Committee Decisions and Monetary Policy

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Dedicated to the memory of my father, William Spencer, 1946-2004
Abstract

Economic theory typically assumes that monetary policy is set by a single policymaker. However, the reality of monetary policy decision-making is very different. Monetary Policy Committees (MPCs) are responsible for setting the short-term interest rate in most countries across the world, and up until very recently, economists paid little serious attention to this fact. In light of this finding, this thesis (i) addresses the current dissonance between the theory and reality of monetary policy decision making and (ii) assesses the empirical evidence on monetary policy committee voting, with emphasis on the voting behaviour of Bank of England MPC members. The thesis contains four core chapters.

In Chapter 3 I extend the game-theoretic literature on jury decision making to include the case of a monetary policy committee faced with making a binary choice under simple majority rule. I gauge the extent to which decision outcomes are a function of the amount of effort put into the decisions by individual members when paying attention is not costless. The game builds on Mukhopadhaya (2003), and is of the ‘contribution’ variety proposed by Rasmusen (2001).

In Chapter 4 I present a boundedly-rational model of how monetary policy committees are able to reach decisions on the interest-rate. I draw upon Morris DeGroot’s (1974) characterization of consensus formation in groups and DeMarzo, Vayanos and Zweibel’s (2003) notion of persuasion bias. Monetary policy committees are shown to reach agreement even when the views its members are initially diverse. The model potentially explains the stylised facts of how members of the United States Federal Open Market Committee, European Central Bank Governing Council and Bank of England Monetary Policy Committee reach a decision on the interest-rate.

Chapters 5 and 6 constitute empirical analyses of MPC voting behaviour, and investigate the voting behaviour of members of the Bank of England Monetary Policy Committee over the first five years of its being. This encompasses the entire spell for which the MPC was chaired by Sir Edward George. Using voting data obtained from Minutes of meetings, I show that as a group, internally appointed MPC members (insiders) on average prefer lower interest rates than external appointees (outsiders). Ordered logit analysis demonstrates that insiders and outsiders are motivated by different concerns when setting interest rates. Asymmetric policy preferences exist for the two groups. Insiders are found to dissent significantly less often than outsiders, with the majority of dissents cast by the former group being on the side of tightness. For outsiders, the reverse is shown to be true, with the majority of dissents being for looser policy.
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## Contents

I Introduction

1 Overview, Scope and Objectives .................................................. 2

II Literature .................................................................................. 7

2 Review of the Literature ................................................................. 8

2.1 Preliminary Concepts ................................................................. 12

2.1.1 What is a Monetary Policy Committee? ................................. 12

2.1.2 Simple and Absolute Majority Voting (SMV) ....................... 14

2.2 Surveys of Monetary Policy Committees ..................................... 15

2.2.1 The Near Ubiquity of Monetary Policy Committees .................. 15

2.2.2 Not all Monetary Policy Committees are the Same ................. 15

2.3 Theory Based Literature .......................................................... 21

2.3.1 Non-Strategic Literature ...................................................... 21

2.3.2 Consensus Formation and Markovian Updating ..................... 25

2.4 Monetary Policy Formulation by Members of a Committee .......... 31

2.4.1 Extensions to the Monetary Policy Games Literature ............. 33

2.4.2 Alternative Approaches to Decision Making by a Monetary Policy Committee ................................................................. 34

2.5 Jury Games Literature ............................................................... 36

2.6 Evidence Based Literature ......................................................... 42

2.6.1 Studies of Bank of England MPC voting behaviour ............... 42

2.6.2 Studies of other Monetary Policy Committees ....................... 42

2.7 Experimental Literature ............................................................ 45

2.8 Conclusions .............................................................................. 46
III Monetary Policy and Theories of Committee Voting Behaviour

3 Monetary Policy Committees and the Free-Rider Problem

3.1 Introduction ........................................... 52
3.2 Play Under a Perfect Signal ............................ 57
  3.2.1 Asymmetric and Symmetric Pure-Strategy Nash Equilibria 58
  3.2.2 Symmetric Mixed-Strategy Equilibrium ................... 59
3.3 Play Under an Imperfect Signal ....................... 63
  3.3.1 Sequence of Play ................................... 63
  3.3.2 Asymmetric Pure-Strategy Nash Equilibria ............ 63
  3.3.3 Symmetric Pure-Strategy Nash Equilibria ............. 68
  3.3.4 Symmetric Mixed-Strategy Nash Equilibrium .......... 69
  3.3.5 Asymmetric Mixed-Strategy Nash Equilibria .......... 73
  3.3.6 Choice of Symmetric or Asymmetric Equilibria ...... 76
  3.3.7 Social Efficiency .................................. 77
3.4 Conclusions ........................................... 77
3.A Appendix to Chapter 3 ................................ 82
  3.A.1 Lemma 1: For an odd sized MPC \( B(k, q) = \frac{1}{2} b(k-1, q); \) for an even sized MPC \( B(k, q) = 0 \) ........................................... 82

4 Consensus Formation in Monetary Policy Committees 87

4.1 Introduction ........................................... 87
4.2 Some Stylised Facts of MPC Voting ................... 89
  4.2.1 Autocratically-Collegial MPCs ....................... 90
  4.2.2 Genuinely-Collegial MPCs .......................... 90
  4.2.3 Individualistic MPCs ................................ 91
4.3 The Model ............................................. 92
  4.3.1 Interest-Rate Preferences .......................... 93
  4.3.2 Informational Criterion .............................. 94
  4.3.3 Graph Theoretic Representation of Direct and Indirect Influence .......................... 97
4.4 Diverse Interest-Rate Preferences ................... 98
  4.4.1 Weighting the Opinions of MPC Members ............ 100
  4.4.2 Allocating Weights to Members' Opinions ......... 100
4.5 Unanimous versus Majority Consensus ................ 104
V Concluding Remarks and Bibliography 214
7 Concluding Remarks 215
Bibliography 219
Part I

Introduction
Chapter 1

Overview, Scope and Objectives

This thesis endeavours to coherently analyse aspects of the formulation of monetary policy by committee, a research agenda with motivations which are straightforward enough. Monetary Policy Committees (MPCs) are responsible for the formulation of monetary policy in most countries across the world, a phenomenon which has up until very recently been neglected at the groves of Academe.\(^1\) Although great advances have been made in developing the policy rules based literature [see Taylor (1999) and Woodford (2003)], understanding the relationship between the independence of a monetary institution and macroeconomic performance [see Grilli et al (1991), Alesina and Summers (1993) and Cukierman (2002)] and developing models of credibility [see Barro and Gordon (1983a, b), Rogoff (1985) and Walsh (1987)] little energy has been devoted to comprehending the role of committees in formulating monetary policy. The credibility literature serves to reinforce this point. Although the emergence of such literature over the past three decades has revolutionised the way economists think about monetary policy - consider how since the publication of highly influential papers by Kydland and Prescott (1978) and Barro and Gordon (1983a, b) the notion of time-consistent monetary policy has rooted itself firmly in modern macroeconomic discourse - overlooked in these contributions is the reality that policy is often determined by a committee, and not a single individual. Barro and Gordon (1983a, b), for instance refer to the monetary authorities as ‘the policymaker’, a title whose singular form epitomises the implicit assumption of monetary policy being under the aegis of a unitary agent.

