; Caselli, Esquivel, and Lefort 1996; Sachs and Warner 1995);

d) *Government Expenditure*\(^{153}\) - Government size has an ambiguous effect on economic growth. On one hand, economists debate whether there is a positive

\(^{151}\) Gross Secondary School Enrolment rate is used. It is the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject, or skill-oriented instruction using more specialised teachers. Logarithm value is taken (World Bank 2004).

\(^{152}\) Gross Capital Formation as a percentage of GDP is used. Gross capital formation consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases, and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Logarithm value is taken (World Bank 2004).

\(^{153}\) Total Government Expenditure over GDP is used. Total government expenditure includes both current and capital expenditure by central government. It does not include government lending or repayments to the government or government acquisition of equity for public purposes. Logarithm value is taken (World Bank 2004).
effect exerted by the role of public capital (government spending) on infrastructure on economic growth. On the other hand there seems to be a negative relationship between government consumption and social security and growth. The empirical literature provides mix results. While Levine and Renelt (1992) show that negative correlation of government consumption and growth is fragile, Easterly and Rebelo (1993) and Kelly (1997) show that government investment on infrastructure will exert a positive and statistically significant effect on growth (Easterly and Rebelo 1993; Kelly 1997; Levine and Renelt 1992);


Together with the financial development indicators, these variables are included in the specification for the growth regression of (6-18).

\textbf{6.3.3.2 Financial development Regression}

Equation (6-19) is the financial development regression. Goldsmith in his seminal work (1969) is the first to try to identify the economic factors which determine financial development by formalising a theoretical model using a macro-approach. He argues that financial development is positively related to the new issue ratio and all of its components, the price of financial assets and the share of price-sensitive issue. It is negatively related to the rate of growth of real income, the general price level and the average capital-output ratio\textsuperscript{155}. Since then, empirical literature in the finance-growth nexus has placed emphasis on the one-way effect of financial development rather than the other way round. One new

\textsuperscript{154} Annual Population Growth rate is used. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship – except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of the country of origin (World Bank 2004)

\textsuperscript{155} p.95 (Goldsmith 1969)
element in this study lies on the modelling of the financial development equation in studying finance-growth nexus.

There are plenty of micro-literatures that explain the development of a country’s financial system, where the existence of transaction cost and information asymmetries will lead to the emergence of a financial system aiming to reduce market friction and provide financial functions such as risk reduction and resource allocation. This in turn will foster capital accumulation and technological progress, thereby raising the long-run economic growth rate. In terms of macroeconomics explanation, the McKinnon-Shaw school emphasises financial liberalisation policy such as removing interest-caps and inflation taxes as a process of deepening the financial system. However, the explanation is policy oriented, and the macroeconomic modelling of the emerging of the financial system are lacking in the current literature. The present study will shed light in this area by trying to model the financial development by providing the specification of a financial development regression in the simultaneous equation systems.

The present analysis will look at the effect of economic growth on financial development. The set of control variables \( Z_n \) includes:

1. Set of Legal Origin Dummies\(^{156}\): As mentioned in section 4.3.4.1, La Porta et al. (1997, 98), stress that the historically determined differences in legal tradition help explain international differences in financial development today. Levine (1998, 1999) and Levine, Loayza and Beck (2000) treat the legal origin variables, which state whether a country’s commercial and company law derives from British, French, German or Scandinavian law, as the exogenous component of financial development, and use an instrumental variable in order to tackle the problems of simultaneity bias and provide a richer analysis for the finance-growth nexus. Therefore, the present analysis will the set of legal origin dummy as the control variables (La Porta et al. 1997;La Porta et al. 1998), (Levine 1998;Levine 1999;Levine 2005;Levine, Loayza, and Beck 2000).

2. Explanatory variables in the growth regression: The set of explanatory variables in the growth regression (i.e. Trade Openness, Educational Attainment, Investment, Government Expenditure, Population Growth) to examine if they exert a significant impact on financial development.

\(^{156}\)British, French, German and Scandinavian legal origin was used (Beck, Demirgüç-Kunt, and Levine 2001b).
3. Inflation Rate\textsuperscript{157}: There is a growing theoretical literature, emphasising the importance of informational asymmetries in the credit market and demonstrating how the inflation rate is exerting an adverse impact on credit market frictions with negative repercussions for financial sector performance. Accordingly, inflation will drive down asset returns and worsen credit market frictions, which in turn lead to credit rationing, hence fewer loans, inefficient resources allocation and the shrinking of the financial system. Boyd, \textit{et al.} (2001) show a negative relationship between inflation and financial sector development. Rousseau and Sylla (2001) and Rousseau and Wachtel (2002) both use inflation as their instrument in their growth regression. Therefore, the inflation rate is included in this context (Boyd, Levine, and Smith 2001; Choi, Smith, and Boyd 1996; Huybens and Smith 1999; Rousseau and Sylla 2001; Rousseau and Wachtel 2002).

4. Geographical location: Regional Dummy Variables are added to examine if geographical location will affect financial development.

\textbf{6.3.3.3 Time Span}

Majority of the Current Growth Regression in the literature uses five year average data for analysis. While the method can tackle the problem of missing data and provide a balanced panel for estimation, significant time series information will be lost by taking the average value of the data rather than using yearly observations. Besides, as mentioned in section 4.2.2.2, the empirical growth literature has not fully addressed the question of the appropriate time horizons over which a growth model should be assessed. The construction of the series observations of five years can appear arbitrary, and it is less clear that employing five year averages are genuinely informative about medium-run growth dynamics.

The present empirical study will be analysed using the following three methods in order to give a broader picture of the analysis:

\textsuperscript{157} Inflation is measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a fixed basket of goods and services that may be fixed or changed at yearly interval. The Laspeyres formula is used (World Bank 2004).
- Panel Time-Series Analysis with annual observation\textsuperscript{158};
- Panel Time-Series Analysis with 5-year averages observations;
- Cross-Section Analysis by using the average-value of each series.

6.3.4 **Ordinary Least Square (OLS) Estimation: Results**

The results of the ordinary least square (OLS) estimation are reported and discussed in this section. Although the OLS results is likely to be biased because of the endogeneity problem, they can serve as a useful starting point for analysis.

6.3.4.1 **Growth Regression**

The following tables report the results of the growth regression using the OLS Estimation. Table 6-1 reports the results of the Cross Section Least Square Estimation (taking the average value for the Economic Growth Regression). Table 6-2 reports the Panel Least Square Estimation for the Economic Growth Regression using 5-year average observations. Table 6-3 reports Panel Least Square Estimation for the Economic Growth Regression using annual observations.

\textsuperscript{158} The missing data is filled using the method of linear interpolation.
Table 6-1: Cross Section Least Square Estimation for the Economic Growth Regression (Average Value)

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>Coefficient</td>
<td>P-value</td>
<td>Coefficient</td>
<td>P-value</td>
</tr>
<tr>
<td>-6.24 (0.00)**</td>
<td>-6.02 (0.00)**</td>
<td>-7.67 (0.01)**</td>
<td>-3.96 (0.18)</td>
<td></td>
</tr>
<tr>
<td>Financial Indicators</td>
<td>Coefficient</td>
<td>P-value</td>
<td>Coefficient</td>
<td>P-value</td>
</tr>
<tr>
<td>-0.20 (0.42)</td>
<td>0.13 (0.46)</td>
<td>0.45 (0.18)</td>
<td>0.21 (0.06)*</td>
<td></td>
</tr>
<tr>
<td>Trade Openness</td>
<td>0.74 (0.00)**</td>
<td>0.77 (0.00)**</td>
<td>0.28 (0.39)</td>
<td>0.60 (0.02)**</td>
</tr>
<tr>
<td>Investment</td>
<td>2.54 (0.00)**</td>
<td>2.33 (0.00)**</td>
<td>3.00 (0.00)**</td>
<td>2.05 (0.03)**</td>
</tr>
<tr>
<td>Education Attainment</td>
<td>0.09 (0.70)</td>
<td>0.36 (0.12)</td>
<td>-0.42 (0.27)</td>
<td>-0.39 (0.28)</td>
</tr>
<tr>
<td>Government Expenditure</td>
<td>0.34 (0.12)</td>
<td>-0.44 (0.01)**</td>
<td>0.79 (0.02)**</td>
<td>0.58 (0.08)*</td>
</tr>
<tr>
<td>Population Growth</td>
<td>-0.38 (0.01)**</td>
<td>-0.06 (0.83)</td>
<td>-0.62 (0.01)**</td>
<td>-0.41 (0.04)**</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>118</td>
<td>105</td>
<td>72</td>
<td>79</td>
</tr>
<tr>
<td>Adjusted R-Square</td>
<td>0.47</td>
<td>0.45</td>
<td>0.44</td>
<td>0.37</td>
</tr>
<tr>
<td>S.E. of Regression</td>
<td>1.29</td>
<td>1.36</td>
<td>1.15</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Note: The table reports coefficient and P-value from the cross-section least square estimation for economic growth regression using the average value of variables. Column 1 uses Domestic Credit provided by the private sector as a percentage of GDP as a proxy for financial development; Column 2 uses Financial Depth; Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stocks-traded as a percentage of GDP. The table also report the time range, the number of cross section, R-square, adjusted R-square and the standard error of each regression. ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively.
Table 6-2: Panel Least Square Estimation for the Economic Growth Regression (5-years average Observations)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coeff</td>
<td>P-value</td>
<td>Coeff</td>
<td>P-value</td>
<td>Coeff</td>
<td>P-value</td>
</tr>
<tr>
<td>Constant</td>
<td>-7.56 (0.00)***</td>
<td>-8.22 (0.00)***</td>
<td>-1.80 (0.49)</td>
<td>-1.46</td>
<td>(0.58)</td>
</tr>
<tr>
<td>Financial Development</td>
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<td></td>
</tr>
<tr>
<td>Indicators</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Trade Openness</td>
<td>0.85 (0.00)***</td>
<td>0.96 (0.00)***</td>
<td>0.06 (0.80)</td>
<td>0.18</td>
<td>(0.45)</td>
</tr>
<tr>
<td>Investment</td>
<td>3.51 (0.00)***</td>
<td>3.58 (0.00)***</td>
<td>4.23 (0.00)***</td>
<td>3.71</td>
<td>(0.00)***</td>
</tr>
<tr>
<td>Education Attainment</td>
<td>-0.31 (0.17)</td>
<td>-0.47 (0.07)*</td>
<td>-2.11 (0.00)***</td>
<td>-1.85</td>
<td>(0.00)***</td>
</tr>
<tr>
<td>Government Expenditure</td>
<td>0.34 (0.07)*</td>
<td>0.35 (0.09)*</td>
<td>0.22 (0.38)</td>
<td>0.42</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Population Growth</td>
<td>-0.52 (0.00)***</td>
<td>-0.53 (0.00)***</td>
<td>-1.41 (0.00)***</td>
<td>-1.28</td>
<td>(0.00)***</td>
</tr>
<tr>
<td>Cross Section</td>
<td>107</td>
<td>95</td>
<td>74</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Number of Observations</td>
<td>551</td>
<td>490</td>
<td>272</td>
<td>297</td>
<td></td>
</tr>
<tr>
<td>R-square</td>
<td>0.24</td>
<td>0.25</td>
<td>0.35</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-Square</td>
<td>0.23</td>
<td>0.24</td>
<td>0.33</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td>S.E. of Regression</td>
<td>2.71</td>
<td>2.87</td>
<td>2.25</td>
<td>2.25</td>
<td></td>
</tr>
</tbody>
</table>

Note: The table reports coefficient and P-value from the panel least square estimation for economic growth regression using the 5-year average value of the data. Each panel consists of 7 observations of the time-span: 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999 and 2000-2002. Column 1 uses Domestic Credit provided by the private sector as a percentage of GDP as a proxy for financial development; Column 2 uses Financial Depth; Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stocks-traded as a percentage of GDP. The table also report the time range, the number of cross section and observation, R-square, adjusted R-square and the standard error of each regression. ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively.
### Table 6-3: Panel Least Square Estimation for the Economic Growth Regression (Annual Observations)

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong></td>
<td>-9.78 (0.00)***</td>
<td>-11.20 (0.00)***</td>
<td>-7.52 (0.00)***</td>
<td>-7.58 (0.00)***</td>
</tr>
<tr>
<td><strong>Financial Development</strong></td>
<td><strong>Indicators</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stock Market</td>
<td>-0.61 (0.00)***</td>
<td>-0.12 (0.27)</td>
<td>0.30 (0.00)***</td>
<td>0.21 (0.00)***</td>
</tr>
<tr>
<td>Domestic Credit</td>
<td>0.76 (0.00)***</td>
<td>0.72 (0.00)***</td>
<td>0.48 (0.00)***</td>
<td>0.55 (0.00)***</td>
</tr>
<tr>
<td>Financial Depth</td>
<td>4.06 (0.00)***</td>
<td>4.12 (0.00)***</td>
<td>4.29 (0.00)***</td>
<td>4.07 (0.00)***</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>0.05 (0.74)</td>
<td>-0.22 (0.19)</td>
<td>-1.16 (0.00)***</td>
<td>-0.96 (0.00)***</td>
</tr>
<tr>
<td>Education Attainment</td>
<td>0.15 (0.22)</td>
<td>0.26 (0.06)*</td>
<td>0.17 (0.26)</td>
<td>0.29 (0.06)*</td>
</tr>
<tr>
<td>Government Expenditure</td>
<td>-0.03 (0.63)</td>
<td>0.00 (0.95)</td>
<td>-0.66 (0.00)***</td>
<td>-0.57 (0.00)***</td>
</tr>
<tr>
<td>Cross Section</td>
<td>115</td>
<td>102</td>
<td>79</td>
<td>77</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>2789</td>
<td>2445</td>
<td>1434</td>
<td>1745</td>
</tr>
<tr>
<td>R-square</td>
<td>0.13</td>
<td>0.12</td>
<td>0.17</td>
<td>0.16</td>
</tr>
<tr>
<td>Adjusted R-Square</td>
<td>0.13</td>
<td>0.12</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>S.E. of Regression</td>
<td>4.35</td>
<td>4.67</td>
<td>3.30</td>
<td>3.35</td>
</tr>
</tbody>
</table>

Note: The table reports coefficient and P-value from the panel least square estimation for economic growth regression using annual observations. Column 1 uses Domestic Credit provided by the private sector as a percentage of GDP as a proxy for financial development; Column 2 uses Financial Depth; Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stocks-traded as a percentage of GDP. The table also report the time range, the number of cross section and observation, R-square, adjusted R-square and the standard error of each regression. ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively.
Several conclusions can be drawn from the results:

a) The four financial development indicators yield different results. The results show that Domestic credit and Financial Depth can exert a negative impact on economic growth, while the effect of the Stock Market Capitalization and the Stock-traded ratio are positive. It seems to suggest that development of stock market has a beneficial effect on economic growth while the effect of financial intermediaries is hazardous;

b) Table 6-1 shows that the effect of financial development is statistically insignificant on economic growth using averaged data;

c) The result of the panel data analysis in Table 6-2 and Table 6-3 shows mixed results. For stock market development, both analyse show that it is statistical significant to economic growth. For financial intermediary development, the effect is insignificant apart from one case.\(^{159}\)

d) The adjusted R-square shows that cross-section analysis provides a better fitted regression than the panel estimation using 5 year average or annual observations.

e) The set of control variables generally exerts an impact on economic growth, which is consistent with the findings in the current literature, apart for the case of education attainment.

6.3.4.2 Financial Development Regression

The following tables report the results of the growth regression. Table 6-4 reports the results of the Cross Section Least Square Estimation (taken the average value for the Economic Growth Regression). Table 6-5 reports the Panel Least Square Estimation for the Economic Growth Regression using the 5-years average observations. Table 6-6 reports the Panel Least Square Estimation for the Economic Growth Regression using the annual observations.

\(^{159}\) Domestic Credit is statistically significant when using panel data approach with annual observations.
Modelling Financial Development and Economic Growth using a Simultaneous Equation Model Approach

Table 6-4: Cross Section Least Square Estimation for the Financial Development Regression (Average Value)

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Coeff</td>
<td>P-value</td>
<td>Coeff</td>
<td>P-value</td>
<td>Coeff</td>
</tr>
<tr>
<td>Constant</td>
<td>2.78 (0.00)****</td>
<td>0.52 (0.41)</td>
<td>-4.85 (0.00)****</td>
<td>-7.65 (0.00)****</td>
</tr>
<tr>
<td>Growth</td>
<td>-0.02 (0.60)</td>
<td>0.20 (0.04)**</td>
<td>0.13 (0.08)**</td>
<td>0.47 (0.03)**</td>
</tr>
<tr>
<td>Education Attainment</td>
<td>0.43 (0.00)****</td>
<td>0.46 (0.00)****</td>
<td>1.60 (0.00)****</td>
<td>1.85 (0.00)****</td>
</tr>
<tr>
<td>Population Growth</td>
<td>-0.13 (0.04)**</td>
<td>0.07 (0.54)</td>
<td>0.30 (0.02)**</td>
<td>0.60 (0.02)**</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.00 (0.02)**</td>
<td>0.00 (0.18)</td>
<td>0.00 (0.63)</td>
<td>0.00 (0.75)</td>
</tr>
<tr>
<td>UK Legal Origin Dummy</td>
<td>-0.39 (0.07)*</td>
<td>0.37 (0.03)**</td>
<td>0.74 (0.00)****</td>
<td>-0.73 (0.35)</td>
</tr>
<tr>
<td>Scandinavian Legal Origin Dummy</td>
<td>-0.39 (0.07)*</td>
<td>-0.47 (0.03)**</td>
<td>0.70 (0.05)*</td>
<td>-0.23 (0.73)</td>
</tr>
<tr>
<td>French Legal Origin Dummy</td>
<td>-0.51 (0.08)*</td>
<td>-0.47 (0.03)**</td>
<td>0.70 (0.05)*</td>
<td>-0.23 (0.73)</td>
</tr>
<tr>
<td>African Dummy</td>
<td>-0.34 (0.02)**</td>
<td>-0.47 (0.03)**</td>
<td>0.70 (0.05)*</td>
<td>-0.23 (0.73)</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>102</td>
<td>86</td>
<td>77</td>
<td>71</td>
</tr>
<tr>
<td>R-square</td>
<td>0.61</td>
<td>0.53</td>
<td>0.52</td>
<td>0.47</td>
</tr>
<tr>
<td>Adjusted R-Square</td>
<td>0.57</td>
<td>0.50</td>
<td>0.48</td>
<td>0.41</td>
</tr>
<tr>
<td>S.E. of Regression</td>
<td>0.47</td>
<td>0.72</td>
<td>0.87</td>
<td>1.48</td>
</tr>
</tbody>
</table>

Note: The table reports coefficient and P-value from the cross-section least square estimation for economic growth regression using the average value of variables. Column 1 uses Domestic Credit provided by the private sector as a percentage of GDP as a proxy for financial development; Column 2 uses Financial Depth; Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stocks-traded as a percentage of GDP. The table also report the time range, the number of cross section, R-square, adjusted R-square and the standard error of each regression. ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively.
Table 6-5 Panel Least Square Estimation for the Financial Development Regression (5-years average Observations)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coeff</td>
<td>P-value</td>
<td>Coeff</td>
<td>P-value</td>
<td>Coeff</td>
</tr>
<tr>
<td>Constant</td>
<td>2.48 (0.00)***</td>
<td>0.96 (0.00)***</td>
<td>-6.21 (0.00)***</td>
<td>-11.59 (0.00)***</td>
</tr>
<tr>
<td>Growth</td>
<td>0.00 (0.84)</td>
<td>0.02 (0.07)*</td>
<td>0.07 (0.00)***</td>
<td>0.15 (0.80)***</td>
</tr>
<tr>
<td>Education Attainment</td>
<td>0.51 (0.00)***</td>
<td>0.68 (0.00)***</td>
<td>2.05 (0.00)***</td>
<td>3.01 (0.00)***</td>
</tr>
<tr>
<td>Population Growth</td>
<td>-0.08 (0.00)***</td>
<td>-0.09 (0.00)***</td>
<td>0.29 (0.00)***</td>
<td>0.48 (0.00)***</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.00 (0.01)**</td>
<td>0.00 (0.02)**</td>
<td>0.00 (0.29)</td>
<td>0.00 (0.37)</td>
</tr>
<tr>
<td>UK Legal Origin Dummy</td>
<td>-0.39 (0.00)***</td>
<td>-0.05 (0.72)</td>
<td>0.43 (0.08)*</td>
<td>-0.17 (0.68)</td>
</tr>
<tr>
<td>Scandinavian Legal Origin Dummy</td>
<td>-0.60 (0.00)***</td>
<td>-0.92 (0.00)***</td>
<td>-0.14 (0.65)</td>
<td>-1.37 (0.01)**</td>
</tr>
<tr>
<td>French Legal Origin Dummy</td>
<td>-0.48 (0.00)***</td>
<td>-0.39 (0.00)***</td>
<td>-0.30 (0.21)</td>
<td>-1.60 (0.00)***</td>
</tr>
<tr>
<td>African Dummy</td>
<td>-0.20 (0.00)***</td>
<td>-0.43 (0.00)***</td>
<td>0.51 (0.01)**</td>
<td>-0.42 (0.26)</td>
</tr>
<tr>
<td>Cross Section</td>
<td>100</td>
<td>88</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>608</td>
<td>540</td>
<td>285</td>
<td>309</td>
</tr>
<tr>
<td>R-square</td>
<td>0.52</td>
<td>0.59</td>
<td>0.45</td>
<td>0.42</td>
</tr>
<tr>
<td>Adjusted R-Square</td>
<td>0.51</td>
<td>0.58</td>
<td>0.43</td>
<td>0.40</td>
</tr>
<tr>
<td>S.E. of Regression</td>
<td>0.35</td>
<td>0.65</td>
<td>1.00</td>
<td>1.77</td>
</tr>
</tbody>
</table>

Note: The table reports coefficient and P-value from the panel least square estimation for economic growth regression using the 5-year average value of the data. Each panel consists of 7 observations of the time-span: 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999 and 2000-2002. Column 1 uses Domestic Credit provided by the private sector as a percentage of GDP as a proxy for financial development; Column 2 uses Financial Depth; Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stock-traded as a percentage of GDP. The table also report the time range, the number of cross section and observation, R-square, adjusted R-square and the standard error of each regression. ***, **and * denotes statistical significance at 1%, 5% and 10% respectively.
### Table 6-6 Panel Least Square Estimation for the Financial Development Regression (Annual Observations)

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.34 (0.00)***</td>
<td>0.83 (0.00)***</td>
<td>-5.17 (0.00)***</td>
<td>-8.66 (0.00)***</td>
</tr>
<tr>
<td><strong>Growth</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.01 (0.01)**</td>
<td>0.01 (0.04)**</td>
<td>0.04 (0.00)***</td>
<td>0.07 (0.00)***</td>
</tr>
<tr>
<td>Education Attainment</td>
<td>0.54 (0.00)***</td>
<td>0.70 (0.00)***</td>
<td>1.84 (0.00)***</td>
<td>2.51 (0.00)***</td>
</tr>
<tr>
<td>Population Growth</td>
<td>-0.04 (0.00)***</td>
<td>-0.02 (0.02)**</td>
<td>0.08 (0.00)***</td>
<td>0.12 (0.00)***</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.00 (0.00)***</td>
<td>0.00 (0.00)***</td>
<td>0.00 (0.15)</td>
<td>0.00 (0.39)</td>
</tr>
<tr>
<td>UK Legal Origin Dummy</td>
<td>-0.45 (0.00)***</td>
<td>-0.17 (0.02)**</td>
<td>0.62 (0.00)***</td>
<td>-0.12 (0.57)</td>
</tr>
<tr>
<td>Scandinavian Legal Origin Dummy</td>
<td>-0.60 (0.00)***</td>
<td>-0.87 (0.00)***</td>
<td>-0.26 (0.08)*</td>
<td>-1.61 (0.00)***</td>
</tr>
<tr>
<td>French Legal Origin Dummy</td>
<td>-0.49 (0.00)***</td>
<td>-0.49 (0.00)***</td>
<td>-0.23 (0.05)*</td>
<td>-1.63 (0.00)***</td>
</tr>
<tr>
<td>African Dummy</td>
<td>-0.25 (0.00)***</td>
<td>-0.43 (0.00)***</td>
<td>0.53 (0.00)***</td>
<td>-0.59 (0.00)***</td>
</tr>
</tbody>
</table>

**Note:** The table reports coefficient and P-value from the panel least square estimation for economic growth regression using annual observations. Column 1 uses Domestic Credit provided by the private sector as a percentage of GDP as a proxy for financial development; Column 2 uses Financial Depth; Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stocks-traded as a
percentage of GDP. The table also report the time range, the number of cross section and observation, R-square, adjusted R-square and the standard error of each regression. ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively.
Several conclusions can be drawn from the results:

a) Economic growth exerts a positive and statistically significant impact on most of the financial development indicators, apart for the case of Domestic Credit, in all three analyses. Therefore, the results seem to confirm the demand leading pattern, where economic growth will create demand for financial services and thereby lead to financial development.

b) The set of control variables generally exerts an impact on economic growth, which is consistent with the findings in the current literature. The legal origin will influence financial development, and the result is consistent with the current literature arguing that common law countries (UK legal origin) will provide a better infrastructure for the development of the financial sector.

c) Inflation will exert a significant impact on financial development, but the effects are trivial.

d) Education attainment exerts a positive and statistical significant impact on financial development, the reason perhaps is that the employment in financial sector is skewed towards the high-skilled. Therefore, higher education attainment will provide enough pool of skilled workers in the financial sector and thereby fostering financial development.

e) The effect of population growth is negative.

f) The African nations generally have a lower level of financial development as suggested by the results.

g) Apart from the series of domestic credit, the results of three part of the analysis (cross section, panel 5 year average, and panel with annual observations) yield a consistent result.

6.3.4.3 Problem of Endogeneity

The above results serve as a useful starting point for analysis, suggesting that financial development will affect economic growth, and economic growth will affect financial development. Hence both variables are endogenous in nature, and therefore the OLS results are likely to be biased because of the endogeneity problem. Therefore, the following section reports use the Two-Stage-Least-Square (2SLS) Estimation to estimate
each single equation in the system to tackle the problem of simultaneous bias.

6.3.5 Two-Stage-Least-Square Estimation: Results

The idea, the formal derivation, the interpretation and the properties of the 2SLS estimators have already been discussed in section 6.2.1. In sum, 2SLS estimation is a special case of instrumental variables regression, where there are multiple instruments for the endogenous variable, in order to tackle the problem of simultaneous bias. The resulting 2SLS estimator will be consistent.

This section will report and discuss the results of the Two Stage Least Square (2SLS) Estimation of the Growth Regression and Financial Development Regression.

6.3.5.1 Regarding the Choice of Instruments

The instrument is for each growth and financial development regression is chosen with reference to each other. The model is estimated simultaneously so that the explanatory variables that are, for example, significant to financial development (growth) but insignificant or exogenous to growth (financial development), will be used as an instruments in the growth (financial development) regression.

6.3.5.2 Growth Regression

The following tables report the results of the growth regression using the 2SLS Estimation. Table 6-7 reports the results of the Cross Section 2SLS Estimation (using the average value for the Economic Growth Regression). Table 6-8 reports the Panel 2SLS Estimation for the Economic Growth Regression using 5-year average observations. Table 6-9 reports the Panel 2SLS Estimation for the Economic Growth Regression using annual observations.
Table 6-7 Cross Section 2SLS Estimation for the Economic Growth Regression (Average Value)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-10.74 (0.00)***</td>
<td>-7.37 (0.00)***</td>
<td>-7.67 (0.01)**</td>
<td>-5.34 (0.19)</td>
</tr>
<tr>
<td>Financial Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stock Market</td>
<td>0.95 (0.11)</td>
<td>0.70 (0.18)</td>
<td>0.45 (0.18)</td>
<td>0.31 (0.26)</td>
</tr>
<tr>
<td>Indicators</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Development</td>
<td>0.47 (0.05)*</td>
<td>0.43 (0.16)</td>
<td>0.28 (0.39)</td>
<td>0.44 (0.11)</td>
</tr>
<tr>
<td>Indicator</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade Openness</td>
<td>3.22 (0.00)***</td>
<td>2.66 (0.00)***</td>
<td>3.00 (0.00)***</td>
<td>2.47 (0.07)*</td>
</tr>
<tr>
<td>Investment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education Attainment</td>
<td>-0.53 (0.12)</td>
<td>0.60 (0.03)</td>
<td>-0.42 (0.27)</td>
<td>-0.44 (0.23)</td>
</tr>
<tr>
<td>Government Expenditure</td>
<td>0.67 (0.01)**</td>
<td>-0.52 (0.01)**</td>
<td>0.79 (0.02)**</td>
<td>0.87 (0.06)*</td>
</tr>
<tr>
<td>Population Growth</td>
<td>-0.35 (0.05)*</td>
<td>-0.41 (0.19)</td>
<td>-0.62 (0.01)**</td>
<td>-0.61 (0.01)**</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>94</td>
<td>81</td>
<td>72</td>
<td>71</td>
</tr>
<tr>
<td>R-square</td>
<td>0.51</td>
<td>0.52</td>
<td>0.44</td>
<td>0.50</td>
</tr>
<tr>
<td>Adjusted R-Square</td>
<td>0.47</td>
<td>0.48</td>
<td>0.39</td>
<td>0.46</td>
</tr>
<tr>
<td>S.E. of Regression</td>
<td>1.18</td>
<td>1.21</td>
<td>1.15</td>
<td>1.09</td>
</tr>
</tbody>
</table>

Note: The table reports coefficient and P-value from the 2SLS estimation for economic growth regression using the average value of variables. Column 1 uses Domestic Credit provided by the private sector as a percentage of GDP as a proxy for financial development; Column 2 uses Financial Depth; Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stocks-traded as a percentage of GDP. The table also report the time range, the number of cross section, R-square, adjusted R-square and the standard errors of each regression. ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively. Instruments Lists:

- Domestic Credit: Inflation, UK, French and Scandinavian Origin Dummy, African Dummy
- Financial Depth: UK Legal Origin Dummy, African Dummy
- Stock Market Capitalization: UK Legal Origin Dummy, African Dummy
**d) Stock-traded: French Legal Origin Dummy**