Fortunately, the institution of committees as devices for setting monetary policy is feature of central banks which has not escaped the attention of all econo-

mists. Professor Alan Blinder, an academic economist and once Vice-Chairman
of the Board of Governors of the United States Federal Reserve Board explicitly
recognized this when delivering the 1996 Robbins Lectures at the London School
of Economics,\textsuperscript{2} asserting that

"...the theoretical fiction that monetary policy is made by a single indi-
vidual maximizing a well-defined preference function misses something
important."\textsuperscript{3}

His recommendations with respect to this theoretical deficit were clear-cut:

"...monetary theorists should start paying some attention to the nature
of decision making by committee, which is rarely mentioned in the academic
literature."\textsuperscript{4} (emphasis added)

By paying some attention to the nature of decision making by committee, this the-
esis addresses the current dissonance between the theory and reality of monetary
policy decision making.

Two chapters of this thesis pick up the 'theoretical gauntlet' thrown down by
Blinder. In Chapter 3 I build on recent work in the political economy arena on
jury decision making (see for example Austen-Smith and Banks (1996), Feddersen
and Pesendorfer (1998) and Mukhopadhaya (2003)). Much of this work has a ba-
sis in Condorcet's Jury Theorem\textsuperscript{5} (CJT hereafter). CJT asserts that when faced
with choosing between two mutually exclusive alternatives under simple majority
rule, a group of individuals is more likely to make a better decision than a solitary
individual. However, CJT has a far broader scope than its name suggests, and
its application to jury trial outcomes is but one area of decision making where the
theory may be applied. This is despite most of the recent literature focusing on
outcomes in a judicial setting.\textsuperscript{6} I extend the game-theoretic literature on jury
decision making to include the case of a monetary policy committee faced with
making a binary choice under simple majority rule. I gauge the extent to which
decision outcomes are a function of the amount of effort put into the decisions by
individual members when paying attention is not costless. The game builds on

\textsuperscript{2}These lectures are now published as the monograph \textit{Central Banking in Theory and Practice}
\textsuperscript{3}Blinder (1998), p.22.
\textsuperscript{4}Ibid.
\textsuperscript{5}As distinct from Condorcet's \textit{paradox of voting}.
\textsuperscript{6}In this sense, the adjective \textit{jury} is a misnomer.
Mukhopadhaya (2003), and is of the ‘contribution’ variety proposed by Rasmusen (2001).

In contrast to Chapter 3, in Chapter 4 I present a **boundedly rational** model of how monetary policy committees are able to reach decisions on the interest-rate. I draw upon Morris DeGroot’s (1974) characterization of consensus formation in groups and DeMarzo, Vayanos and Zweibel’s (2003) notion of persuasion bias. Implicit to both approaches is the use of Markov chains to model how members of a group or committee are able to reach a consensus. I demonstrate how members of a monetary policy committee are able to reach agreement even when the views of members are initially diverse. The model potentially explains the stylised facts of how members of the United States Federal Open Market Committee, European Central Bank Governing Council and Bank of England Monetary Policy Committee reach a decision on the interest-rate. Central to my rationalization of how members of a monetary policy committee reach an agreement is the suggestion that some members pay more attention to - and effectively *weight* - the opinions of some individuals more than others in course of MPC deliberations. Most pertinently, my approach gives prominence to the role of consensus formation in MPC decision making: this is because many monetary policy committees arrive at a decision through reaching a *consensus*, and not through taking a formal vote. However, the model can still be used to make sense of instances where decisions are made through a formal vote.

However, during the course of my research I have deliberately tried to strike a balance between the *theory* and *practice* of monetary policy - accordingly, not all of this thesis is of theoretical bent, and one would be far from correct to infer that the lack of theoretical underpinnings for monetary policy formulation by committee is matched by an equally poor showing of empirical studies of the phenomenon. The last two chapters therefore constitute empirical analyses of MPC voting behaviour. There exists a considerable body of work which ventures to ascertain the determinants of voting behaviour of the United States Federal Open Market Committee (FOMC). This literature is typified by the use of the FOMC voting record to (i) estimate members’ reaction functions and (ii) test for partisanship between different types of members. The *reaction function literature* usually involves the estimation of anything from Taylor-style rules [Taylor (1993)] to more broadly specified reaction functions for FOMC members using limited dependent variable analysis. The *partisanship literature* attempts to measure the influence
of members' backgrounds and career characteristics on voting behaviour.\(^7\) Again, this second strand of empirical enquiry relies heavily on limited dependent variable analysis.\(^8\) Common to all of this literature is the notion that a member's type - in the case of the FOMC Board member or Bank President - is a significant determinant of voting behaviour. For this reason it is commonplace for most empirical studies of FOMC behaviour to test for differences in the policy preferences of these groups.

Despite the substantial body of FOMC studies, literature examining the voting behaviour of monetary policy committees other than the FOMC is somewhat less common. The dearth of studies is on the one hand attributable to the fact that even when voting takes place, votes are simply not published: many central banks simply lack transparency in this area. On the other hand, where the voting record is in the public domain - as is the practice with the Monetary Policy Committees of the Bank of England and Bank of Japan respectively - the period for which voting data is available has previously contained too few observations to warrant any meaningful analysis, especially in the econometric sense of the word.\(^9\) The absence of 'non-FOMC' studies is an issue directly addressed in this thesis. Enough data now exists to facilitate a meaningful study of the voting behaviour of the Bank of England's Monetary Policy Committee (BoEMPC), a body given operational responsibility for setting interest rates to meet a Government inflation target of 2.5% RPIX inflation.\(^10\) Accordingly, Chapters 5 and 6 investigate the voting behaviour of MPC members over the first five years of its being. This encompasses the entire spell for which the BoEMPC was chaired by Sir Edward George,\(^11\) namely the period June 10\(^{th}\) 1997 - 6\(^{th}\) June 2003. In all, this amounts to 74 meetings,\(^12\) a period over which MPC members cast 642 votes.

\(^7\)The distinction between the reaction function literature and partisanship literature is made by Meade and Sheets (2002). The current author believes this to be a sensible way of classifying the different approaches.

\(^8\)Logit and probit analysis of the binary, multinomial and ordered variety are most commonly used.

\(^9\)For some monetary institutions, committees were only granted responsibility for setting interest rates relatively recently. In the case of the Bank of England the MPC was established in 1997. Monetary policy came under the aegis of a committee in Japan in 1998.

\(^10\)This target was changed to 2% CPI inflation in January 2004 by the Chancellor of the Exchequer, Gordon Brown MP.

\(^11\)During this period, Sir Edward George also presided as Governor of the Bank of England. In July 2003 Sir Edward George was replaced by Mervyn King as both Governor of the Bank and chairman of the MPC.

\(^12\)Also included are votes cast in the special MPC meeting held on September 18th 2001, which followed the terrorist attacks on the World Trade Centre.
Using voting data obtained from Minutes of meetings, I show that as a group, internally appointed MPC members (insiders) on average prefer lower interest rates than external appointees (outsiders). Amongst other things, ordered logit analysis demonstrates that insiders and outsiders are motivated by different concerns when setting interest rates. Insiders are found to dissent significantly less often than outsiders, with the majority of dissents cast by the former group being on the side of tightness. For outsiders, the reverse is shown to be true, with the majority of dissents being for looser policy.
Part II

Literature
Chapter 2

Review of the Literature

It is only up until very recently that economists began paying serious attention to monetary policy decision making by committees. As stated in the introduction, the number of studies devoted to examining monetary policy formulation by committees is meagre compared to the literature on policy rules, time-consistency and central bank independence. Accordingly, this literature review reflects the reality that the study of MPCs is in its infancy. It assumes an eclectic character, considering literature which is not geared specifically towards monetary policy committees. Indeed, the study of how groups reach decisions and how best to aggregate collective preferences is a research enterprise which has received much coverage in the social and collective choice literature. As a monetary policy committee is an example of a group - albeit one charged with making a collective decision on the interest-rate - it is arguably necessary to make reference to such literature during the course of this review.

From a historical perspective, the study of how groups make decisions can be traced back as far the Marquis de Condorcet’s (1785) Essai sur l’application de l’analyse à la probabilité des décisions rendues par des personnes de sens contraire or Essay on the Application of Analysis to the Probability of Majority Decisions. This work is probably best known for the paradox of voting, which has received much coverage in the social choice literature, and demonstrates how collective preferences can be intransitive (or cyclic) even when individual voter preferences are not. To illustrate the voting paradox, suppose that the government decides to delegate monetary policy to a group of three people, a, b and c, who must collectively set the interest-rate. Assume that each member may choose from three policy alternatives: the interest-rate may either be increased (I), decreased (D) or left unchanged (U), relative to its level in the previous period. The first step involves
each member ordinally ranking their policy preferences over the three alternatives, as depicted in Figure A. For example, consider member b who prefers no change (U) to a decrease (D) in interest rates, which is in turn preferred to an increase (I). More formally this ordering can be expressed as $U \succ D \succ I$, where “$\succ$” means strongly preferred to. Now define the group policy choice as the alternative which beats all others in a series of pairwise majority votes. Looking to Figure A, it is evident that a majority of members - a and c - prefer an increase (I) in the interest-rate to no change (U). Further, no change (U) is preferred to a decrease (D) by a majority of members, a and b. Finally, a majority of members, b and c, prefer a decrease (D) to an increase (I). This entails that the group preference is captured by the ordering $I \succ U \succ D \succ I$, which is clearly intransitive: $I \succ D$ and $D \succ I$ cannot hold simultaneously. Thus in this example, setting the interest-rate is characterised by the absence of an alternative which defeats all others in a pairwise competition. Such ‘failure to identify a Condorcet winner leads straight to the heart of problems of social choice,’ or in context of this example, failure to determine the interest-rate. Further work has been done in this general area. DeMeyer and Plott (1970) and Riker (1982) show that when individual preferences are strongly ordered the probability of there being no Condorcet winner is an increasing function of group size and the number of alternatives under consideration. This implies that when groups are large, or faced with many choices, it is much more difficult to reach a decision. According to Shepsle and Bonchek (1997), for a group of n members faced with choosing between m alternatives,

"...we cannot rely on the method of majority rule to produce...[in a transitive sense] what the group "wants," especially if there are no institutional mechanisms for keeping participation restricted (thereby keeping n small)"
or weeding out some of the alternatives (thereby keeping \( m \) small).”

This point can be related to the composition of monetary policy committees. In a monetary policy committee, \( n \) and \( m \) are typically small - the Bank of England’s MPC has 9 members, as does its counterpart at the Bank of Japan. The US FOMC has 12 voting members and the ECB Governing Council 18 members, although this is anticipated to increase as a result of EU enlargement. Further, the number of alternatives to choose from is somewhat restricted due to the nature of the decision. Qualitatively speaking, members have three choices: to tighten, loosen, or leave interest rates unchanged. Taken together, this might imply that the probability of MPC reaching an impasse is very small. Yet once we allow for weak preference orderings, the probability of no Condorcet winner arising turns out to be a decreasing function of group size. Jones et al (1995) find that for a three member committee faced with choosing between three alternatives, the probability of no Condorcet winner arising is 0.336 as opposed to 0.056 when only strong preference orderings are permitted. Perhaps most famously, Arrow’s (1951) celebrated ‘impossibility’ theorem can be viewed as a generalization of the voting paradox.

Yet the applicability of these results to monetary policy making should be treated with caution. Although monetary policy committees reach decisions by majority rule, the choice of interest-rate is not determined by choosing the alternative which defeats all other interest rates in pairwise competition. In this sense, the paradox of voting might be construed as at best a useful theoretical device for examining how monetary policy committees reach a decision. I therefore do not pursue the voting paradox further in the course of this thesis, despite its undeniable impact on the theory of social choice.

However, in addition to discovering the paradox of voting, Condorcet also developed what is now known as Condorcet’s Jury Theorem (CJT hereafter), which argues that under certain conditions, the institution of majority rule produces socially superior outcomes to those made by any individual in isolation. CJT owes its ‘rediscovery’ in the modern era to Black (1957).
Austen-Smith and Banks (1996), Feddersen and Pesendorfer (1998)) which apply techniques from game-theory that subsequently undermine some of the core assumptions underpinning Condorcet's result. Perhaps more pertinently the game-theoretic contributions that follows Condorcet's seminal analysis 'makes a strong case for decision making in committees,' to quote Gerling et al (2003). Such findings presumably have implications for the study of monetary policy, given the near ubiquity of MPCs as vehicles for setting interest rates. CJT therefore forms the basis of the model developed in the next chapter.

For clarity of exposition, the review is partitioned into four broad sections. In Preliminary Concepts, I turn to the social choice literature [Black (1958) and Riker and Ordeshook (1973)] to provide a definition of (i) what a committee is and (ii) simple majority voting, the latter being the mechanism by which many MPCs reach a decision. In Surveys of Monetary Policy Committees the findings of three surveys of monetary policy frameworks are reviewed, namely Courtis and Weller (2001), Fry et al (2002) and Schmidt-Hebbel (2003). These studies shed light on the scope and diversity of MPCs across the world regarding their size, the method by which decisions are arrived at, voting rights and member composition. Theory Based Literature pulls together theoretical contributions which include extensions to the monetary policy games literature [Sibert (2003)] and other models geared specifically towards how MPCs make decisions [Cothren (1988), Waller (2000) and Gerlach-Kristen (2004)], the jury games literature [Austen-Smith and Banks (1996), Feddersen and Pesendorfer (1998), Wit (1998) and Mukhopadhyaya (2003)] and other more general theoretical approaches to modelling how committees and groups are able to reach an agreement. In Empirical Based Literature studies of MPC voting behaviour [Belden (1989), Havrilesky and Schweitzer (1990), Tootell (1991a, b), Gildea (1990), Meade and Sheets (2002) and Gerlach-Kristen (2004)] are analysed, particularly those which examine the voting behaviour of members of the United States Federal Open Market Committee (FOMC). I now turn attention to defining some preliminary concepts which are employed throughout the thesis.

\footnote{Gerling et al (2003), p.41.}
2.1 Preliminary Concepts

2.1.1 What is a Monetary Policy Committee?

In 'The Theory of Committees and Elections', Duncan Black (1957), a pioneer of formal political theory defines a *committee* as follows:

**Definition 1:** A committee: 'Any group of people who arrive at a decision by means of voting. The job of...[a] committee is to choose either a motion or a candidate.'

Here, *motion* is taken to mean the following:

**Definition 2:** A motion: 'Any proposal before a committee which it may adopt or reject by a method of voting.'

The focus of this thesis is with committees whose sole task is to set monetary policy. In practice Monetary Policy Committees (MPCs) are faced with a reaching a decision on the short-term interest-rate. Where formal votes are taken, the *motion* tabled before an MPC typically pertains to the choice of an appropriate interest-rate for the economy. As an example, consider the motion tabled before the Bank of England Monetary Policy Committee in August 2002. During the meeting, the Governor of the Bank and Chairman of the MPC

"...invited [MPC] members to vote on the proposition that the Bank's repo-rate should be maintained at 4%.""}

The committee then voted *unanimously* in favour of the proposition. As all members were in favour of leaving repo-rate unchanged the motion tabled by the Governor was passed, and UK interest rates were left at 4%.