**Table 6-8 Panel 2SLS Estimation for the Economic Growth Regression (5-years average Observations)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coeff</strong></td>
<td><strong>P-value</strong></td>
<td><strong>Coeff</strong></td>
<td><strong>P-value</strong></td>
<td><strong>Coeff</strong></td>
</tr>
<tr>
<td>Constant</td>
<td>10.27 (0.00)***</td>
<td>-8.38 (0.00)***</td>
<td>-0.66 (0.81)</td>
<td>-0.44</td>
</tr>
<tr>
<td><strong>Financial Development Indicators</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.89</td>
</tr>
<tr>
<td>1. Trade Openness</td>
<td>0.50 (0.09)*</td>
<td>0.59 (0.06)*</td>
<td>0.01 (0.98)</td>
<td>0.21 (0.42)</td>
</tr>
<tr>
<td>2. Investment</td>
<td>3.48 (0.00)***</td>
<td>3.43 (0.00)***</td>
<td>4.53 (0.00)***</td>
<td>3.91 (0.00)***</td>
</tr>
<tr>
<td>3. Education Attainment</td>
<td>-0.80 (0.03)**</td>
<td>-0.92 (0.01)**</td>
<td>-2.72 (0.00)***</td>
<td>-2.26 (0.00)***</td>
</tr>
<tr>
<td>4. Government Expenditure</td>
<td>0.51 (0.04)**</td>
<td>0.44 (0.07)**</td>
<td>0.29 (0.29)</td>
<td>0.48 (0.14)</td>
</tr>
<tr>
<td>5. Population Growth</td>
<td>-0.59 (0.00)***</td>
<td>-0.59 (0.00)***</td>
<td>-1.67 (0.00)***</td>
<td>-1.45 (0.00)***</td>
</tr>
<tr>
<td><strong>Cross Section</strong></td>
<td>90</td>
<td>78</td>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td><strong>Number of Observations</strong></td>
<td>494</td>
<td>431</td>
<td>260</td>
<td>286</td>
</tr>
<tr>
<td><strong>R-square</strong></td>
<td>0.24</td>
<td>0.24</td>
<td>0.37</td>
<td>0.36</td>
</tr>
<tr>
<td><strong>Adjusted R-Square</strong></td>
<td>0.23</td>
<td>0.23</td>
<td>0.36</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>S.E. of Regression</strong></td>
<td>2.75</td>
<td>2.93</td>
<td>2.23</td>
<td>2.23</td>
</tr>
</tbody>
</table>

Financial Depth: Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP. Column 4 uses Stocks-traded as a percentage of GDP. The table also report the time range, the number of cross section and observation, R-square, adjusted R-square and the standard error of each regression. ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively. Instruments Lists:

c) Domestic Credit: UK, French and Scandinavian Legal Origin Dummy, African Dummy

d) Financial Depth: UK, French and Scandinavian Legal Origin Dummy, African Dummy

e) Stock Market Capitalization: UK Legal Origin Dummy, African Dummy

f) Stock-traded: French Legal Origin Dummy
Table 6-9 Panel 2SLS Estimation for the Economic Growth Regression (Annual Observations)

<table>
<thead>
<tr>
<th></th>
<th>Domestic Credit</th>
<th>Financial Depth</th>
<th>Stock Capitalization</th>
<th>Market</th>
<th>Stock-traded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong></td>
<td>-15.11***</td>
<td>-11.50***</td>
<td>-6.25***</td>
<td>-6.02***</td>
<td></td>
</tr>
<tr>
<td><strong>Financial Development</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indicators</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade Openness</td>
<td>1.98***</td>
<td>1.41***</td>
<td>0.45***</td>
<td>0.34***</td>
<td></td>
</tr>
<tr>
<td>Investment</td>
<td>0.68***</td>
<td>0.46***</td>
<td>0.50***</td>
<td>0.57***</td>
<td></td>
</tr>
<tr>
<td>Education Attainment</td>
<td>3.89***</td>
<td>3.56***</td>
<td>4.42***</td>
<td>4.12***</td>
<td></td>
</tr>
<tr>
<td>Government Expenditure</td>
<td>-1.27***</td>
<td>-1.00***</td>
<td>-1.63***</td>
<td>-1.42***</td>
<td></td>
</tr>
<tr>
<td>Population Growth</td>
<td>0.51***</td>
<td>0.42***</td>
<td>0.20***</td>
<td>0.41***</td>
<td></td>
</tr>
<tr>
<td><strong>Cross Section</strong></td>
<td>93</td>
<td>80</td>
<td>71</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td><strong>Number of Observations</strong></td>
<td>2417</td>
<td>2151</td>
<td>1362</td>
<td>1405</td>
<td></td>
</tr>
<tr>
<td><strong>R-square</strong></td>
<td>0.04</td>
<td>0.07</td>
<td>0.17</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td><strong>Adjusted R-Square</strong></td>
<td>0.04</td>
<td>0.07</td>
<td>0.17</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td><strong>S.E. of Regression</strong></td>
<td>4.38</td>
<td>4.69</td>
<td>3.24</td>
<td>3.30</td>
<td></td>
</tr>
</tbody>
</table>

Note: The table reports coefficient and P-value from the panel 2SLS estimation for economic growth regression using annual observations. Column 1 uses Domestic Credit provided by the private sector as a percentage of GDP as a proxy for financial development; Column 2 uses Financial Depth; Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stocks-traded as a percentage of GDP. The table also report the time range, the number of cross section and observation, R-square, adjusted R-square and the standard error of each regression. ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively. Instruments Lists:
i) Domestic Credit: Inflation, UK, French and Scandinavian Legal Origin Dummy, African Dummy
j) Financial Depth: UK, French and Scandinavian Legal Origin Dummy, African Dummy
k) Stock Market Capitalization: UK and French Legal Origin Dummy, African Dummy
l) Stock-traded: UK, French and Scandinavian Legal Origin Dummy, African Dummy
Several conclusions can be drawn from these results:

a) After using 2SLS estimation, all four financial development indicators exert a positive influence on economic growth in all 3 analyses, as shown in Table 6-7, Table 6-8, and Table 6-9. These results are significantly different from the OLS estimation in section 6.3.4.1. Hence this provides an indirect proof for the usefulness of the 2SLS approach for estimation, which provide a more consistent result in all three cases that match with theory and the findings in the current literature;

b) Financial development is statistically insignificant in the cross section analysis (Table 6-7) and the 5-year average panel data (Table 6-8). However, using the annual observations panel data (Table 6-9), all four financial development indicators exert a statistically significant impact to economic growth;

c) The financial intermediary development indicators (i.e. Domestic Credit and Financial Depth) exert a larger impact on economic growth than the stock market development indicators (Stock Market Capitalization and Stock-traded) in all 3 analyses, suggesting financial intermediation places a relatively more important role than the stock market in the process of economic development;

d) The set of control variables generally exerts a significant impact on economic growth, which is consistent with the findings in the current literature, apart from the case of education attainment;

e) The standard error and the adjusted R-square remain generally similar for the OLS and 2SLS Estimation in all three cases;

6.3.5.3 Financial Development Regression

The following tables report the results of the growth regression using 2SLS Estimation. Table 6-10 reports the results of the Cross Section 2SLS Estimation (taking the average value for the Financial Development Regression). Table 6-11 reports the Panel 2SLS Estimation for the Financial Development Regression using 5-year average observations. Table 6-12 reports the Panel 2SLS Estimation for the Financial Development Regression using annual observations.
Table 6-10 Cross Section 2SLS Estimation for the Financial Development Regression (Average Value)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td></td>
<td>2.79</td>
<td>(0.00)**</td>
<td>***</td>
<td>0.52</td>
<td>(0.41)</td>
<td>-5.25</td>
<td>(0.00)**</td>
<td>***</td>
<td>-7.65</td>
<td>(0.00)**</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>Growth</td>
<td></td>
<td>-0.01</td>
<td>(0.81)</td>
<td></td>
<td>0.20</td>
<td>(0.04)**</td>
<td>0.34</td>
<td>(0.02)**</td>
<td></td>
<td>0.47</td>
<td>(0.03)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education Attainment</td>
<td></td>
<td>0.42</td>
<td>(0.00)**</td>
<td>***</td>
<td>0.46</td>
<td>(0.00)**</td>
<td>***</td>
<td>1.56</td>
<td>(0.00)**</td>
<td>***</td>
<td>1.85</td>
<td>(0.00)**</td>
<td>***</td>
</tr>
<tr>
<td>Population Growth</td>
<td></td>
<td>-0.13</td>
<td>(0.05)**</td>
<td></td>
<td>0.07</td>
<td>(0.54)</td>
<td>0.36</td>
<td>(0.02)**</td>
<td></td>
<td>0.60</td>
<td>(0.02)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation</td>
<td></td>
<td>0.00</td>
<td>(0.02)**</td>
<td></td>
<td>0.00</td>
<td>(0.18)</td>
<td>0.00</td>
<td>(1.00)</td>
<td></td>
<td>0.00</td>
<td>(0.75)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK Legal Origin Dummy</td>
<td></td>
<td>-0.36</td>
<td>(0.08)**</td>
<td></td>
<td>0.37</td>
<td>(0.03)**</td>
<td>0.55</td>
<td>(0.04)**</td>
<td></td>
<td>-0.73</td>
<td>(0.35)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scandinavian Legal Origin Dummy</td>
<td></td>
<td>-0.51</td>
<td>(0.07)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.94</td>
<td>(0.01)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France Legal Origin Dummy</td>
<td></td>
<td>-0.38</td>
<td>(0.07)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.06</td>
<td>(0.27)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African Dummy</td>
<td></td>
<td>-0.31</td>
<td>(0.02)**</td>
<td></td>
<td>-0.47</td>
<td>(0.03)**</td>
<td>0.99</td>
<td>(0.02)**</td>
<td></td>
<td>-0.23</td>
<td>(0.73)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of Observations | 94 | 86 | 72 | 71 |
R-square | 0.64 | 0.53 | 0.42 | 0.47 |
Adjusted R-Square | 0.61 | 0.50 | 0.36 | 0.41 |
S.E. of Regression | 0.45 | 0.72 | 0.94 | 1.48 |

Note: The table reports coefficient and P-value from the cross-section 2SLS estimation for economic growth regression using the average value of variables. Column 1 uses Domestic Credit provided by the private sector as a percentage of GDP as a proxy for financial development; Column 2 uses Financial Depth; Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stocks-traded as a percentage of GDP. The table also report the time range, the number of cross section, R-square, adjusted R-square and the standard error of each regression. ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively. Instruments for Economic Growth:
Modelling Financial Development and Economic Growth using a Simultaneous Equation Model Approach

- Domestic Credit Regression - Investment, Trade Openness, Government Expenditure
- Financial Depth Regression - Investment, Government Expenditure
- Stock Market Capitalization Regression - Investment, Trade Openness, Government Expenditure
- Stock-traded Regression - Investment, Trade Openness, Government Expenditure
### Table 6-11 Panel 2SLS Estimation for the Financial Development Regression (5-years average Observations)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coef</td>
<td>P-value</td>
<td>Coef</td>
<td>P-value</td>
<td>Coef</td>
</tr>
<tr>
<td>Constant</td>
<td>2.21 (0.00)***</td>
<td>0.57 (0.14)</td>
<td>-6.44 (0.00)***</td>
<td>-11.18 (0.00)***</td>
</tr>
<tr>
<td>Growth</td>
<td>0.06 (0.01)**</td>
<td>0.17 (0.00)***</td>
<td>0.10 (0.06)*</td>
<td>0.11 (0.21)</td>
</tr>
<tr>
<td>Education Attainment</td>
<td>0.53 (0.00)***</td>
<td>0.66 (0.00)***</td>
<td>2.08 (0.00)***</td>
<td>2.96 (0.00)***</td>
</tr>
<tr>
<td>Population Growth</td>
<td>-0.02 (0.56)</td>
<td>0.02 (0.60)</td>
<td>0.32 (0.00)***</td>
<td>0.43 (0.01)**</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.00 (0.48)</td>
<td>0.00 (0.60)</td>
<td>0.42 (0.09)*</td>
<td>0.00 (0.43)</td>
</tr>
<tr>
<td>UK Legal Origin Dummy</td>
<td>-0.38 (0.00)***</td>
<td>-0.07 (0.68)</td>
<td>-0.13 (0.68)</td>
<td>-1.40 (0.01)**</td>
</tr>
<tr>
<td>Scandinavian Legal Origin Dummy</td>
<td>-0.58 (0.00)***</td>
<td>-0.84 (0.00)***</td>
<td>-0.13 (0.68)</td>
<td>-1.40 (0.01)**</td>
</tr>
<tr>
<td>France Legal Origin Dummy</td>
<td>-0.49 (0.00)***</td>
<td>-0.27 (0.12)</td>
<td>-0.29 (0.21)</td>
<td>-1.62 (0.00)***</td>
</tr>
<tr>
<td>African Dummy</td>
<td>-0.14 (0.11)</td>
<td>-0.35 (0.00)***</td>
<td>0.54 (0.01)**</td>
<td>-0.50 (0.22)</td>
</tr>
</tbody>
</table>

Financial Depth; Column 3 uses stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stocks-traded as a percentage of GDP. The table also report the time range, the number of cross section and observation, R-square, adjusted R-square and the standard error of each regression. ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively. Instruments for Economic Growth:

- Domestic Credit Regression - Investment, Trade Openness, Government Expenditure
- Financial Depth Regression - Investment, Trade Openness, Government Expenditure
- Stock Market Capitalization Regression - Investment
- Stock-traded Regression - Investment
Table 6-12 Panel 2SLS Estimation for the Financial Development Regression (Annual Observations)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff</td>
<td>P-value</td>
<td>Coeff</td>
<td>P-value</td>
</tr>
<tr>
<td>Constant</td>
<td>2.25 (0.00)***</td>
<td>0.98 (0.00)***</td>
<td>-6.97 (0.00)***</td>
<td>-10.29 (0.00)***</td>
</tr>
<tr>
<td>Growth</td>
<td>0.00 (0.76)</td>
<td>0.13 (0.00)***</td>
<td>0.13 (0.00)***</td>
<td>0.11 (0.01)**</td>
</tr>
<tr>
<td>Education Attainment</td>
<td>0.55 (0.00)***</td>
<td>0.60 (0.00)***</td>
<td>2.15 (0.00)***</td>
<td>2.76 (0.00)***</td>
</tr>
<tr>
<td>Population Growth</td>
<td>-0.03 (0.01)**</td>
<td>-0.04 (0.02)**</td>
<td>0.33 (0.00)***</td>
<td>0.39 (0.00)***</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.00 (0.70)</td>
<td>0.00 (0.70)</td>
<td>0.00 (0.82)</td>
<td>0.00 (0.21)</td>
</tr>
<tr>
<td>UK Legal Origin Dummy</td>
<td>-0.42 (0.00)***</td>
<td>-0.19 (0.05)*</td>
<td>0.44 (0.00)***</td>
<td>-0.34 (0.11)</td>
</tr>
<tr>
<td>Scandinavian Legal Origin Dummy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France Legal Origin Dummy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African Dummy</td>
<td>-0.62 (0.00)***</td>
<td>-0.83 (0.00)***</td>
<td>-0.21 (0.18)</td>
<td>-1.58 (0.00)***</td>
</tr>
<tr>
<td>Time Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970-2002</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross Section</td>
<td>93</td>
<td>80</td>
<td>71</td>
<td>70</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>2417</td>
<td>2072</td>
<td>1359</td>
<td>1402</td>
</tr>
<tr>
<td>R-square</td>
<td>0.45</td>
<td>0.14</td>
<td>0.34</td>
<td>0.36</td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.44</td>
<td>0.13</td>
<td>0.34</td>
<td>0.36</td>
</tr>
<tr>
<td>S.E. of Regression</td>
<td>0.60</td>
<td>0.95</td>
<td>1.15</td>
<td>1.92</td>
</tr>
</tbody>
</table>

Note: The table reports coefficient and P-value from the panel 2SLS estimation for economic growth regression using annual observations. Column 1 uses Domestic Credit provided by the private sector as a percentage of GDP as a proxy for financial development; Column 2 uses Financial Depth.
Column 3 uses Stock Market Capitalisation of listed companies as a percentage of GDP; Column 4 uses Stocks-traded as a percentage of GDP. The table also reports the time range, the number of cross section and observation, R-square, adjusted R-square and the standard error of each regression.