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6 Other prominent contributions are Riker and Ordeshook (1973), Arrow (1963), Mueller (1989), Plott (1967) and McKelvey (1967).
8 Ibid., p.2.
9 The Bank of England MPC, for example, have the task of setting the rate on repurchase agreements, more commonly referred to as the repo rate.
10 Minutes of Monetary Policy Committee Meeting, August 2002, paragraph 28.
11 The vote on the interest-rate is typically not unanimous.
Yet Black’s general characterization of a committee - implicit to which *formal* voting takes place - is too restrictive to encompass the way in which decision is arrived at for some MPCs. Precluded in much social choice literature is the possibility of groups arriving at a decision thought reaching a *consensus*, a decision mechanism used by a sizable number of MPCs. This is because social choice and formal political theory is geared toward *electorates* and situations where a formal voting mechanism is in place. Consider the formulation of monetary policy by members of the *Governing Council* of the European Central Bank, in which it is claimed no formal vote is taken; rather, all members reach a consensus;\textsuperscript{12} with members’ opinions reportedly converging on a single interest-rate.\textsuperscript{13,14} This assertion has a basis in numerous answers provided by the first President of the ECB, Wim Duisenberg, to questions fielded at the routine ECB press conferences which follow monetary policy decisions made by the Governing Council. Remarks made on February 3\textsuperscript{rd} 2000 reflect this:

"First, there was no formal vote. Again....it was a consensus decision."

*(emphasis added)*

In light of this, it is more apposite to define a monetary policy committee as follows:

**Definition 3: A Monetary Policy Committee (MPC):** ‘Any group of people to whom monetary policy is delegated who arrive at a decision on the short term interest-rate by means of voting or consensus. The job of a monetary policy committee (MPC) is to choose the short-term interest-rate.’

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\textsuperscript{12}I thank Nick Vidalis and Marco Catensaro at the ECB for helpful discussions relating to this matter.  
\textsuperscript{13}This is in spite of ECB statutes stating that decisions taken by the GC on the short term interest rate are to be taken using the mechanism of simple majority rule. Simple majority rule is outlined in **Definition 4.**  
\textsuperscript{14}In light of this, Riker and Ordeshook (1973) might be seen as providing the archetypal definition of a committee decision, namely;

"(1) a solicitation by the chairman of individual members’ opinions and preferences, and (2) an announcement by the chairman of that alternative which, on the basis of some generally approved rule of decision, he has picked out to be the choice of the collectivity. One can describe an abstract committee in which a motion is formulated by some member; the other members carry through private calculations to determine whether or not they wish this motion to be the social choice; they vote yes if their calculations lead them to favour the motion, otherwise they vote no; and finally, the chairman uses some rule of decision which combines the individual yeas and nays to decide whether or not the motion is to be the social choice." (Riker, W. H. and Ordeshook, P. C. (1973): *An Introduction to Positive Political Theory*, Prentice Hall: New Jersey, pp.79-81)
Having defined what an MPC is, I now turn to a closer examination of the decision rules typically employed by monetary policy committees. For many central banks where monetary policy is delegated to a committee, *simple majority voting* is the statutorily prescribed decision mechanism of choice. This is certainly the case with the BoEMPC - a simple majority of votes supporting a repo-rate of 4% would have been sufficient for the Chairman's motion to be passed.\(^\text{15}\)

### 2.1.2 Simple and Absolute Majority Voting (SMV)

SMV is a straightforward form of voting whereby the alternative with a simple majority of votes wins. It is defined as follows:

**Definition 4: Simple Majority Voting:** A system of voting where for a motion to be passed requires at least half of the members of the committee to cast votes in favour of it. For an \(m\) member committee, at least \(\frac{m+1}{2}\) members (odd \(m\)) or \(\frac{m}{2} + 1\) members (even \(m\)) must support a motion for it to be passed. For even \(m\), in the even of a tie, the chairman has the casting vote.

Noted here is the distinction between *simple* majority voting (SMV) and *absolute* majority voting (AMV). The latter treats abstentions as votes *against* a motion, whereas SMV treats abstentions as non-votes. Specifically, define *absolute* majority voting as follows.

**Definition 5: Absolute Majority Voting:** A system of voting where for a motion to be passed requires at least half of all committee members to cast votes in favour of it. Any uncast votes are classified as votes *against* a motion. For an \(m\) member committee, at least \(\frac{m+1}{2}\) members (odd \(m\)) or \(\frac{m}{2} + 1\) members (even \(m\)) must support a motion for it to be passed. For even \(m\), in the even of a tie, the chairman has the casting vote.

Should all members of an MPC not be present at a given meeting, much central banking legislation also stipulates that a *quorum* of members is required for a

\(^{15}\) Similar rules apply to court cases. In some US states such as California, jurors must be unanimous in their verdict that a defendant is innocent or guilty in criminal cases - for example, when an individual is charged with felony and misdemeanor. Failure to reach a unanimous decision results in a "hung" jury, with the case being dismissed. The prosecutor is then free to take the case to court again if he or she holds the view that a retrial will result in a conviction. However, civil cases require a majority verdict, and as long as three-quarters of the jurors are in agreement with each other a verdict can be reached. This is equivalent to a 'qualified' majority.
decision to be taken. Assuming that enough members are present to meet the fulfillments of the quorum, a *simple majority* is then required for a motion to be passed. However, where theory is developed in this thesis, it is assumed that (i) all members of a monetary policy are present, and (ii) abstentions are not permitted. Further, to the best knowledge of the author, no member of an MPC has ever *abstained* from voting. In the context of this thesis the difference between SMV and AMV is thus rendered immaterial.\(^\text{16}\)

### 2.2 Surveys of Monetary Policy Committees

Presented in this section are the results of three surveys of monetary policy frameworks, notably Courtis and Weller (2000), Fry *et al* (2000) and Schmidt-Hebbel (2002). This literature reveals the scope and diversity of MPCs across the world with respect to their size, the method by which decisions are arrived at, voting rights and member suffrage, and their composition.

#### 2.2.1 The Near Ubiquity of Monetary Policy Committees

In a survey of 69 central banks, Courtis and Weller (2000) find that monetary policy decisions are dominated by committees. Only four central banks are found to delegate monetary policy to a single central banker, namely Israel, New Zealand, Oman and Qatar. It is worth noting the diverse nature of the countries in the sample. Included are countries from the richest industrialized nations (United States, United Kingdom, Japan) to some of the poorest developing nations (Sri Lanka, Sierra Leone, Botswana). Further, the institution of committee cuts across different political systems. States which might be classified as dictatorships and one party systems (Pakistan, China, Kazakhstan, Libya), sultanates or entities ruled by a single royal house or family (Jordan, Kuwait, Bhutan) and liberal western style democracies (United States, UK, Denmark, Australia, Japan, Poland) all delegate monetary policy to committees of one form or another. Monetary policy committees then virtually constitute the rule and not the exception.

#### 2.2.2 Not all Monetary Policy Committees are the Same

Courtis and Weller report considerable variation in the size of MPCs. *Figure* 2.1 and *Figure* 2.2 reveal the extent of this variability. In *Figure* 2.1 the

\(^{16}\text{For a synthesis of the differences between absolute and simple majority voting, the reader is referred to Dougherty and Edward (2002).}\)
Size of MPCs: A cross-country comparison

largest MPC is shown to be the *Governing Council* of the European Central Bank, comprising 18 members; the smallest is the Sri Lankan Monetary Board, which contains three members. **Figure 2.2** shows the size distribution of MPCs. Most committees (41) contain between 6-10 members, with a corresponding median and mean committee size of 7 and 7.4 members respectively. Yet MPCs exhibit considerable heterogeneity according to other criteria. Fry *et al.* (2000) report that of 79 countries where monetary policy is delegated to a committee, the majority of committees make decisions through respective members reaching a *consensus*, as distinct from through the application of a formal voting procedure such as SMV. Specifically, 43 committees arrived at an agreement through consensus, whereas 36 applied a formal voting procedure. Further, out of those countries where decisions are determined by a formal voting procedure, only six publish the *individual* voting patterns of its members.\(^\text{17}\)^\(^\text{19}\)

\(^{17}\)Consider the distinction between the European Central Bank Governing Council and the Bank of England MPC.

\(^{18}\)In addition to the UK, these countries are Japan, Korea, Poland, Sweden and the United States. Other countries, such as the Czech Republic publish voting patterns, but individual members are not identified.

\(^{19}\)To understand how MPCs function it is also fruitful to examine central bank statutes. Some previous empirical studies have used central bank statutes to gauge the degree of independence enjoyed by a monetary institution and associated macroeconomic benefits (see Grilli *et al.* (1991), Alesina and Summers (1993) and Cukierman (2002)). A recurring finding is that countries with a higher degree of central bank independence enjoy *ceteris paribus* lower inflation with no cost to output growth. Yet statutes are also useful in so far as they reveal the precise nature and *modus operandi* of a monetary policy committees. A cursory glance at statutes from different central banks indicates that committees differ in terms of size, member composition, method of appointments and the voting rights afforded to different member types. Accordingly, one
The *internalness* and *externalness* of MPC members is also a consideration that should be borne in mind when examining monetary policy committees. The nine-member Monetary Policy Committee of the Bank of England comprises five members employed from the ranks of its staff - often referred to as *insiders* - and four experts from outside the bank more popularly known as *outsiders*, appointed by the Chancellor of the Exchequer. In relation to this point, the BoE MPC is not unique in so far as it contains external members. Schmidt-Hebbel (2002), in a survey of 18 monetary policy committees found that five countries - Australia, Hungary, Poland, South Korea and the UK - contain external members, or *outsiders*. Full results of the survey are reproduced in Table 2.1. For example, in the case of the nine-member Reserve Bank Board (RBB) of the Reserve Bank of Australia, *outsiders* comprise the majority of RBB members: six out of the nine individuals serving on the RBB are external members chosen by Treasurer. The remaining three *ex-officio* members are the Governor and the Deputy Governor - who hold positions of Chairman and Deputy Chairman of the RBB respectively - and the Secretary to the Department of the Treasury.\(^20\)

Suffrage is also restricted in some MPCs: not all members are afforded the same voting rights. The 19-member strong US Federal Open Market Committee (FOMC) practices a system of *rotation*: voting is restricted to twelve members, even though all 19 members actively participate in FOMC meetings. Seven members - namely members of the Federal Reserve Board - are granted permanent voting rights. The remaining five votes are allocated to the twelve Federal Reserve Bank Presidents. The president of the Federal Reserve Bank of New York is granted a permanent voting right due to the significance of New York as a world financial centre. The remaining four votes rotate amongst the presidents of the eleven residual banks on one-yearly terms. The precise structure of the FOMC is stylised in Figure 2.3 (overleaf). The system of rotation employed by the FOMC shares much in common with that adopted by the European Central Bank Gov-

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20 The *Secretary to the Department of the Treasury* is a senior civil servant, not to be confused with the *Treasurer*. The Treasurer is typically an elected member of the Australian government who holds a position equivalent to the post of Chancellor of the Exchequer in the UK, or Minister for Finance in other countries.
<table>
<thead>
<tr>
<th>Country</th>
<th>Number of members</th>
<th>Outside members?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>9</td>
<td>Yes</td>
</tr>
<tr>
<td>Brazil</td>
<td>8</td>
<td>No</td>
</tr>
<tr>
<td>Canada</td>
<td>7</td>
<td>No</td>
</tr>
<tr>
<td>Chile</td>
<td>5</td>
<td>No</td>
</tr>
<tr>
<td>Columbia</td>
<td>7</td>
<td>No</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>7</td>
<td>No</td>
</tr>
<tr>
<td>Hungary</td>
<td>8</td>
<td>Yes</td>
</tr>
<tr>
<td>Iceland</td>
<td>3</td>
<td>No</td>
</tr>
<tr>
<td>Mexico</td>
<td>5</td>
<td>No</td>
</tr>
<tr>
<td>Norway</td>
<td>7</td>
<td>No</td>
</tr>
<tr>
<td>Peru</td>
<td>7</td>
<td>No</td>
</tr>
<tr>
<td>Poland</td>
<td>10</td>
<td>Yes</td>
</tr>
<tr>
<td>South Africa</td>
<td>7</td>
<td>No</td>
</tr>
<tr>
<td>South Korea</td>
<td>7</td>
<td>Yes</td>
</tr>
<tr>
<td>Sweden</td>
<td>6</td>
<td>No</td>
</tr>
<tr>
<td>Switzerland</td>
<td>3</td>
<td>No</td>
</tr>
<tr>
<td>Thailand</td>
<td>7</td>
<td>No</td>
</tr>
<tr>
<td>UK</td>
<td>9</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Source: Schmidt-Hebbel (2002)
erning Council in anticipation of an enlarged Eurozone. Highlighted in Figure 2.3 is the role of the FOMC in relation to its policy objectives, and, additionally, appointment procedures for its members. Inclusion of this information underscores a pertinent message. All MPCs invariably make policy within a broader context of particular policy objectives. In relation to this assertion, Section 2.A of the Federal Reserve Act stipulates the objectives of monetary policy to be the achievement of economic growth in line with the economy's potential to expand, a high level of employment, stable prices and moderate long-term interest rates. One tentatively concludes therefore that in spite of the ubiquitous nature of MPCs, their size, structure, and the corresponding behaviour of their members may vary substantially from one country to the next. Certainly, where minutes of meetings are available, it can be readily observed that dissent is more commonplace in some committees than others. This is particularly evident when one contrasts the frequency of dissent voting between members of the Bank of England Monetary Policy Committee and FOMC respectively, and is discussed in later chapters. I now turn to the examination of the Theory Based Literature.

21 The FOMC arrangement it is considerably simpler and more transparent than that for its European counterpart.
22 These objectives were stipulated in the International Banking Act of 1978, sometimes referred to as the Humphrey-Hawkins Act, which amended the original Federal Reserve Act of 1913.
2.3 Theory Based Literature

The theoretical literature is partitioned into two distinct categories - (i) strategic and (ii) non-strategic approaches to modelling committee decision making. Strategic approaches are typified by the assumption of rational agency, and use techniques developed in game theory to model the behaviour of members of a committee. Non-strategic approaches are characterised by ad-hoc behavioural assumptions on the part of individuals. As non-strategic approaches are relatively more straightforward, I turn to them first.

2.3.1 Non-Strategic Literature

Condorcet's Jury Theorem (CJT)

CJT produces a very general result that when a group of voters uses majority rule to make a decision, it is more likely to make a better decision than any individual voter. A corollary of the theory is that as the size of the group tends to infinity, its judgmental competence approaches perfection. As such, CJT has a far broader scope than its name suggests, and its application to jury trial outcomes is but one area of decision making where the theory may be applied. On the one hand, the theory can be viewed as a stylized argument for democracy in providing a formal underpinning for the institution of majority rule in a democratic society. The argument goes that if groups make better decisions than individuals, and better decisions lead to improved welfare, then democracy - through the conduit of majority rule - is preferable to political systems where suffrage is either non-existent or highly restricted. Coupling this with the propensity to delegate responsibility for decision making to committees and boards across an array of institutions, public bodies and organizations suggests that the scope of CJT is highly encompassing. This is especially true when one considers that where committees are charged with such responsibilities, majority rule is quite often the decision mechanism of choice. In this sense, decision making by a monetary policy committee represents but one area where CJT might be fruitfully applied.

\[\begin{align*}
^{23}\text{In this sense, the adjective jury is a misnomer.}
^{24}\text{The question of what makes majority rule desirable is one which has received considerable attention from political philosophers, social choice theorists and economists in recent times. As a defining feature of modern democratic countries, majority rule is inextricably bound to the very notion of democracy itself in the sense that to be democratic is to submit de facto to the will of the majority. In The Social Contract, Rousseau (1762) famously spoke of the "General Will", where the view of the majority is that which necessarily best serves society.}
^{25}\text{For example, autocracy, plutocracy or dictatorships.}
\end{align*}\]
A Formal Statement of CJT

CJT has inspired a vast literature in the political science arena. It is a powerful yet simple theorem. However, the proofs on which it is based are purely statistical [Grofman (1978), Boland (1989), Karotkin and Paroush (2003)]. Further, virtually all variants of CJT assume dichotomous choice, a practice which this analysis restricts itself to. What follows is a formal statement of CJT in its simplest form.