***, ** and * denotes statistical significance at 1%, 5% and 10% respectively. Instruments for Economic Growth:

- Domestic Credit Regression - Investment, Trade Openness, Government Expenditure
- Financial Depth Regression - Investment, Trade Openness, Government Expenditure
- Stock Market Capitalization Regression - Investment, Trade Openness
- Stock-traded Regression - Investment, Trade Openness, Government Expenditure
Several conclusions can be drawn from the results:

a) As with the OLS estimation, economic growth exerts a positive and significant impact on most of the financial indicators except Domestic Credit in all 3 analyses. Again, the results confirm the demand-leading hypothesis;

b) All 3 analyses suggest that legal origin will significantly affect financial development, and Common Law Countries (UK legal origin) are significantly better in fostering financial development. These results are consistent with the findings in the literature;

c) The results of inflation on financial development are mixed, and the effects are trivial;

d) Educational attainment exerts a positive and significant impact on financial development in all 3 analyses. One of the reasons is suggested in section 6.3.4.2, where higher education attainment will provide enough pool of skilled workers in the financial development and thereby foster financial development.

e) The effect of population growth on financial development is mixed as suggested by the results;

f) The African nations generally have a lower level of financial development as suggested by the results;

g) The results of three part of analysis generally yield a consistent result apart from the regression on Domestic Credit.

6.4 Discussion and Policy Implications

Recall that the correlation analysis in chapter 4 shows that economic growth is positively correlated with financial development. The analysis in this chapter further provides evidence for the bi-directional relationship between financial development and economic growth using a structural simultaneous equations framework. Previous works place emphasis on the growth regression in order to discover the underlying causes of economic growth. However, macro-evidence for the underlying causes of financial development remains scant, and therefore the results from this study are able to fill this gap in the literature.

The results seems to shed light on the causality question concerning financial development and economic growth, and it suggests that the two patterns of development
process crystallised by Patrick (1966): (1), the demand following pattern, where the evolutionary development of financial system is a continuous and spontaneous response to the rising demand of financial services established by the process of economic development and the resulting increase in returns to scale in the financial sector due to specialisation; (2), the supply leading pattern, where the creation of financial institutions and their supply of their financial assets, liabilities and related financial services induced economic growth, by channelling savings into productive investment in modern sectors, by stimulating entrepreneurial activities in these sectors, by reducing the overall risk in the economy, and by improving corporate governance - occur simultaneously in the economy. In other words, there is an instantaneous causal relationship between financial development and economic growth, and the relationship run in both directions.

Taking the results of the annual panel data in Table 6-9, for the supply leading pattern, the elasticity of growth with respect to financial development range is as follows:

- Domestic Credit: 1.98%
- Financial Depth: 1.41%
- Stock Market Capitalisation: 0.45%
- Stock-traded ratio: 0.34%

In other words, a 1% increase in private sector domestic over GDP will result in a 1.98% increase in economic growth. A 1% increase in quasi-liquid liabilities over GDP will result in a 1.41% increase in economic growth. A 1% increase in stock market capitalisation over GDP will result in a 0.45% increase in economic growth. A 1% increase in the total value of stocks traded over GDP will result in a 0.34% in economic growth.

Taking the results of the annual data, for the demand following pattern in Table 6-12, the elasticity of financial development with respect to economic growth ranges as follows:

- Domestic Credit: 0%
- Financial Depth: 0.13%
- Stock Market Capitalisation: 0.13%
- Stock-traded ratio: 0.11%

A 1% increase in economic growth will in turn result in a 0%, 0.13%, 0.13% and 0.11% increase in private sector domestic over GDP, quasi-liquid liabilities over GDP,
Modelling Financial Development and Economic Growth using a Simultaneous Equation Model Approach

stock market capitalisation over GDP and total value of stocks traded over GDP respectively.

The results show that the relationship of financial development and economic growth is reciprocal and gives rise to a cumulative process. Insufficient financial development might therefore be a reason for the emergence of a poverty trap. In the same way, insufficient economic growth might also lead to underdevelopment of the financial system, which in turn prevents economy from taking off.

Therefore, policy that fosters financial development or economic growth will have a cumulative beneficial effect to the economy. This study identifies that the legal system can influence financial development. One reason is because of legal traditions which lead to difference in terms of the priority they attach to private property rights and the rights of investors in firms, and the protection of private property rights and outside investors from the basis of financial development, so that historically determined differences in legal tradition help explain international differences in financial development today (La Porta et al. 1997; La Porta et al. 1998; La Porta et al. 1999; La Porta et al. 2000). Another explanation is that legal traditions differ in terms of their abilities to adapt to changing commercial and financial conditions, and legal systems that adapt quickly to minimise gaps between the needs of the economy and the legal system’s capabilities will more effectively promote contracting and financial development (Beck and Levine 2002; Johnson et al. 2000). Therefore, a policy that fosters the protection of private property rights and investor rights, and that can minimise the gaps between the needs of the economy and legal system’s capabilities, will promote financial development, which in turn fosters economic growth.

The results show that inflation will exert a significant though trivial impact on financial development. Further analysis has to be done to examine this channel. Yet this seems to suggest the financial liberalisation thesis, that liberalising the financial system by removing the inflation tax in the economy will foster financial development and economic growth.

Education attainment exerts a positive and statistically significant impact on financial development. One reason is that employment in the financial sector is skewed towards the high-skilled. Another possibility is that higher education level will foster technological innovations, though this link has to be examined in the future works. Therefore, government should devise policy to raise the level of education attainment in
society in order to provide enough pool of skilled workers in the financial sector as well as induce innovation, thereby fostering financial development. The effect of population growth is negative. One of the reasons may be because population growth would lower the average human capital and the steady-state capital-labour ratio for a given investment in the financial sector. Yet further work has to be done to examine the link between population growth and financial development.

Regarding policy that promotes growth, apart from financial development, the current study has identified increase in trade openness, investment, government expenditure and a decrease in population growth will exert a positive impact on growth, and for the reasons explained in section 6.3.3.1. Therefore, government should also pursue these policies in order to foster economic development.

6.5 Limitations and Remarks

The theoretical model in chapter 3 forms a testable hypothesis that there is a bi-directional causal relationship between financial development and economic growth. The motivation of this chapter has been to look at the structural simultaneous equation system and draw a causal interpretation of the relationship between financial development and economic growth, in order to form the basis for policy analysis. The results show that the relationship between financial development and economic growth is bi-directional and give rise to a cumulative process. Each regression is being tested with a set on control variables, and the factors that determine economic growth and financial development are being identified in a simultaneous equation system. Taking account of simultaneous bias by using 2SLS estimation and unobserved panel heterogeneity using a set of country-specific dummies has helped to alleviate the estimation bias and improve the robustness of the results.

While 2SLS estimation can tackle the simultaneous bias, another source of bias comes from the use of a panel approach. There is an unobserved factor in each panel that will result in biases if the regression does not take into account for it. Besides, the estimation will be biased if the assumption of parameter homogeneity across sectors is violated. Also, the present approach does not use the standard fixed effect estimator to model the unobserved country effect. The reason is that the fixed-effects identification strategy cannot be applied in this context as some of the explanatory variables like
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geographical location and Legal origin are fixed in nature and the variation is between rather than within the country. The method to eliminate the country-specific intercepts by either within group transformation or first differencing will tend to aggravate the measurement errors. Furthermore, growth episodes within countries looks more alike than growth episodes across countries, and therefore offers less identifying variation (Durlauf, Johnson, and Temple 2005).

The approach this study has adopted is to devote more attention to model the heterogeneity, rather than treating it unobserved and try to eliminate its effect. This is done by including a complete set of regional dummies, as well as some of the variables in the (Beck, Demirguc-Kunt, and Levine 2001b)) dataset that claim to be financial-development determined variables, such as Law and Order, Credit Rights and Market Structure, and which can reflect between country-variation. However, it is found that some of the variables of insignificant and they will increase the standard error of the regression. Therefore, the current specification of growth and financial development regressions are parsimonious in nature, and have eliminated all insignificant variables that may affect the standard error of regression. These parsimonious forms of equation have several variables (i.e. regional dummies and legal origin dummies) that are able to model the heterogeneity of each panel and the unobserved country effect, and thereby alleviate bias associated with omitted variables.

Further work can be taken to better understand the causality question and the cumulative process of financial development and economic growth. While the previous chapter resorts to temporal ordering in examining the causality question, the present chapter address the causality question using the method of controllability, relevant theory and the outside knowledge (i.e. exogeneity) (Granger 1998). The use of the General Method-of-Moment (GMM) Approach, by using lagged levels of series as instruments for lagged first differences, may shed further light to the causality question of finance-growth nexus so that the temporal ordering can be examined in this context, yet researchers are sceptical about using lag value as instruments, as it may increase the biasedness in short panels.
7 Concluding Remarks

The current thesis aims at looking at the causal relationship between financial development and economic growth. The main argument of this thesis is that the relationship between financial development and economics is bi-directional. They will give rise to cumulative effects that will lead to economic development.

The theoretical model in chapter 3 suggests that financial development can facilitate capital accumulation through liquidity provision and risk amolieration, which in ternes ecouages growth. Economic growth will in turn lead to expansion of real sector, increased savings, and higher bank productivity that induce financial development. The model also shows that in the early stage of development, economic growth cause financial development. In order words, the new model is able to provide a theoretical basis to suppor the notion that economic growth causes financial development, and financial development causes economic growth.

The correlation analysis in chapter 4 suggests that financial development is positively correlated to economic growth. The empirical findings in chapter 5 and 6 suggested that the bi-directional casual relationship, in the sense of cross sectional causation and temporal causation, exists between financial development and economic growth. The causal asymmetry is identified through the temporal causation (Granger Causality Test in chapter 5) that look at how current (cause) help in predicting future (event), and through cross-section causation (Simultaneous Equation Model in Chapter 6) that looks at how instantaneous relationship between the cause and effect at current time. The cross country empirical analysis in chapter 5 and chapter 6 suggested in the economy will shift from demand-following pattern, where current economic growth will cause a rising demand of financial service and hence current and future financial development in the early stages of economic development. In the later stage, supply-leading pattern will be observed, where current finance development will further cause cuurent and future economic growth. The findings match the description of the theoretical model formalised in chapter 3. Therefore, drawing the results together, the following story could be told.

The analysis shows that the proportion of saving that is channelled to productive investment is greater in the presence of financial intermediation. Accordingly, by preventing premature liquidation of capital and improvement of risk sharing through
Inter-mediation, the banking system will result in a larger capital investment in the portfolio through the provision of liquidity. This justifies the existence of the financial system.

The profit-maximising motives of the bank entrepreneur will result in the starting off of bank system. At the infant stage of development, less people are employed in the financial sector relative to the real sector. This result in a higher marginal labour productivity (and hence wage) in the bank relative to the real sector. Workers will therefore migrate to the financial sector, which therefore lead to an expansion of financial sector.

Financial development can facilitate capital accumulation through liquidity provision and lowering risk in the system. It will also exert a positive influence on long-run economic growth through interest-rate channel by increasing bank competition and by increasing the efficiency of financial intermediation. Hence, financial development encourages growth and lead to an expansion of real sector.

Economic growth in the real sector will generate more saving and thereby a positive external effect on banking productivity. Because of the less developed financial system and the monopolistic or oligopolistic nature of banking system at the early stage, bank intermediation margins tend to be less sensitive to the change in financial structure, and therefore the negative effect of financial development on marginal labour productivity through the lowering bank margin will be significantly less than the positive external effect by growth. Therefore the marginal productivity, and hence the wage rate, for the bank will rise. This in turn will attract more labour to migrate to the financial sector because of higher wage. Hence, this will result in further expansion of the financial sector (and hence financial development).

The process will continue and the country will reach their later stage of development with a highly developed financial system. At this stage, marginal labour productivity will be significant higher due to the migration of workers away from this sector. Besides, as there is a continued development of financial sector, bank margins will be more sensitive to these changes because there is more competition and a more efficient use of resources, and bank margins will continue to fall. The negative effect of bank intermediation margin on wage will therefore counteract the positive external effect by growth. With a rising wage rate in real sector and a constant falling wage rate in the financial sector, the economy will reach the steady-state where marginal productivity of labour become equal.
Concluding Remarks

across the real sector and the financial sector. Expansion of the financial system will cease, and the steady-state of economic growth rate is governed by the total factor productivity and the capital share of income in the final good sector, as well as the financial technology, the time preference and magnitude of the elasticity of marginal utility of consumption.

This study also identifies certain factors that influence financial development. First, legal systems can influence financial development. Policy that fosters the protection of property rights and investor rights, and that can minimise the gaps between the needs of the economy and the legal system capabilities, will promote financial development, which in turn foster economic growth. The second factor is inflation though its effect is trivial. This result seems to suggest that financial liberation thesis, where liberalising the financial system by removing the inflation tax in the economy will foster financial development and economic growth. This is a possible research area where further analysis can be done to examine this channel. The third factor is educational attainment, as high education level of workers will foster technological innovation, and will provide enough pools of skilled workers in the financial sector. The forth is the negative effect of population growth, as it will lower the average human capital and the steady-state-labour ratio for a given investment in financial development. The literature on the relationship between financial development and population growth has remained scant, and therefore this is an area where further works can be done to examine the relationship. Regarding factors that promote growth apart from financial development, the current study has identified an increase in trade openness, investment, government expenditure and a decrease in population growth will exert a positive impact on growth. Therefore, government should also pursue these policies in order to foster economic development. Though there is a discrepancy between the above description and the empirical results, because the empirical framework does not look at labour market dynamics and the market structure of the financial system, the explanation provides a formal foundation to explain the underlying dynamics of the reciprocally of the finance-growth nexus.

Further works can be built on from this thesis by calibrating and estimating the theoretical model that is presented in this study. Further extension of the theoretical model includes adding equity markets in the model and by introducing risk-adjusted elements in investment return so as to examine the risk-ameliorating function by financial system. Other possible research areas include testing the central assumptions of the
model that a financially developed country will have a high interest-elasticity of savings.

For the empirical part, the econometrics approach can be further refined by use of the General Method-of-Moment (GMM) approach to shed light on the causality question of finance-growth nexus so that the temporal ordering can be examined in this context, though the use of lag variable as instrument is questionable. Other possible research areas in the future may include the analysis of information content of country-specific effect in the regression.

The study of financial liberalisation is outside the scope of this thesis. Future research works can be done in this area to examine the link of domestic financial system liberalisation, capital account liberalisation and stock market liberalisation on domestic financial development and economic growth.

Finally, as mentioned in the chapter 2, the narrative, historical and country-study approach will still have a lasting role in the study of finance-growth nexus. Therefore further works can be done to examine the political, social and cultural factors that shape the financial development and economic growth, in order to uncover a new set of stylised facts that allow economists for future investigations in the finance-growth nexus.
A Appendix: Brief History of Modern Growth Theory

This appendix aims to provide a non-technical survey of the development of the theory of economic growth that serves as the supplements to the background literature review in chapter 1. At the study of finance-growth nexus is relevant to economic growth theory, in order to better study the underlying mechanism of the finance-growth nexus, it is important to understand the process of economic growth.

For centuries economists have been preoccupied with the growth of nations. The work of the classical economists provides the basic foundations of the modern theories of economic growth. The classical economist provides the basic economic concepts that were widely used in the modern theories of economic growth. These ideas, as listed in Barros and Sala-i-Martin (2004), include:

- The basic approaches of competitive behaviour and equilibrium dynamics;
- The role of diminishing returns and its relation to the accumulation of physical and human capital;
- The interplay between per capita income and the growth rate of population;
- The effects of technology progress in the forms of increased specialization of labour and services of new goods and methods of productions;
- The role of monopoly power as an incentive for technological devices (Barro and Sala-i-Martin 2004)

According to Eltis (1984), the classical theory of economic growth developed successively by Francois Quesnay, Adam Smith, Thomas Malthus, David

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160 Quesnay’s legacy lies in his publication of the *Tableau Economique* (Economic Table) in 1758, which served as the foundation of the ideas of the Physiocrats in 18th century, and provided the first work to describe the full economic interrelationships in an analytical way. His objective was to lay down a system in which the agricultural product, the only source of wealth in the society, would be in a state of perfect liberty by being distributed among the several classes of community, namely the landowners, the farmers, the merchants and manufacturers. (Quesnay 1972).