Envisage a defendant in a court case, who is either innocent (I) or guilty (G) of committing a crime. A \( j = (1, 2, \ldots, J) \) member jury is faced with deciding the fate of the individual. Each member \( j \) must choose to either acquit (A) or convict (C) the defendant and makes their decision on the basis of a private signal, \( a_j \) (acquit) or \( c_j \) (convict), which is more likely accurate than not. Specifically, write that

\[
\Pr(c_j|G) = \Pr(a_j|I) = p \in \left(\frac{1}{2}, 1\right)
\]

(2.1)

Essentially, member \( j \) votes to acquit if she receives signal \( a_j \) and convict upon receiving signal \( c_j \). This obtains because each member prefers to make the correct decision. CJT asserts that the probability of a group making a correct decision by majority rule increases monotonically with \( J \). Assuming odd \( J \), the probability of the jury reaching a correct verdict under majority rule is characterised by [Miller

\[\]
Judgmental Accuracy under Majority Rule, p=0.7, 0.5, 0.3

From a mathematical perspective, (2.2) is just an application of the Binomial distribution. Assigning a value of $p = 0.7$ Chart 2.1 confirms that $P_J$ is monotonically increasing in $J$ and $\lim_{J \to \infty} P_J = 1$. Specifically, for $J = 31$ members $P_{31} > 0.99$. The probability that at least half of all jury members votes makes the correct decision, $P_J$, is greater than the probability of any jury member making the correct decision in isolation $p$. For all other values of $p \notin [0, 0.5)$ this property does not hold. For $p \in [0, 0.5)$, $P_J$ is monotonically decreases in $J$ and $\lim_{J \to \infty} P_J = 0$. Further, if $p = 0.5$, $P_J = 0.5 \forall J$. Chart 2.1 plots results for $p = 0.3$ and $0.5$.

Numerous criticisms can be levelled at the version of CJT outlined above. A practical implication of CJT is that it is desirable to expand the size of, for instance, a monetary policy committee indefinitely, a clearly dubious finding. This

28 In developing CJT, McLennan (1998) describes Condorcet as having presented a precursor to the law of large numbers, demonstrating how

"...decisions made under majority rule are asymptotically perfect as the population of voters becomes large." p.413 (emphasis added)
would imply that at 18 members, the ECB Governing Council is not large enough. Secondly, ignored by CJT is the fact that quite often interdependencies between members of a committee exist. Minutes from meetings of the Bank of England Monetary Policy Committee, the US FOMC and the Bank of Japan MPC clearly show that its members share information and deliberate. In light of this, the assumption that committee members vote independently of one another is unrealistic, as pointed out by Lahda (1995):

"...independence requires that jurors do not confer with each other, remain immune to opinion leaders, lack similar experiences or training, and share no common information." 29

Votes will thus be correlated because in practice members of a committee or group invariably communicate with each other, are influenced by different ideas and opinions and share common information. For example, the policy preferences of two economists on an MPC who share very distinct views about the way the economy works may also hold very different views about the appropriate policy stance. However, Lahda finds that even when the independence assumption is relaxed, CJT still holds, a result which reinforces CJT. Similar findings are also presented in Lahda (1992, 1993) and Berg (1993). Monetary policy committees are often justified on the premise that communication between MPC members and the associated pooling of information associated with it leads to fewer mistakes, something which CJT completely neglects: yet the central result of CJT that groups make better decisions than individuals has no basis in this presumption. Further, the model of CJT presented here assumes members' signals are obtained at no cost: indeed, when information acquisition is costly, some members may free-ride on the signals of others. This prospect is considered by Mukhopadhaya (2003) and Persico (2004), and discussed in the strategic literature. Both authors show that under costly information acquisition, CJT does not hold. Finally, the most far-reaching and damaging criticism emanates from Austen-Smith and Banks (1996), who shed light on the sincere voting assumption implicit to CJT. Sincere voting says that members of a group vote in exactly the same way to how they would in isolation, an assumption which is invalidated under most conditions once decision making is modelled as a game between rational players. Again, this point is discussed further in the strategic literature.

2.3.2 Consensus Formation and Markovian Updating

One strand of literature which might be applied to account for communication and deliberation amongst MPC members, but which is rarely mentioned is the work on consensus formation in groups associated with Morris DeGroot (1974).\textsuperscript{30,31} I suggest this literature is of some relevance to the formulation of monetary policy by committee, even though previous contributions have not to the best knowledge of the author exploited it to that end. Using the theory of \textit{Markov chains}, DeGroot (henceforth DG) specifies the conditions under which \textit{consensus} can be reached by members of a group of individuals.\textsuperscript{32} Specifically, agents of a group or network update their beliefs in successive periods, using a procedure which I hereafter refer to as \textit{Markovian Updating} (MU). Although originally envisaged as a mechanism for pooling individuals' \textit{subjective probability distributions}, DG's model is also applicable to situations where opinions are represented by point estimates. Here, the preferred interest-rate of a member of a monetary policy committee can be construed as falling into this class of estimate. As the process which individuals use to update their beliefs is formally modelled and applied to a monetary policy committee in Chapter 4, only the general features of the model are described here.

The theory of Markov chains lies at the heart of the DG approach. Each member of the group is assumed to (i) identify a subjective probability distribution for the value of some parameter, \( \theta \), the value of which is unknown and (ii) weight the opinions of all other group members, including herself. For a group of \( j = 1, 2, \ldots, J \) members, let \( F_j \) be the subjective probability distribution for member \( j \) associated with her appraisal of \( \theta \) and by \( F^{(t)}_j \) a \( J \times 1 \) vector containing the subjective distributions corresponding to each group member in period \( t = 1, 2, \ldots, \infty \). Further, denote \( p_{j,k} \) as the \textit{weight} placed on member \( k \)'s opinion by the \( j^{th} \) member. For each member the sum of weights equals one such that

\[
\sum_{j=1}^{J} p_{j,k} = 1, \quad p_{j,k} \in (0, 1) \quad (2.3)
\]

Members' weightings are then assigned to a \( j \times j \) matrix \( P \), where the element in

\textsuperscript{30}A precursor to the work of DeGroot is found in the mathematical sociology literature on social networks, starting with French (1956).

\textsuperscript{31}Recall that in the section on Surveys of Monetary Policy Committees how Fry et al (2000) find that most committees arrive at a decision through reaching a consensus.

\textsuperscript{32}A highly readable introduction to the theory of Markov chains is found in Searle and Hausman (1970), Chapter. 8.
the $j^{th}$ row and $k^{th}$ column captures the weight placed on member $k$'s opinion by member $j$. In other words, any given row contains a member's weightings of the opinions of her peers. A shortcoming, however, is that it provides a somewhat ad hoc approach to committee decision making, lacking tractable microfoundations in as far as the allocation of opinion weights is purely arbitrary. However, in the language of Markov chains, $P$ has all the characteristics of a transition matrix, as the elements in each row are non-negative and sum to unity. DG then assumes that starting from an initial period $t = 0$, members revise their distributions in subsequent discrete deliberative rounds. In the first round of deliberation, members' revised distributions are determined by the vector $PF^{[1]} = F^{[1]}$. In the second, third and $n^{th}$ deliberative rounds, revised distributions are given by $PF^{[2]} = F^{[2]}$, $PF^{[3]} = F^{[3]}$ and $PF^{[n-1]} = F^{[n]}$ respectively, noting here that $PF^{[n-1]} = F^{[n]}$ may also be expressed as $P^nF = F^{[n]}$. Each consecutive deliberative round is characterised by members revising their subjective distributions, a process which continues until all distributions $F_t$ in the vector $F^{[t]}$ converge to a unique limiting subjective distribution. Once this occurs, a consensus is said to have been reached. Essentially, in each deliberative round, all information is treated as new.\textsuperscript{33} DG argues that in order for a consensus to be achieved, the matrix $P$ must have particular properties. By DG Theorem 2, it is claimed that if all the recurrent states of the Markov chain communicate with each other and are aperiodic, a consensus is reached. Alternatively, if two states of the chain consist of two disjoint sets of communicating states, or the states are periodic, a consensus is not reached.\textsuperscript{34} These conditions, it is attested, are both necessary and sufficient for a consensus to be reached.

In a later paper, Berger (1981) shows that DG's conditions for reaching a consensus are sufficient, but not necessary. Berger demonstrates how within DeGroot's framework, whether consensus is reachable depends not only on $P$, but $F^{[0]}$. For instance, if members' subjective probability distributions are identical from the outset, a consensus is reached irrespective of the properties of matrix $P$. Like DeGroot, Berger applies standard results from the theory of Markov chains in providing the necessary and sufficient conditions for consensus to be reached. His paper outlines how to check these conditions, and he shows how it is possible

\textsuperscript{33}It is noted here that although DG draws on the theory of Markov chains, the iterative process underlying the dynamics of the model does not strictly follow a Markov chain. This is because when iterating the process, the matrix $P$ capturing members' weights is post-multiplied by the vector $F$ of members subjective assessments, as opposed to being pre-multiplied by a distribution. See for example the social mobility literature, such as Aebi et al (2003) and Theil (1972), Chapter 5.

\textsuperscript{34}Degroot (1974), p.120.
to reach a consensus when the matrix $P$ contains disjoint states of communicating and periodic classes.

Lehrer and Wagner (1981) are also notable for providing a formal model of consensus which is virtually identical to DeGroot. More recently, Collignon (2001), Neilson and Winter (2003) and DeMarzo, Vayanos and Zweibel (2003) have rediscovered this strand of literature. Collignon (2001) uses the model of Lehrer and Wagner (1981) to analyse the formulation of collective policy preferences over a combination of monetary and fiscal policy in a European Monetary Union. Neilson and Winter (2003) construct a model of Jury deliberation with a theoretical basis in DeGroot. According to the authors, the focus on deliberation is particularly apposite as in any jury trial 'it is the last task jurors face before a verdict is reached'.

In many ways extending the work of DeGroot (1974), DeMarzo, Vayanos and Zweibel (2003) - hereafter DVZ - construct a model where individuals' opinions are subject to persuasion bias. DVZ make explicit the fact that theirs is a 'boundedly-rational' model of agency - in their set-up, individual belief formation is assumed not to follow martingales, unlike models which assume full rationality. Previous work, such as DG does not explicitly recognise this, even though in their model group members fail to adjust for repetitions of information at each round of the deliberation process, treating all information as new. To illustrate the concept of martingales, consider the following example. Suppose that at the beginning of an MPC meeting, all members exchange their views. Denote by $\Psi_{j,t}$ member $j$'s information set at date $t$ based on the exchange of information in period $t$, and by $x_{j,t}$ member $j$'s beliefs corresponding to the appropriate policy stance based on $\Psi_{j,t}$. More formally, write that

$$x_{j,0} = \Pr(\text{Interest rate } i_0 \text{ is best}|\Psi_{0,j}) \quad (2.4)$$

Assuming in subsequent periods that members contribute no new information, by the law of iterative expectations, $E(x_{j,1}|\Psi_{j,1}) = x_{j,0}$. Expressed differently, the expected impact on member $j$'s policy stance of listening to members in subsequent periods is zero.

Applied to a monetary policy committee, persuasion bias says that in much

\textsuperscript{35}Neilson and Winter (2003), p.1.
that same way that newspapers sway readers toward their views over time - even when the political affiliation of a newspaper is common knowledge - some members of a monetary policy committee sway other members to their views, even when all member’s views are commonly known. Put another way, when trying to reach a decision on an issue, individuals are unable to adjust for repetitions of information they receive, as is the case in DG - although DVZ go much further than DG in justifying why this occurs.

DVZ suppose that individuals are often members of deeply intertwined social networks or groups. Consider two individuals, $A$ and $B$, who discuss an issue amongst themselves having previously been independently influenced by another individual $C$. During the course of their discussions, if $A$ fails to account for the fact that $B$ also sought advice from $C$, $A$ is effectively double-counting the information given by $C$. Thus when listening to $B$, the problem facing $A$ is adjust for any repetition of information by disentangling $B$’s opinion from that of $C$. Likewise, $B$ is confronted with a similar problem when listening to $A$. DVZ suppose that the situation confronting $A$ and $B$ constitutes a complex inference problem, particularly when communication between $A$ and $B$ takes place over multiple rounds. More generally, this problem will proliferate as the size, structure and complexity of the social network or group increases. Thus under persuasion bias, the demands associated with processing all information is assumed to be computationally burdensome to the extent that individuals comprising the group resort to a simple ‘boundedly rational’ heuristic to tackle a given inference problem. Agents are consequently unable to adjust for repetitions of information, and all information is treated as new. Such failure to adjust, it is argued, can particularly account for ‘the effectiveness of airtime, propaganda, censorship, political spin, [and] marketing’.36

Persuasion bias entails two further phenomena: social influence and unidimensional opinions. Social influence is the degree to which the opinions of members of a group are a function of not only the accuracy of a member’s signal regarding an issue, but the extent to which one is connected within a social network, the latter construct being an area which has received considerable attention in recent years.37 By unidimensional opinions it is supposed that for any given multidimensional issue set, individuals’ opinions are characterised by a unitary “left-right” spectrum.

37See for example Wasserman et al’s (1994) text on social network analysis.
In terms of the formal model, DVZ construct a setting where a finite number of individuals must estimate an unknown parameter $\theta \in \mathbb{R}^L$, where each dimension in $\mathbb{R}^L$ can be construed as a different issue. Assume that individual $i$'s estimate of parameter $\theta$ is given by the noisy signal

$$x_i^0 = \theta + \epsilon_i, \quad \epsilon_i \sim i.i.d(0, \sigma^2) \quad (2.5)$$

Individual $j$ is assigned initial precision $\pi_{ij}^0$ by individual $i$, precision which applies to all components of $j$'s error term, namely

$$\pi_{ij}^0 = \text{var}_i(\epsilon_j)^{-1}, \quad l = 1, ..., L. \quad (2.6)$$

In other words, the greater the variance associated with $j$'s information, the smaller the associated precision. Now introduce $q_{i,j}$ which is a binary variable

$$q_{i,j} = \begin{cases} 1, & \text{if } i \text{ listens to } j; \\ 0, & \text{if } i \text{ does not listen to } j. \end{cases} \quad (2.7)$$