In the world of Quesnay, agricultural product is the only source of wealth and only farmers are productive and generate surplus. Economic growth depends primarily on the reinvestment of the agricultural surplus, as well as the demand for agricultural produce that depends on the society’s propensity to consume food. Reinvestment of surplus would allow farmers to increase their agricultural capital stock, which in turn improves productivity and produce growth in the economy (Eltis 1984).
The classical economists accepted the main perspective of Smith’s seminal work ‘Wealth of Nation’ (1776) was an analysis of the machinery of productive organisation and a discussion of the nature, the causes and the objective of growth (Robbins 1998). It related to the essence of Quesnay’s work by linking the generation of economic surplus to capital accumulation and economic growth. However, for Smith, rather than solely focusing on the agricultural sector, industry and commerce will also contribute to the surplus that affect economic growth rate (Eltis 1984).

Smith looked at the question of economic growth from the supply-side. The crucial elements are the ability to specialise through division of labour and increasing economies of scale. Smith assumes returns to scale are different in each sectors of the economy. There is increasing return for the manufacturing sector where there is more scope for division of labour compared with the agricultural sector. As division of labour is limited by the extent of the market, and the improvements in machinery and trade that can increase the market scale and scope will facilitate further specialisations, which therefore serve as the source of technological progress to improve productivity and economic growth. Growth in this sense is therefore self-reinforcing as it exhibit increasing returns to scale (Smith 1776; The History of Economic Thought Website 2006a).

An account of Smith’s work gives a great emphasis on the overwhelming importance of the rate of capital accumulation and its causes. The rate of accumulation will increase when there is an increase in the proportion of the labour force that is employed productively, and the improvement on the efficiency of productively labour. According to Smith, the source of accumulation lies on savings or thrift, and which allow reinvestment of surplus of the productive sector and thus creates investment to capital. Greater accumulation will increase the resources available to sustain the population, and therefore can accommodate an increasing labour force. Industry will expand, and they can exploit the advantage of further sub-division of labour and result in potential gains in productivity. Total output in the society will therefore increase (Eltis 1984).

Smith also visualises the long-run stationary state in the economy. The increased accumulation of capital tends to raise the demand for labour and consequently the wage rate, which will exert a depressing effect on the rate of profit. Competition among the owners of capital for profitable investment becomes keener, and capital is driven into employments of diminishing profitability. The rate of capital accumulation and wages will fall. Therefore in the very long run, there are low wages and low profit, where population growth, capital accumulation and economic growth are zero. From this argument, income distribution between wages and profit are being one of determinant of how fast a nation will grow in the short run. Yet in the long-run stationary state, growth is zero (Eltis 1984; Spiegel 1991; The History of Economic Thought Website 2006a).

Smith’s analysis becomes the predominant model of classical growth. It provides a foundation for the later classical economist to understand the process of economic growth.

To Malthus, as in common with Quesnay but contrary with Smith, agricultural output was the prime engine of economic growth because he assumed that food output is the only support for the population. He identified diminishing returns in agriculture as the one of the most important constraint on economic growth. In his theory of population (1798), population growth was not so easily checked and would quickly outstrip growth, causing increasing misery as there is not enough food. The idea is that whereas
Ricardo\textsuperscript{163} and Karl Marx\textsuperscript{164} has two fundamental characteristics, where a certain part of the economic activities generate an investable surplus over costs, and growth is dependent population if unchecked is increasing at an exponential rate, the food supply only grows at linear rate and therefore not able to feed on the whole population. (Malthus 1798).

Malthus questions Smith's belief in the overriding importance of capital accumulation as a determinant of growth, and he looks at the questions of growth from the demand side. Large physical surplus of food over the consumption needed would not guarantee growth unless there is an effective demand for food surplus so as to provide incentive for farmers to expand or maintain output. Through this channel, manufacturers became important to growth not because of factor input, but for their effect on reciprocal demand (of farmers for manufactures and of manufacturers for farm produce) to raise food supply. He believed that growth would cease if effective demand failed to expand. He considers the lack of effective demand provided an explanation of the underdevelopment of most of the world, which was no less important than a general inability to raise supply (Eltis 1984).

\textsuperscript{163} The work of David Ricardo (1817) provides a complete theory of the interactions of the economy, that provide a complete account of the underlying forces which produce economic growth, and how these can be expected to influence wages, profits and rents. His theory of income distribution was seen as an extensions of Smith's thought, and opposed to Malthus, he was unconvinced that effective demand will influence growth (Ricardo 1817)

The essence of Ricardo's theory can now be summarised. His model assumes the diminishing agricultural productivity, and assumes that the entire productive sector could be represented by the corn-producing farmer. Similar to Smith, the questions of growth are in the supply-side, and output growth requires growth of factor input of labour, capital and land. However, unlike labour and capital, the supply of land is limited in a country. As the economy develops, the agricultural diminishing returns gradually reduced corn output per worker relative to the wage and rent, because labour productivity will decline marginally, but the increasing demand of labour and the limited supply of land will push up wages and landowners' rent respectively over time (the persistent rising in rent is not merely measured in terms of food. The increase will become more when the rising relative price of food is taken into account). The corn-surplus will fall, which squeezes the capitalists' profit and lowers the profit rate. This will lower investment and capital accumulation, and the rate of economic growth. On this account, anything that would maximise surplus, such as raising productivity on the margin of corn production (such as technological progress, and increasing specialization through trade), reducing wage, or increasing supply through cultivation would maximise economic growth. Although in the long run, similar to Smith, he also envisaged the stationary state where population growth, capital accumulation and economic growth are zero (Eltis 1984; The History of Economic Thought Website 2006a).

According to the above, machinery would reduce costs of production and thereby improve profit rates and economic growth. However, in the 3\textsuperscript{rd} edition of his work "Principal" (1821), he modified his position on machinery and offered a new life of analysis. Though improvement in machinery would increase profit rates and economic growth, it will at the same time displace labour and reduce the employment growth rate. The displaced labour might not be reabsorbed from other sectors; it will create downward pressure on wages and thus lower labour income. Hence the capital-labour ratio will drop.
on the reinvestment of a sufficient fraction of that surplus. Decline in economic growth rate is inevitable if luxury consumption or unproductive consumption exceeds the surplus that the productive sector generates (Eltis 1984).

At the end of the 19th and early 20th century, conventional economics underwent a profound transformation designated as the ‘marginal revolution’. The period saw the demise of a labour theory of value and the building up of the demand-supply analysis in

Yet Ricardo is optimistic as he believes that the mechanisation would follow a faster rate of capital accumulation (even though there is no obvious mechanism provided from Ricardo for this to happen), which would produce a faster rate of increased demand of labour. To him, mechanisation would maximise long-term demand for labour as well as growth even though in the short run worker will become worse off. (Eltis 1984; The History of Economic Thought Website 2006a).

Contrary to the view of his classical economist predecessors that reinvestable surpluses are beneficial to all different classes in the society, Marx (1867-83) believed that at the fundamental level the economic surplus resulted from that exploitation of labour engaged in material production in both industry and agriculture. According to Marx, all surpluses over wage (i.e. profit and rent) are due to the social, political and legal conditions that allow the capitalist class to exploit labour by suppressing their wage and coerce workers to labour for excessive hours and with unnecessary intensity than the production of goods for workers' subsistence actually requires. Accordingly, wage is determined by bargaining between capitalist and workers but not by the labour demand, and labour supply are exogenous to wage and is influenced by the amount of unemployed labours in the economy (Eltis 1984; Marx 1974; The History of Economic Thought Website 2006a).

For Marx, only labour produces surplus value. The rate of profit, which equal to surplus over total advances (wage fund + fixed capital stock), is positively related to the rate of exploitation (surplus over wage fund) and negatively to the organic composition of capital (surplus over fixed capital). In the Marx model, only labour (variable capital) generates surplus. Capital accumulation through reinvestable surplus will raise the fixed capital stock. Therefore, profit rate has a tendency to decline overtime due to the rising organic composition of capital. To maintain the profit rate, the rate of exploitation must rise to offset the effects. This was done by capital concentration through introducing labour-saving machinery into production and thereby displacing labour and reducing the wage fund (cost of employing labour). The increasing ‘reserve army of labour’ (unemployed) will further influence the labour bargaining process that further holds down wage to subsistence because of competition for jobs. Therefore though the capitalists can maintain their profit rate in the process of competition, there is an increasing misery of the proletariat (the working class people) (Spiegel 1991).

Capitalism would collapse because effective demand would cease to keep pace with the enormous growth in productive potential that was created by increasing mechanisation. When the process continue until there are no more labour to be laid off, profit rate will declined and the less competitive firm will begins to go bankrupt. In the long-run stationary state, the economic system will collapse (The History of Economic Thought Website 2006a)
relation to price. Mainstream economists turned their focus to equilibrium and optimisation; from the Jevons theory of utility, the Austrian school of utility analysis, to the completion of general and partial equilibrium analysis by Walras and Marshall. Classical growth theory that tends to draw inference from history has therefore been relegated into secondary importance and has been replaced by the mainstream analytical approach offered by neoclassical economists.

Prior to the development of the Keynesian and Neoclassical Growth theory, the period also saw the development of ideas of economic growth that is unorthodox to the mainstream. Schumpeter (1911) stressed the importance of entrepreneurship and innovation for development and growth, and Young (1928) emphasised the importance of the increasing returns on economic progress. These developments served as the precedence of endogenous growth theory that has emerged during the late 1980s.

The central idea of Schumpeter (1911) was the importance of the entrepreneur for development, for change and growth, for the business cycle, and for the survival of capitalism. Economic changes are mainly originated by producers and enterprise but not by individual consumers. The strategic element in entrepreneurial activity was innovation, which is the application of new ideas in technique and organisation which would bring about change in the production function. Innovation would brake the circular flow of the static economy and generate economic development with a new equilibrium position at higher level of income (Schumpeter 1911; Spiegel 1991).

Schumpeter’s theory represents a line of thought that is different from the mainstream Keynesian analysis. He considers monopoly power a suitable incentive and a fitting reward for the innovating entrepreneur, who would enjoy this power for only a limited time, until it was broken and replaced in a chain of ‘creative destruction’ by another innovator’s monopoly. For similar reasons, he considers the driving force in the economy to be by private initiative, rather than through public policy as in Keynes (Spiegel 1991).

The prevalence of the neoclassical growth model in the following decades, which accrue the exogenous technical change as the sole determinant of long-run economic growth, makes the Schumpeter theory of economic growth become unorthodox. Only until with the emergence of the endogenous growth theory in the late 80’s have economist discovered the Schumpeterian approach of growth through innovation and creative destruction.

The central idea of Young (1928) was the importance of the increasing returns as an explanation of economic progress. He argued that ‘the apparatus which economists have built up for the analysis of supply and demand in their relation to prices does not seem to be particularly helpful for the purpose of an inquiry into the broader aspects of increasing return’. Tracing back from Smith’s notion that the division of labour depends upon the extent of the market, and with introduction by Marshall of the distinction of internal and external economies, he forms a fundamental insight of growth dynamics. In capitalist economies using roundable method of production, the securing of increasing return that originated from the intertwining forces of division of labour, specialisation of industry,
A.1 Neoclassical Growth Theory

While the classical growth theory tends to draw inference from history, neoclassical growth theory is analytical in nature. The main purpose is to supply an element in an eventual understanding of certain important sources of growth and to provide a systematic analysis on the mechanism of growth. Most of the theory is in the context of the equilibrium of a competitive economy through time, with an aim to characterise an economy in steady-state growth and to analyse its properties. Specifically, the theory aim to solve the following questions:

- Question of Existence - Is a steady-state solution possible?
- Question of Comparative Dynamics - Assuming that a steady-state solution does exist, what are its properties?
- Question of Stability - Does the system tend toward the steady-state path if it is initially off it?
- Question of Equilibrium and Dis-equilibrium Dynamics – What are the behaviour of equilibrium paths of any given model, whether they converge to the steady-state path or not? How do people react to the disequilibrium to bring the system back to the equilibrium path?

Attentions of the neoclassical theory are paid to capital accumulation, population growth and technical progress. Connected with it is the treatment of savings and investment (Hahn 1987; Hahn and Matthews 1964).

From the chronological viewpoint, neoclassical growth theory starts with the work of Ramsey (1928). To draw a more complete picture for the path of consumption and saving (capital accumulation) in the process of economic growth, Ramsey has formulated a

and the extent of market size, will lead to economic progress that come through the operation of forces engendered within the economic system (Young 1928).

Young's insights on increasing returns serve as precedence for the endogenous growth theory that becomes prevalent in the 1980s. His work inspires later economists to formulate the dynamics model of increasing returns with externalities to endogenise growth process

167 Steady-State growth is the rate of growth of all the relevant variables remains constant over time (Hahn and Matthews 1964).
168 There are possibilities that paths generated are not steady-state growth paths as growth is not proceeding at a constant rate, but that are none the less equilibrium paths in the sense that all markets are clear and mistakes are instantly corrected. (Hahn and Matthews 1964).
macro-dynamic model using the concept of inter-temporality, representative agents, and household optimisation techniques. His formulation of the problem served as a model for the subsequent studies of optimal economic growth\textsuperscript{169} (Ramsey 1928).

A.1.1 Keynesian Growth Theory and The Harrod-Domer Growth Model

Keynes developed the theory of effect demand in his seminal work ‘General Theory of Employment, Interest, and Money’ (1936), to put forward a theory based upon the notion of aggregated demand to explain variations in the overall level of economic activity. Total income will rise only if there is increase consumption and expenditure that boost aggregate demand. As distinct from the classical economist that focuses on the supply-

\textsuperscript{169} At least at far back as Bohm-Bawerk (1889), economists had entertained the idea that people are ‘myopic’ or ‘irrational’ in the sense that they tend to underestimate their future needs and desires and therefore ‘discount’ their future utilities. The market failure thesis by Pigou (1920), and his argument that economic agents are irrational as they tend to underestimate their future utility and thus personally save less than at the optimal level\textsuperscript{169}, implies that there is a sort of market failure in the saving markets, and that the equilibrium rate of saving in the market system is suboptimal. The paper by Ramsey (1928) was aimed to determine the optimal saving rate in order to show the sub-optimality of the equilibrium saving rate in the market. (Bohm-Bawerk 1889; Pigou 1920; Ramsey 1928; The History of Economic Thought Website 2006a).

Ramsey assumed a one-good world, in which labour with a stock of capital would produce a flow of output, part of which was consumed, and the balance was saved and thereby added to the capital stock. The model assumed that there is no population growth, no technical progress and no discounting of utility in order to simplify the analysis. The method of analysis was the problem of intertemporal welfare maximisation using the technique of dynamic optimisation. The objective was to achieve the maximum level of enjoyment (utility of consumption minus disutility of working), summing over time. By minimising the total net rate enjoyment of utility falls short of the maximum possible rate (i.e. Bliss point minus utility level) subject to the income constraint (i.e. consumption plus savings), the mathematical conclusion of the model is that the rate of saving, multiplied by the marginal utility of consumption, should always be equal to the amount by which the total net rate enjoyment of utility falls short of the Bliss (Newbery 1998).

Ramsey concluded that the economy is under-saved and the optimal saving should be higher than the equilibrium (or steady state) level. The level of saving is independent on the production function and the rate of interest, as it is driven by the demand for future consumption whilst the interest rate is determined by the current stock of capital. Subsequent extension of Ramsey’s model relaxes the simplifying assumptions, showing that population growth will exert a positive, while technical progress an ambiguous, effect on the saving rate. Allowing for utility discounting, interest rate and the marginal utility consumption can serve as guidance for saving rate (Newbery 1998).

Ramsey’s work laid the foundations for the study of optimal accumulation and optimal growth.
side of economy and the market to restore equilibrium, Keynes offers a new paradigm that places emphasis on the demand side and government intervention. Investment accordingly is determined by the propensity to save and the interest rate. As different from not Schumpeter, they are not related to finance and innovation. Yet Keynes' theory only offers insight in the short-turn and he does not provide a theory of economic growth.

Harrod (1939) and Domer (1946) were the first to translate the Keynes theory of effective demand into a long-run economic growth model. Investment, one of the determinants of aggregate demand that is determined by propensity to save and is linked to output in Keynes model, becomes the driving force of economic growth as it leads to capital accumulation and increases the productive capacity of an economy. Yet the model is gloomy about the existence of balanced growth, an equilibrium condition where growing variables grow at common rates, and argues that capitalist systems and actual growth are inherently unstable. (Domer 1946; Harrod 1939)

The model derives the warranted rate of growth – the rate of capital accumulation (i.e. saving rate) over the capital-output ratio.

If the actual growth rate is faster (slower) than the warranted rate, aggregate demand growth will outstrip (lag behind) the growth of the economy's production capacity. Entrepreneurs will increase (decrease) investment to generate extra (reduce) production capacity, which in turn further increases (decrease) aggregate demand. Therefore, with demand always one-step ahead of supply, unless growth of aggregate demand is equal to the warrant growth rate, the economy will either grow indefinitely or collapse in the long run, and the steady state growth path would thus be inherently unstable. This is known as the Harrod 'knife-edge' (Sinclair 2001; The History of Economic Thought Website 2006a).

A.1.2 Neoclassical (Solow-Swan) Growth Model

The neoclassical growth model was originated by Robert Solow (1956) and Trevor Swan (1956). The original version of the Solow-Swan Growth model was seen as an extension.

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170 For balance growth, capital growth (saving rate times capital) is equal to output growth (output time output growth rate). Rearranging the equation that gives saving rates over capital-output ratio is the (warranted) output growth rate (also equal to the growth rate of labour force).
of the Harrod-Domer analysis\textsuperscript{171}. The Neoclassical growth analysis resolves the problem of inherent instability of the steady-state growth path in the Harrod-Domer model. By claiming the endogeneity of the capital-output ratio, by introducing labour as a factor of production and allowing substitutions between labour and capital, Solow and Swan were able to conclude that growth paths in a capitalist economy have a tendency to converge to a steady state in the long run (Solow 1956; Swan 1956; The History of Economic Thought Website 2006a; Uzawa 1987)

A.1.2.1 Development

The original version of the Solow-Swan growth model is formulated in terms of a one-commodity economy, where output is produced by capital and labour. By assuming that capital accumulation (net investment) is equal to saving (exogenous constant saving rate times output), and labour grows at an exogenous constant rate, the model shows that the rate of change of capital-labour ratio is equal to saving minus the part of net investment that keeps capital-labour ratio constant\textsuperscript{172}. The balance growth equilibrium

\textsuperscript{171} Solow extended the Harrod-Domer Model by taking labour as a factor of production, introducing technology as a third independent variable. The model assumes constant returns to scale for the production function, and positive and diminishing marginal returns to each factor input. The ratio of capital output and capital labour are not fixed as in the Harrod-Domer Model.

\textsuperscript{172} The specification of the aggregate production function assumes the followings:

- Aggregate production function is continuous differentiable so that the marginal rate of substitutions between factor inputs is well defined;
- Diminishing marginal rate of substitution between capital and labour, expressed by the concavity of the per capita output functions, so that capital-output ratio is perfectly flexible in the long run;
- Constant returns to scale, so that aggregate production function is linear and homogenous;
- Positive and diminishing returns to each factor inputs;
- Inada conditions: i.e. assuming that the marginal product of factor input approaches infinity (zero) as factor input goes to zero (infinity), to guarantee the existence of stationary state.
- Perfect competition in its fullest sense. i.e. It assumes marginal productivity factor pricing, no externalities, perfect price flexibility and perfect foresight
- No technological progress;
- Labour grows at a constant geometric rate;
- A constant fraction of output is saved and is not consumed. Saving is always equal to investment (Barro and Sala-i-Martin 2004; Hahn 1987; Sinclair 2001; Uzawa 1987)
and steady-state equilibrium exists uniquely at the same point when the capital-labour ratio ceases to change. The results of the model state that saving and capital accumulation can only affect economic growth in the short run during the path towards the steady state. In the steady state, the long run per-capita economic growth rate is zero, and the absolute magnitudes of output and capital will grow at the given exogenous population rate.

As mentioned in the above section of the Harrod-Domar Model, a simple Keynesian growth model with a given capital-output ratio will lead to the disturbing conclusion that neither steady growth nor optimal allocations are achievable. The Neoclassical growth model responds by allowing substitutions between labour and capital in response to price signals, so that capital-output ratio will adjust to bring the economy to the steady growth path. Hence, the model disposes the Harrodian unstable ‘knife-edge’ and provides an account of the long run economic growth with uniform expansion of all inputs and outputs (Neil 1987).

To reconcile the neoclassical growth model with Kaldorian stylised fact, economists argue that there is some sort of exogenous technical progress that shifts the production function outwards through times so that economic variable growth is in steady state. The production function in this case can be represented by $Y = F(K, L, t)$.

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173 For example, if the rate of growth of labour exceeds the warrant rate of economic growth (i.e. saving over the capital-output ratio), real wages will tend to fall, leading firms to substitute labour for capital as labour cost is relatively cheaper. Capital-output will fall, which raises the warrant rate of economic growth until the warrant rate is equal to the labour growth rate. This will bring the economy to equilibrium and guarantees a steady-state growth path (Neil 1987).

174 With the subsequent empirical works of Abramovitz (1956) and Solow (1957), which shows that at least 3 quarters of US economic growth was due to increased efficiency in the use of productive inputs but not the growth in factor input, this implied that the source of economic growth appeared to lie outside the traditional concerns of economists (Abramovitz 1956; Metcalfe 1987; Solow 1957). Besides, the steady-state empirics of the model contradicts at least three of the ‘stylised facts’ of industrial economies laid out in Kaldor (1961), namely that capital-labour and per capita output ratios have been rising over time, the capital coefficients are constant, and that the real wage has been rising (Kaldor 1961; The History of Economic Thought Website 2006a). Given this, economists review the basic assumptions of the neoclassical growth model, and pay more attention to the role of technical progress in the economic growth model to account for the growing capital stock at the steady state.

175 The idea that technical progress exerts a positive influence on economic growth was first mentioned by Schumpeter (1911). According to Harrod (1937), technical inventions are neutral if the optimum capital coefficient remains constant when the interest rate is kept constant. Robinson (1938) shows that if technical inventions are neutral in Harrod
Uzawa (1961a) shows that neutral technological inventions are labour-augmenting and can be represented by the production function \( Y = G(K, A(t)\*L) \). He demonstrates that Harrod-neutral technical progress was the only type of technical progress consistent with a stable steady state ratio. If technology is Harrod-neutral, the neoclassical growth model with technical progress can account for all Kaldorian stylised facts. The steady state is characterised by the conditions that the capital coefficient remains constant while the capital labour ratio continues to increase at the rate equal to that of labour efficiency that is exogenous to the model, and paths of economic growth necessarily converge to the steady state (Uzawa 1961a; Uzawa 1987).

A.1.2.2 Remarks

Before the development of the Neoclassical Growth Model, the sources of economic expansion were considered to be population growth and saving (that accumulate capital), with growth in labour productivity dependent upon the substitution of capital for labour within the neoclassical and Keynesian tradition. The breakthrough of the Solow-Swan model demonstrated the apparent independence of long-term economic growth from capital accumulation, and show that technological progress is crucial to long-run economic growth.

A.1.3 Growth Accounting

There is a subsequent body of empirical literature known as ‘growth accounting’ that attempts to address the empirical validity of neoclassical growth model with technical progress. Growth accounting refers to allocation of economic growth rates among the determinants of output that influence growth. It estimates the size of the effect upon output of a given change in each input determinant. In estimation, growth accounting assumes that the technical progress is Hicks-neutral (or Total Factor Productivity augmenting) rather than Harrod-neutral (labour augmenting) rather than Harrod-neutral (labour augmenting) (Denison 1987).

\[ Y = A(t)F(K, L) \]

\( Y \) indicates output; \( K \) indicates capital stock; \( L \) indicates labour; and \( t \) indicates time. \( A(t) \) indicates the efficiency measure for labour at time \( t \), to be determined independently of \( K \) and \( L \). The technical progress function \( A(t) \) lies outside the production function, i.e. \( Y = A(t)F(K, L) \). It is possible for technical progress to be both Hicks-neutral and Harrod-
This history of output growth can be decomposed into growth of capital inputs, labour inputs and technological progress. The early investigations of growth accounting begin with the studies of Abramovitz (1956) and Solow (1957), who deduct the factor accumulation from the output growth and ascribes the residual (the Solow residual) to technological progress. Subsequent works by such as Denison (1962) and Jorgensen and Griliches (1967) extend the method and refined the measurement of the productive input by taking a detailed account of the effects of education on labour quality and on the accurate measurement of capital goods and their services, and finds that the importance of Solow residual (i.e. the growth of total factor productive growth) was argued to be substantially less than estimated by earlier researchers, as output growth can be accounted by qualitative growth (i.e. improvement) of factor inputs. The residual debate therefore focuses on the measurement of total factor productivity and the implications which follow economists' understanding of the growth process. It is only until the emergence of the endogenous growth theory in the late 1980s that further light was shed on the understanding of the role of technical progress on economic growth. (Abramovitz 1956; Denison 1962; Jorgenson and Griliches 1967; Metcalfe 1987; Solow 1957; The History of Economic Thought Website 2006a).

A.1.4 Other Development: Two-Sector Model & Multi-Sector Growth Model

The neoclassical growth model has been based on the concept of aggregate production function, which measures the total output in terms of a certain homogenous quantity of labour and capital inputs. A line of research makes several extensions to the model in order to analyse the situation where there exists various sectors of goods that are produced by different technologies. This led to an explosive of research of multi-sector growth model in the 60's, though the movement dies down in the 70's (Uzawa 1987)

A.1.4.1.1 Two-Sector Model

Two-sector extensions of neoclassical growth models are introduced by Uzawa (1961b, 1963) and Meade (1961). They consider an economy where there are two sectors, neutral if the production function has a constant unit of elasticity of substitutions. Economists tend to use the Cobb-Douglas form of production function, as this is the only functional form that fulfills this criteria (The History of Economic Thought Website 2006a).
one producing investment goods and the others consumption goods, by using capital and labour. The crucial result of the model is that uniqueness and stability depends crucially on the relative factor-intensities of the two sectors (i.e. the capital intensity assumptions, where consumption goods are always relatively more capital intensive than investment goods if the optimum capital-labour ratio is higher in the consumption sector than in the investment sector for all possible wage-rental ratios) and the saving hypothesis (which state that a fixed proportion income is allocated between consumption and saving) (Meade 1961; Uzawa 1961b; Uzawa 1963; Uzawa 1987).

The central results of the Uzawa two-sector model are very sensitive to the assumptions of capital-intensity condition. In order to pin down the requirement, as well as to explore the rate at which society should save out of current income to achieve an optimum growth, Uzawa (1964) and Srinivasan (1964) analyse the problem by adding optimality criterion in the context of the two-sector growth model (Srinivasan 1964; Uzawa 1964). The Srinivasan-Uzawa analysis focused its attention on evaluating the impact of a roundabout method of production179 upon the welfare of the society, as expressed by a discounted sum of per capita consumption over time. The capital intensity conditions are no longer fundamental to the stability and the uniqueness of the model. The system after all is driven by the social planner aiming to optimise the consumption path. The mathematical conclusion shows that the maximisation problems of the social planner results in an automatic adjustment mechanism for the system to reach the steady-state growth path that maximise per capita consumption, regardless of the capital intensity condition (The History of Economic Thought Website 2006a; Uzawa 1987).

A.1.4.1.2 Multi-Sector Growth Model

The Multi-Sector Growth model is a general equilibrium analysis that addresses the situation where there exist various sectors of goods produced by different technologies where aggregation is inappropriate for formal analysis. The purpose is to inquire whether

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179 Methods of production are roundabout if they used produced means of production or the services of capital goods as well as those of land and labour, the latter being considered original or primary factors of production. It used to describe the capitalistic production process whereby capital goods are produced first and then, with the help of the capital goods, the desired consumer goods are produced (Hennings 1990).
a connection between optimality and competitive equilibrium price (and hence efficiency) can be established in a dynamic growth model (Majumdar 1987).

The foundation is laid by von Neumann (1938) (von Neumann 1945), who is concerned the existence and the properties of balanced growth paths. According to the model with a finite number of goods and process\textsuperscript{180}, the steady state equilibrium is found where producer choose to optimise inputs. The mathematical conclusion of the model shows that there exists a kind of unique competitive equilibrium in which the maximal rate of uniform expansion of capital stocks is achieved. In the associated growth path there are equilibrium relationship between prices and interest rate that lead a competitive economy to expand along this path, and the economy (also the interest rate) will grow at the highest balanced growth rate that the economy is capable of, given that there are classical saving assumptions. (Hahn 1987; Hahn and Matthews 1964; McKenzie 1987; von Neumann 1945). In other words, the model is capable of establishing the connection between optimality and equilibrium condition, and the uniqueness of equilibrium relationship, in the dynamic growth process. The competitive equilibrium has shown to converge to the steady state where variable grows at the same constant rate.

Yet another important paper by Malinvaud (1953)\textsuperscript{181} shows that when economic activity does not terminate at a known date (i.e. in an infinite horizon), the outcome of a period-by-period competitive process may fail to be optimal. Subsequent literatures therefore study the possibility of designing an informational decentralized resource allocation mechanism that leads to optimal outcomes and it has become a classical problem in the dynamic models with an infinite horizon (Majumdar 1987; Malinvaud 1953).

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\textsuperscript{180}The model consists of several produced goods (capital) and one non-produced goods (e.g. labour), and there is a price vector that correspond to the produced goods in terms of the non-produced goods. In this model, there are many alternative production processes with many capital goods as inputs and outputs. Labour was treated as an intermediate product produced by given consumption process (i.e. they are assumed to be to be in infinitely elastic supply at a given vector input of consumption goods), which were then integrated into the process in the model. These processes had stocks of goods as their only inputs and outputs, so all flows of services and intermediate products were suppressed through integration with other processes. There were no natural resources in this model (Hahn 1987; McKenzie 1987).

\textsuperscript{181}The Malinvaud (1953) paper is concerned with efficient accumulation in the infinite duration path and with the optimal paths of finite duration (Hahn and Matthews 1964).
A.1.5 Optimal Growth Theory

Optimal growth theory was initiated by Ramsey (1928) who aims to determine the optimal saving rates in the economy by using household optimisation techniques. Yet the economics profession did not widely use the Ramsey approach until the 1960s. During the 1950s and 1960s, the work by Malinvaud (1953) has raised the question about the efficient programme of accumulation in the capital and growth theory, which resurrect the original Ramsey questions of optimal saving rate\textsuperscript{182}. The optimal saving question is first applied on the Harrod-Domar growth models by Tinbergen (1956, 1960). With the emergence of the neoclassical Solow-Swan growth model where the exogenous rate of saving is a crucial parameter to determine the steady-state path, economists start to examine the optimal saving rate in the neoclassical growth model, and hence set out the

\textsuperscript{182} Recall the paper by Ramsey (1928) that is aimed to determine the optimal saving rate in order to show the sub-optimality of the equilibrium saving rate in the market, and thereby locating a source of market failure in the inter-temporal context stemming from Pigou's (1920) defective telescopic faculty – individuals will see future pleasures on a diminished scale, and therefore will display impatience by discounting future satisfaction at a positive rate, which thereby results in economic disharmony in a competitive market situation as individuals will tend to under-save (Chakravarty 1987; Pigou 1920; Ramsey 1928).

Ramsey developed the ingenious method of determining the optimal saving rate on the logic of inter-temporal utility maximisation and derived the characteristics of the optimal path. However, the economics profession did not widely use Ramsey's approach in the following three decades. The reasons are partly because of the Great Depression era where it was the excessive saving and a high propensity to save, not under-save, which posed problems. Besides, with the emergence of new welfare economics and the Paretian revival of ordinalism, the cardinal approach towards utility embedded in Ramsey's formulation of the problem becomes questionable in economists' eyes (Chakravarty 1987).

During the 1950s, attention was redirected to the question that Ramsey had posed. The result by Malinvaud (1953) shows the sub-optimality outcome in an infinite horizon has raised the question about the efficient programme of accumulation in the capital and growth theory, and thereby resurrected the original Ramsey questions of optimal saving rate. Besides, there are particular concerns with problems of development planning in relation to low income countries. The postwar popularity of national economic planning therefore raises the question of the optimal level of saving and investment central to Ramsey analysis. The von Neumann-Morgenstern axioms of expected utility hypothesis have made the cardinal approach towards utility more receptive in the intellectual environment. In the light of the above, there is a revived interest in the Ramsey model, and growth economists start to apply Ramsey's approach to the neoclassical growth theory (Chakravarty 1987; Malinvaud 1953).
‘Golden Rule’ of efficient economic growth\(^{183}\). The two-sector growth model derived by Uzawa (1964) and Srinivasan (1964) synthesises the question of intertemporal optimality into growth theory. With the construction of the inter-temporal social welfare function and its axiomatic foundations laid by Koopmans (1960)\(^{184}\), the optimal growth theory

\(^{183}\) In the Solow-Swan neoclassical growth model the steady-state path is exogenously determined by the saving rate, the population rate, the depreciation rate and the rate of technical progress. It is consumption inefficient in the sense that it does not maximise consumption per capita. Kahn (1959) suggests that one can make the model consumption efficient by finding the optimal saving rate that maximise the steady-state consumption per capita that is consistent with steady-state growth. Phelps (1961) terms the solution to this problem the ‘Golden Rule’ of growth. By maximising consumption per capita subject to the steady-state constraints of stationary capital-labour ratio, one can derive that the condition of the Golden Rule of efficient growth is when the steady-state capital-labour ratio is at the point where the marginal product of capital is equal to the natural growth rate (Kahn 1959; Phelps 2006; The History of Economic Thought Website 2006a).

The above analysis only sets the condition of the Golden Rule of growth, but does not derive the optimal saving rate that maximise consumption per capita and is consistent with steady-state. Besides, it is not clear whether the condition is socially optimal in the wider sense (i.e. whether it will maximise the social welfare in the society over time). The work of Cass (1965) and Koopmans (1965) complete the picture by synthesising the Solow-Swan growth model with the Ramsey (1928) dynamic optimisation technique of Inter-temporal Social Welfare analysis (Cass 1965; Koopmans 1965; The History of Economic Thought Website 2006a).

\(^{184}\) The construction of inter-temporal social welfare function is an integral part in the one-sector optimal growth model. Its axiomatic foundations give a formal support to impose time discounting to solve an inter-temporal optimisation programme, which allows economists to integrate the neoclassical Solow-Swan growth model with the Benthamite utilitarianism, thereby solving the optimal saving rate and formulating the golden rule of economic growth that maximise social welfare in the economy.

In the world of Benthamite utilitarianism, the social welfare function can be conceived as the sum of aggregate utilities of each generation, and the social optimum is the allocation of consumption bundles with an infinite horizon that maximises the social welfare function. The early economists such as Bohm-Bawerk (1886) and Fisher (1930) argue that discounting future utility is an irrationality and the line of Pigou (1920) and Ramsey (1928) reasons that there are no ethical justification for putting a utility discount factor in the social welfare function as utility and personal discounting is a subjective and ordinal measurement, yet the absence of time-preference implies incompleteness of the social preference ordering. Samuelson (1937) is the first to formulate the notion of utility discounting in the analysis, by putting the time discount factor in the social welfare function in a way that the sum of social utility should be weighted higher in the earlier generations than of the latter one to take into account of the behavioural postulate of human impatience. Two decades later, Koopmans (1960) laid the axiomatic foundation of inter-temporal social welfare function with discounting (Bohm-Bawerk 1889; Fisher 1930; Koopmans 1960; Pigou 1920; Ramsey 1928; Samuelson 1937; The History of Economic Thought Website 2006a).
finally brought in completion by Cass (1965) and Koopmans (1965), who has brought Ramsey's analysis of consumer optimization back into the neoclassical growth model and thereby provided for endogenous determination of saving rate and for a richer dynamics in their analysis, and the equilibrium can be supported by decentralized, competitive framework (Cass 1965; Koopmans 1960; Koopmans 1965; Malinvaud 1953; Ramsey 1928; Srinivasan 1964; The History of Economic Thought Website 2006a; Tinbergen 1960; Tinbergen 1956; Uzawa 1964).

A.1.5.1 The Cass-Koopmans Optimal Growth Model

Cass (1965) and Koopmans (1965) allow time preference in their model. The objective of the representative household is to maximise the inter-temporal stream of utility (which is a positive function of consumption per capita) over an infinite horizon subject to economic wide constraints\(^\text{185}\). The mathematical conclusion of the model shows that steady-state growth rate is equal to natural rate (i.e. population growth rate plus the rate of technological progress). The result is the same as the Solow-Swan model, apart from the fact that in the Cass-Koopmans optimising framework the growth rate does not depend on the exogenous parameters that describe the production function and preference parameters that characterise household attitude on consumption and saving. The steady state growth occurs where the marginal product of capital is equal to the effective discount rate\(^\text{186}\). This is the social optimal level where the household utility is being maximised. Besides, in the Cass-Koopmans optimising framework, inefficient oversaving cannot occur, although it could arise in the Solow-Swan model with an arbitrary, constant saving rate. The reason is that in the optimising framework, the impatience reflected in the effective discount rate makes it not worthwhile to sacrifice more of current consumption to reach the maximum consumption (golden rule) in the steady state (Barro and Sala-i-Martin 2004; Cass 1965; Koopmans 1965; The History of Economic Thought Website 2006a).

\(^{185}\) Economic-wide constraints include household budget constraint, the credit market constraint. And the Solow steady-state investment constraint

\(^{186}\) The effective discount rate picks up the rate of household impatience (time preference) and the effect from diminishing marginal utility of consumption due to assumed consumption growth at the rate of technical progress.
The model exhibits the saddle-path stability, where there are unique initial conditions to converge the system into equilibrium. The path to the equilibrium level starting from this unique initial condition is known as saddle path.

The Cass-Koopmans analysis therefore completes the basic neoclassical growth theory and has shown optimality in the long-run economic growth. Their model assumes that competitive firms rent capital and hire labour to product and sell output, and a fixed number of infinitely lived households supply labour, hold capital, consume and save. The equilibrium can be supported by a decentralised, competitive framework in which the productive factors are paid according to their marginal products. The model thus becomes a natural benchmark case for optimal growth (Barro and Sala-i-Martin 2004; Romer 2000).

A.1.5.2 Overlapping Generation Model

One of the problems of the Cass-Koopmans model is that it avoids all market imperfections and all issues raised by heterogeneous households and links among generations. Samuelson (1958) and Diamond (1965) originated another type of model that tackles the issue of heterogeneous and finite horizon households. Their models are known as the overlapping generation (OLG) model (Diamond 1965; Romer 2000; Samuelson 1958).

The central difference between the overlapping generation model and the Cass-Koopmans model is that there is a turnover of population\(^{187}\). The key assumption in the OLG model is that individuals have finite horizons in the sense that they do not care about their descendents. The mathematical conclusions of the model show that the steady-state always exists and is unique under the assumption of logarithmic utility and Cobb-Douglas production. The steady-state growth path are the same as those of the Solow and Cass-Koopmans framework – a constant saving rate and capital output ratio, and the output per work is growth at the natural rate. However, if the assumptions of the utility and production function are being relaxed, it will results in multiple equilibrium\(^{188}\), and

\(^{187}\) Instead of having a fixed number of infinitely lived households, new individuals are continually being born and old individuals is continuing dying. The most popular form of the OLG framework assumes that each individual lives for only two periods – work in the first period and retired in the second period.

\(^{188}\) A wide range of behaviours of the economy is possible. The economy can be in on a sustained growth path, or it may fall into the poverty trap, depending on initial condition.
sustained growth may not be possible or it may depend on initial condition (Barro and Sala-i-Martin 2004; Romer 2000).

Besides, the equilibrium in the OLG framework may not be dynamically efficient. As distinct from the Cass-Koopmans framework, oversaving can occur even though households choose saving optimally. It is because finite individuals born at different times attain different utility levels, and so the appropriate way to evaluate social welfare with an infinite horizon is not clear. The OLG model also shows that it is possible for a decentralised economy to accumulate capital beyond the golden-rule level and to produce an allocation that is Pareto inefficient. The results therefore spark an interest in examining whether dynamic efficiency occur in actual decentralised economies (Barro and Sala-i-Martin 2004; Romer 2000)

A.1.6 Monetary Growth Theory

The neoclassical theory of monetary growth studies the link between money and economic growth. In neoclassical theory, the analysis ignores the institutional aspects of monetary transmission mechanism and assumes money is distributed to economic units through transfer payments. Money performs the two functions of a consumer good and factor of production that contributes to the increase in the individual utility level, and the marginal products of real factor respectively. Money demand is assumed to depend on the market interest rate and income level. Aggregate demands for real capital and money are related to price level, where the equilibrium price is determined by the intersection of the money demand and supply function. Fisher interest parity states that nominal interest rate is equal to the real interest rate plus the expected rate of price increase (inflation). The stability of monetary growth in the neoclassical framework is therefore related to the expected future price. The steady-state growth of the monetary growth is dynamically stable provided the speed of adjustment in expectations is relative small. The following will survey the monetary growth model constructed by Tobin (1965) and Sidrauski (1966) that follow the lines of the Solow-Swan neoclassical model and the Cass-Koopmans optimising growth model respectively (Sidrauski 1966; Tobin 1965; Uzawa 1987).

The setup of the OLG framework assumes competitive market and the absence of externality, and therefore a decentralized economy. The possibility of the inefficiency of the decentralized economy stems from the fact that the infinity of generations gives the social planner a means of providing for the consumption of the old that is not available to the market, and thereby improving on the decentralized allocation.
A.1.6.1 Tobin Model

Tobin (1965) develops a portfolio allocation model to study the link between money and economic growth based on Solow’s neoclassical growth model. His result show that moderate inflation can lead to higher economic growth rates – a phenomenon commonly known as the ‘Tobin effect’ (Tobin 1965).

In the original Solow model, physical capital is the only form of wealth and all savings will translate into the accumulation of physical capital. In the Tobin model, money is treated as a durable asset yielding a stream of services to money-holders and is another form of wealth. Individuals will then choose between two assets, money and physical capital. The mathematical conclusion of the model show that the steady-state at a lower capital-labour ratio and lower output labour ratio with the presence of money, although the long-run economic growth rate will remain the same as in the case of Solow. If there is a rise of return on capital relative to money, they will increase the ratio of capital to money in their portfolios. The portfolio shift will increase capital accumulation. This effect will lead to a greater per capital income attained in the steady state, and a greater economic growth during the transition from a lower to a higher capital-labour ratio. Moderate inflation, which will lower the rate of return of money-holdings according to Fisher interest rate parity, will result in capital deepening and lead to higher short-run economic growth rate as the system moves towards its steady-state value. Money is therefore not neutral and will exert a real effect in the economy (Fry 1995; The History of Economic Thought Website 2006a; Tobin 1965).

A.1.6.2 Sidrauski Model

The Tobin model is being challenged on the basis that the model treats money solely as a store of wealth, but ignores the other functions such as the medium of transactions that yield utility to individual. Besides, the notion of non-neutrality of money is being questioned. Sidrauski (1966) attempts to construct a monetary growth model using the Cass-Koopmans optimising framework, which places money in the utility function and explicitly take long-run neutrality into the system but allows for short-run non-neutrality as the system moved towards its steady state values. According to the model, the objective of consumers is to maximise their inter-temporal utility that is a function of
Appendix: Brief History of Modern Growth Theory

consumption and money holding. The mathematical conclusion shows that steady-state growth rate is the same as those in the Cass-Koopmans model, and interest rate is independent of the monetary variables. The result therefore rejects the Tobin effect, because inflation in this case will not affect the real interest rate that determines optimal capital levels, thereby exerting no effect on capital accumulation. However in the short-run, as individuals will find balance between money and capital to maximise the inter-temporal utility, money is non-neutral during the process of adjustment towards the steady state (Sidrauski 1966; The History of Economic Thought Website 2006a).

A.2 Endogenous Growth Theory

The main conclusions of the neoclassical growth theory are that in the long-run steady state the economy grows at an exogenous natural growth rate, which is the summation of population growth rate plus the rate of technological progress, while in the long-run equilibrium it may or may not be a dynamic efficient subject to the different assumptions.

After the completion of the basic neoclassical growth model by the Cass-Koopmans analysis, growth theory becomes excessively technical and loses contact with empirical applications, and it died as an active research field by the early 70's, on the eve of rational expectation revolution and the oil shock. Macroeconomic research has focused on the understanding of the causes of short-term aggregate fluctuations in the 70's and 80's. After the mid-80's, research on economic growth experienced a boom owing to the recollection that the determinants of long-run economic growth are crucial issues, far more important than the mechanics of business cycles or the countercyclical effects of monetary and fiscal policies (Barro and Sala-i-Martin 2004).

The major innovation of the growth theory in the 80's is that there is a line of research that try to determine the long-run growth rate within the model, rather than treat the origin of long-run growth as exogenous as in the neoclassical growth theory. The new growth theory is named as 'endogenous growth theory'.

Romer (1994) summarises the origin of the endogenous growth in the following, 'The phrase “endogenous growth” embraces a diverse body of theoretical and empirical work that emerged in the 1980s. This work distinguishes itself from neoclassical growth by emphasizing that economic growth is an endogenous outcome of an economic system, not the result of forces that impinge from outside. For this reason, the theoretical work
does not invoke exogenous technological change to explain why income per capita has increased by an order of magnitude since the industrial revolution. The empirical work does not settle for measuring a growth accounting residual that grows at different rates in different countries. It tries instead to uncover the private and public sector choices that cause the rate of growth of the residual to vary across countries. As in neoclassical growth theory, the focus in endogenous growth is on the behaviour of the economy as a whole. (Romer 1994)

A.2.1 The weakness of neoclassical growth theory

The major weakness of the neoclassical growth model is that they are not able to explain sustained growth. Though the model provide a framework for studying short-run transition dynamics, they are not helpful for understanding the source of the long-run economic growth. It is because the long-term per capita growth rate was pegged by the rate of exogenous technological progress, which is determined outside the model and is independent of preferences, most aspects of the production function and policy behaviour. Besides, the conclusion of the theory could not explain the stylised facts that long-run growth rate is different across nations though it is able to explain the short-run differences (Barro and Sala-i-Martin 2004; McCallum 1996)

There are also other weaknesses for the neoclassical growth theory. The inconsistencies in the capital theory uncovered during the Cambridge Controversy challenge the idea that heterogeneous capital can be treated as a single capital good and thereby question the usage of the aggregate production function in the growth model. One way to tackle the Cambridge Controversy, as shown in the later, is by introducing human capital into the production function (The History of Economic Thought Website 2006a).

On the other hand, the optimal growth version of neoclassical theory begins to recede in the 70’s. The development of micro-foundation in macro-theory challenges the appeal to the notion of representative agents in constructing economic model, as the notion lacks microeconomic foundation and does not take into account the heterogeneity of individual household. Besides, the saddle-path dynamics of the optimal growth model has become excessively technical and inherently inapplicable to empirical world. There are no good economic reasons to suppose the economy would fail to converge to equilibrium and become unstable if its initial condition has deviated from the saddle path.
It is only until the rational expectation revolution does the saddle-path dynamics being rescued, as rational expectation is precisely the mechanism by which an economy would jump onto the saddle path if there are deviations from the path (The History of Economic Thought Website 2006a).

A.2.2 The precedence of endogenous growth theory: Arrow Learning-by-doing growth model

Young’s (1928) fundamental insight of the importance of the increasing returns as an explanation of economic progress was picked up by Arrow’s paper (1962) on learning-by-doing and further elaborated by Sheshinski (1967). Arrow (1962) originated dynamic models of growth driven by increasing returns by formulating an endogenous theory of changes in knowledge that underlie inter-temporal and international shifts in production function. Taking into account the generalisation that learning is the product of experience and learning with repetition is subject to diminishing return, he put forward the hypothesis that technical change can be ascribed to experience. In his model, the productivity of a firm is assumed to be an increasing function of cumulative aggregate investment for the industry. He argues that increasing return arises because learning take place and new knowledge is discovered through investment and production. Knowledge becomes a by-product of production, which in turns will result in increasing return to individual firms that are external in nature. Arrow’s model serves as a precedence for the Romer (1986) model on endogenous growth (Arrow 1962; Romer 1986; Sheshinski 1967; Young 1928).

Uzawa (1965) formulated a two-sector optimal growth model in which there is both intangible human capital and physical capital. Human capital in this sense resembles knowledge as in Arrow’s model. Uzawa’s model assumes constant return to scale with linear production of human capital, and does not possess any form of increasing returns. Private and social returns in this case depend only on the ratio of human and physical capital, the model yield a constant asymptotic growth rate. Uzawa’s model serve as a precedence for the Lucas (1988) model on endogenous growth (Lucas 1988; Romer 1986; Uzawa 1965).

190 The model does not take into account the effect of specialization and division of labour in the industry.
A.2.3 Scale Effect and Knowledge Accumulation in Growth Model - Romer (1986), Lucas (1988) and Rebelo (1991)

The initial wave of the new research on growth theory – Romer (1986), Lucas (1988), Rebelo (1991) – built on the work of Arrow (1962), Sheshinski (1967), and Uzawa (1965). Their way of construction of a theory of endogenous growth is to eliminate the long-run tendency for capital to experience diminishing return to the accumulation of capital by appealing to increasing or constant return to scale of production which results from the process of spill-over of knowledge across producers and external benefits from human capital accumulation. Their analysis does not introduce a theory of technological change. In these models, growth may go on indefinitely because the returns to investment in a broad class of capital goods, which includes human capital, do not diminish as economies develops (Barro and Sala-i-Martin 2004).

A.2.3.1 Endogenous growth models with increasing return to scale (Romer 1986)

The work of Romer (1986) represents the starting point of the endogenous growth literature. The foundation is based on the Ramsey-Cass-Koopmans optimisation framework and the Arrow learning-by-doing model, yet Romer originates a new line of thought. Assuming knowledge is a capital good with an increasing marginal product, his model is able to reconcile the opposing forces of increasing and diminishing returns and thereby generates sustained growth that is in consistent with competitive market equilibrium with many firms. The setup of the model is as follows:

- Goods are produced with a single capital – ‘knowledge’ capital, and each producer’s output depend on both his stock of capital as well as those of other firms.
- New knowledge is produced through a research technology with diminishing marginal productivity at individual level.
- Yet aggregation over producers, production in the economy as a whole is subject to increasing return. It is because investment in research has a positive external effect and will spill-over to other producers, because knowledge is public good in
nature and it cannot be kept completely secret;

- There are possibilities for the production of consumption goods that have increasing returns if the increasing marginal productivity of knowledge is sufficient to outweigh the decreasing marginal productivity associated with the physical capital.

The fundamental results of the model show that long-run growth is determined principally by the accumulation of individual knowledge, where knowledge in this case is determined within the model through the investment in research technology. Yet the competitive equilibrium is suboptimal because individuals cannot internalise the positive externality of knowledge that spills-over to other firms, thereby resulting in under-investment in research. A policy implication is that government intervention to subsidize research will result in Pareto improvement and higher growth (Lucas 2002; Mattalia 2000; Romer 1986).

The model allows economists to have a deeper understanding for income inequalities across the rich and poor countries. Rich countries have a higher level of knowledge capital that will foster faster accumulation through the increasing returns of aggregate capital stock, thereby resulting in higher growth compared than the poor country (Lucas 2002).

A.2.3.2 Endogenous growth models with constant returns to scale (Lucas 1988)

The next line of development comes from Lucas (1988), who make use of the Uzawa (1965) model to formulate a two-sector endogenous growth model in which there is both physical and human capital that are produced by different technologies. According to Lucas, the source of growth comes from human capital accumulation – i.e. the decision of the individuals to acquire knowledge and skill in order to modify the level of technology present in the economy. Similar to Romer’s (1986) work, Lucas appeals to the external effects of knowledge to characterise the source of technical change and hence economic growth. While the essence of the Romer (1986) model stresses the importance of increasing returns of knowledge, Lucas’s (1988) human capital model replaces Romer’s assumption of increasing returns with a kind of constant returns to counteract the effect of diminishing returns to the broad concept of capital. With the relaxation of the constraint of diminishing return, physical and human capital can grow at the same rate and their
return will remain constant at steady state. The setup of the model is as follows:

- Each worker with different skill levels devotes himself in part to production and in part to education to accumulate human capital;
- The human capital of each worker influences the labour force and production. The average level of human capital also contributes to the productivity of all factors through the external effect of human capital accumulation;
- The production function depends on physical capital, labour force, the fraction of time devoted to production, as well as the internal and external effect of human capital;
- The rate of change of human capital depends on the level already attained and on the fraction of time devoted to education with constant returns in the human capital accumulation.

The mathematical conclusion of the model shows that existence of balanced paths and competitive equilibrium, though the equilibrium is suboptimal, and the external effect is not needed to guarantee its existence as in Romer (1986) model. In the steady state there is growth of per capita quantities (physical capital, human capital and consumption) and hence of economic growth. Growth is endogenous as it is depends on the production of human capital and its external effect. The relative intensity in human capital to physical capital as input to production, which depends on the opportunity cost of human capital devoted to education, affects growth. If human capital is relatively abundant, growth rate tend to be higher. The balance path has the property that each country's relative income position is governed by its initial situation. Initial inequality across country persists, and poor country which has a low initial level of physical and human capital will permanently trap in a low-growth environment. (Barro and Sala-i-Martin 2004; Lucas 1988; Lucas 2002; Mattalia 2000; Romer 1986)

A.2.3.3 AK Model (Rebelo 1991)

A way to construct a theory of endogenous growth is to eliminate the long-run tendency for capital to experience diminishing returns. Rebelo (1991) formulates a simple one-capital model to allow output to grow in proportion to capital to generate endogenous growth. The model is known as the AK model, as the production technology is assumed to be linear and constant return, and is specified as AK in which A represents technology
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and K represents capital in a broad sense. The AK model assumes technology and labour to grow constantly and automatically in proportional to capital to counteract the effect of diminishing returns to the capital accumulation. By combining AK technology with optimising behaviour of household, the model generates endogenous growth and the outcomes are optimal as in the optimal growth model (Aghion and Howitt 1998; Barro and Sala-i-Martin 2004; Rebelo 1991).

Rebelo differs from the model proposed by Romer (1986) and Lucas (1988) in that it tries to explain the cross-country growth differences through the effects of economic policy, such as fiscal policy and income tax, on the growth of a nation. He strips the model down to its simple one-capital good AK model and removes the external effect. In this sense, the model becomes easier to analyse and still continues to be internally consistent. However, eliminating the need to appeal to external effects will remove the appeal to idea and knowledge accumulation as the engine of economic growth, as in the Romer and Lucas model (Lucas 2002; Mattalia 2000).

A.2.4 Endogenous Technical Change in Growth Model

The early endogenous growth model appeals to external effect or a linear production function to counteract the effect of diminishing returns to capital accumulation. However, these models do not introduce the theory of technological change into the framework. The incorporation of endogenous technical progress into the growth framework begins with Romer (1987, 1990), Aghion & Howitt (1992) and Grossman and Helpman (1991). According to these models, technological improvements stem from purposive research and development activities, and these activities are rewarded by some form of monopoly rent. Growth rates can remain positive in the long run if there are tendencies of continuous technological advances and innovation in the economy. However, the steady state in the case is not Pareto optimal, because of the nature of an imperfect competitive environment and of the distortions related to the creation of the new goods and methods of production (Aghion and Howitt 1992; Barro and Sala-i-Martin 2004; Grossman and Helpman 1991; Romer 1987; Romer 1990).
A.2.4.1 Horizontal Model of Product Development with Expanding Product Variety

A.2.4.1.1 Romer (1987) Model on Specialisation

Romer (1987) formalises Young’s idea (1928) that growth is sustained by the increase in specialisation of labour across an increasing variety of activities. According to his model, knowledge accumulation now is the result not of learning in externalities among individuals (as in Romer 1986), but of the continuous increase in the variety of inputs\textsuperscript{191}. There are three types of agents in the model, and the basic setup is as follows.

- Final Good Sector – It consists of a large number of perfectly competitive firms that hire labour and intermediate goods to produce final homogenous outputs, which is sold at unit price;
- Intermediate Good Sector – It consists of local monopolists who produce the intermediate capital goods that are sold to the final good sector. The equilibrium level of production is determined by zero-profit condition of free entry, where marginal revenue of producing is equal to marginal cost;
- Representative Households - Households maximise their utility subject to the budget constraint over an infinite horizon.

The mathematical conclusion of the model shows that in equilibrium the aggregate production functions exhibit increasing returns to scale for factor input. A key feature of the model is its introduction of monopolistic competition (monopoly rents) in the intermediate good sector, so that as the economy grows, the larger market make the monopolist worth paying the fixed cost of producing a large number of intermediate inputs and engage in specialisation, which in turn raises the productivity of labour and capital, thereby maintaining growth. Therefore, the model is able to yield the result that specialisation, ignoring the positive external effect of knowledge accumulation and spillover, can also lead to increasing returns and therefore long-term economic growth (Aghion and Howitt 1998; Romer 1987).

\textsuperscript{191} The models borrow the product variety theory originated from Dixit and Stiglitz (1977), in which there is a continuum of intermediate goods measured on the finite interval, where it is produced by a local monopolist. The final output is produced using labour and intermediate goods as inputs (Aghion and Howitt 1998; Dixit and Stiglitz 1977; Romer 1987).
A.2.4.1.2 Romer (1990) Model on Endogenous Technological Change

In the Romer (1987) model, the introduction of imperfect competition (monopoly rents) in the intermediate good sector allows the possibility for firms to be represented as engaging in deliberate research activities aimed at creating new knowledge, thereby being compensated with monopoly rents for a successful innovation. Romer (1990) further extends his previous model by assuming that in order to enter the immediate-good sector, the monopolist firm must pay a sunk cost of product development, which can be compensated with monopoly rent (i.e. the sector is monopolistic competitive). The monopoly rents come from the existence of fixed production costs of increasing returns in the intermediate-good sector. Accordingly, there are four types of agent in this model. The setup of the final good and the household sector are the same as in the Romer (1987) model, whereas the immediate good sectors are being modified as follow:

- **Intermediate Good Sector** – It consists of local monopolists who use the invention from the research sectors to produce the intermediate capital goods that are sold to the final good sector. These firms gain their monopoly power by purchasing the invention for a specific product from the research sector. Zero-profit condition of free entry applies.

- **Research Sector** – The research and development (R&D) firms devote resources to invent new products. Once a product has been invented, the innovating R&D firm obtains a perpetual patent from the government for the exclusive rights to produce the new product, which allows the firm to sell their goods at whatever price they chooses to maximise profit;

The mathematical conclusion shows that growth increases with the productivity of research activities and with the size of the economy as measured by total labour supply, and decreases with the rate of time preference. In order words, specialization and product differentiation, together with research spill-over generated by the production of idea and knowledge, will lead to increasing returns, thereby resulting in long-run economic growth. In the model, technological progress is thus endogenously determined by the expansion of the variety of intermediate goods used by producers, which in turn are being motivated by the prospect of monopoly profits to expend resources to discover new type of good
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(Aghion and Howitt 1998; Barro and Sala-i-Martin 2004; Jones 2002; Romer 1990).

Because intermediate firms do not internalise their contribution to product diversity through specialisation and division of labour, and because researchers do not internalise research spill-over, the outcomes in the decentralised economy of the Romer model is always less than the social optimum. A policy implication is that there are possibilities for Pareto improvement by means of tax and subsidy schemes (Aghion and Howitt 1998; Barro and Sala-i-Martin 2004).

A.2.4.2 Vertical Model: Schumpeterian Approach of Quality Ladders

A critical component of technological progress and growth stressed by Schumpeter in his work on creative destruction (1911) is the obsolescence of old products and techniques and displacement by a new innovative one. An important limitation of the above Romer’s horizontal approach to innovations and growth based on expanding product variety is that it does not take into account the obsolescence of old intermediate inputs. In order to formalise the notion of obsolescence, one needs to move away from horizontal models of product development into vertical models of quality improvements, so as to take into the account the ongoing refinements of products and techniques (Aghion and Howitt 1998; Barro and Sala-i-Martin 2004; Schumpeter 1911).

Aghion and Howitt (1992) and Grossman and Helpman (1991) formalise an endogenous growth theory that model a Schumpeterian idea of growth through quality improvements and creative destruction. Similar to the analysis of Romer, there are four types of agent in the model, namely the consumer, the final good producer, the intermediate-sector monopolist, and the research firms. The new line of thought comes from the premise that each type of intermediate good has a quality ladder along which improvements that can occur and only the leading edge quality is actually used in equilibrium. Through the competition among research firms that generate innovation and quality improvement of product, will result in technological progress and thereby long-run economic growth. Each innovation consists of a new intermediate good that is motivated by the prospect of monopoly rents which in turn can be captured when a successful innovation is patented. But these monopoly rents are only temporary in nature and will be destroyed by the next successful innovation, which will render obsolete the existing intermediate good. The mathematical conclusion of the model shows that growth
will increase when there are

- an increase in the size of the labour market, the size of innovation and the productivity of the research firm,
- a reduction of the interest rate and in the degree of market competition.

An implication of the process of creative destruction is that current innovations will exert a positive externality for future research and development, but a negative externality on the current incumbent producers. Besides, it will lead to a business stealing effect, where firms have an incentive to seek the monopoly rents of the incumbents. This may lead firms to perform more research than is socially optimal and result in the possibility of excessive growth rate in a decentralised economy (Aghion and Howitt 1992; Barro and Sala-i-Martin 2004; Grossman and Helpman 1991).

A.2.5 Summary of the early endogenous growth theory

The horizontal model of expanding product variety and the vertical model of quality ladder both examine the source of technological progress, whereas the former describe the basic innovation and the latter describes the ongoing refinements of products and techniques. The motivations for these purposive research and development activities stem from the reward of ex post monopoly power. These new lines of research, together with the initial wave of endogenous growth models that place emphasis on scale effect and knowledge accumulation, open a new way to understand growth, as the implication on these framework is that the long-term growth rate depends on governmental actions, such as taxation, maintenance of law and order, provision of infrastructure and services, protection of intellectual property rights, and regulations of international trade, financial markets, and other aspects of the economy. Economists are thus able to counteract the growth-destroying effect of diminishing return of capital accumulation in neoclassical growth models and move beyond its conclusion that long-run growth is solely determined by exogenous technological progress. The new intellectual development allows economists to formulate growth theories that are more application and better fit to the stylised facts in the modern world.
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