Information pertaining to individuals' initial signals is then communicated to each other through a social network, and members update their views in contiguous deliberative rounds. Unlike DG, the weight which members of a committee place on the opinions of others is determined by members' precisions, and the precision assigned to another member's information is a members subjective assessment. More formally, for an $m$ member group, the weight given by a member $c$ to the information of a member $k$ is given by $q_{c,k}^{\pi_{i,j}} \sum_{j=1}^{m} q_{c,j}^{\pi_{i,j}}$. The sum of these weights is necessarily one, and in line with in DG, these weightings are then assigned to an $m \times m$ matrix $T$, where the weighting $q_{c,k}^{\pi_{i,j}} \sum_{j=1}^{m} q_{c,j}^{\pi_{i,j}}$ corresponds to the element in the $c^{th}$ row and $k^{th}$ column. Matrix $T$ thus has the characteristics of a transition matrix, the elements in each row being non-negative and summing to unity. Updating occurs through applying the updating rule

$$x_i^1 = \frac{q_{i,j}^{\pi_{i,j}} - x_j^0}{\sum_{j=1}^{m} q_{i,j}^{\pi_{i,j}}} \quad (2.8)$$

where $x^t$ is a matrix whose $t^{th}$ row is the vector $x_i^t$ of agent $i$'s beliefs in commu-
nformation round $t$. This is generalizable to the following expression:

$$x^1 = Tx^0$$  \hspace{1cm} (2.9)

The process defined in (2.8) is then repeated over multiple communication rounds, with agents treating the information in each round as new and independent. However, unlike previous models of MU, DVZ allow agents to increase the weight given to their own beliefs over subsequent rounds of communication via the innovation

$$T_t = (1 - \lambda_t)I + \lambda_t T, \quad \lambda_t \in (0, 1]$$  \hspace{1cm} (2.10)

Assuming agents are strongly connected, beliefs are shown to converge over time to a *weighted average* of initial beliefs. In other words, in the limit, a unique consensus is reached by all agents. Further, if $\lambda_t$ tends to zero too quickly, consensus would not be reached as agents would stop listening to each other.$^{38}$

It is perhaps useful here to compare the approaches of DG and DVZ. Although sharing key similarities, both approaches differ from each other in two important respects. Firstly, DG provides no theory as to why members of a committee or group would choose to listen to the opinions of some members and not others, or even why views on a particular issue - for example, which interest-rate to set - might be diverse. There are no theoretical underpinnings so to speak, and members a group are assumed to listen to - or rather 'weight' - the opinions of their peers in purely arbitrary fashion. In this sense, DG merely shows how consensus can be determined within the context of a particular iterative framework. Second, the suitability of the DG model as a process by which agents update beliefs is justified merely on its being 'intuitively appealing' and 'simple.$^{39}$ No other reasons are explored as to why MU is preferable to more robust procedures for updating beliefs.$^{40}$ This is a crucial observation given that modern economic models typically assume *full rationality* on the part of agents. However, in DG, members of group are assumed to update their beliefs *without* adjusting for repetitions of information: agents are emphatically *not* endowed with being fully rational.

DVZ flesh out the bones of some of these criticisms, particularly with respect

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$^{38}$i.e. $T$ reduces to an identity matrix in the limit.


$^{40}$When DeGroot published his paper in 1974, the so-called rational expectations 'revolution' in economics was well underway. Indeed, the seminal paper on *rational expectations* was published by Muth almost fifteen years earlier [See Muth (1961)].
to the second. Agents are assumed to use MU because other methods of updating beliefs are computationally too burdensome to process. With respect to the first criticism, agents choose to listen to each other on the basis of whether they believe others' information is useful: the smaller the variance associated with an individual’s information, the more useful it is, and the greater its consequent role - and thus weight - in forming individual beliefs. This innovation clearly goes some way to ‘micro-founding’ the arbitrary nature of weighting members’ opinions in DG. However it turns out that in DVZ, the problem of who to pay attention to is still arbitrarily determined, and compared to DG, merely relocated. Yet this problem is perhaps not as problematic as it appears. In social life, people may hold that only the views of some people are worth listening to. An excellent example of this is provided by DeMarzo at al (1999), asserting that:

"...the economist may dismiss as out of hand the market analyst who begins his argument with chartist notions, whilst the chartist might in turn dismiss the views of anyone subscribing to “crazy” academic notions of market efficiency."42

Similar arguments may conceivably apply to members of a monetary policy committees with very different views on how the economy works. I now turn to theoretical literature which examines the formulation of monetary policy by committee.

### 2.4 Monetary Policy Formulation by Members of a Committee

I now turn to studies which specifically model monetary policy formulation as a game or a process between members of a committee or group. Relatively few contributions to the theoretical literature explicitly consider the formulation of monetary policy by committee, especially considering the predominance of MPCs as vehicles for setting policy in the real world.43 However, the study of monetary

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41 A more comprehensive formal description of the model is provided in Chapter 4.


43 Perhaps more surprising is that the pioneers of the monetary policy games literature - leading US based academic economists - instigated a research programme which pays scant attention to the reality of domestic policy making. Since 1913, US monetary policy has been delegated to the Federal Open Markets Committee (FOMC). Voting records of FOMC meetings clearly reveal that in terms of its composition, its members share differing tastes over inflation and output - the FOMC is emphatically not the ‘single individual maximizing a well defined preference function’ Blinder (1998) refers to.
policy committees is now fast becoming a fertile research area. Some of the papers reviewed here build on the monetary policy games literature, particularly Sibert (2004) and Mihov and Sibert (2004). Yet not all approaches use an underlying theoretical framework with a basis in the monetary policy games literature. These ‘alternative’ approaches are exemplified in contributions by Cothren (1988), Waller (2000) and Gerlach-Kristen (2004). I turn first to the contributions with a clear basis in the monetary policy games literature.

Whilst recognising that decision making is determined by committee, many recent papers which have sought to analyse policy making by the ECB do not explicitly model the formulation of policy as a game or process between the members of a committee or group. This occurs even when it is explicitly acknowledged that policy does not fall under the aegis of a unitary agent. Following Rogoff (1985), Alesina and Grilli (1992, 1993) develop a simple one-shot model of inflation and output stabilization to examine the incentives for a country to join a monetary union, in particular EMU. A particular assumption they model is the prospect that

"In the transitional phase, before monetary union, different countries will still have strong national and political identities, and it is therefore likely that the effects of common monetary policies will also be assessed on the basis of national welfare and preferences." (Alesina, A and Grilli, V. (1991): The European Central Bank: Reshaping Monetary Policies in Europe. In Persson, T and Tabellini, G, eds. (1994): Monetary and Fiscal Policy - Volume 1: Credibility, M.I.T. Press, p.257.)

Effectively, policy makers sitting on the Governing Council of the ECB are assumed to care only about the welfare of the citizens of the country they represent. Their findings are manifold. Firstly, the higher a country's inflation bias, the more it has to gain from joining a currency union in terms of monetary policy credibility. Secondly, the greater the differences in output variability between a country and a monetary union the more costly it is from a stabilization perspective to adopt a common currency, such as the Euro. Thirdly the costs of adopting a common currency increase as the correlation between economic shocks for a given country and a currency union become smaller. Lastly, in the absence of complete political integration in Europe, the composition and voting rules of the ECB Governing Council may lead to decisions which significantly misrepresent the preferences of the European median voter, especially if members of the ECB Governing Council are not independent from the political persuasions of those who appointed them. Close attention to the institutional design of the ECB is therefore imperative to its success. Similarly, von Hagen and Stuppel (1994) model the decision making structure at the ECB, assessing its implications for inflationary and output stabilisation. Like Alesina and Grilli, they argue that

"...policy-makers in the union may look at monetary policy from two different perspectives: A unified one considering union-wide aggregates of output, employment, and prices as the relevant policy targets, and a regional or national one taking regional or national aggregates as targets." (von Hagen, J. and Stuppel, R. (1994): Central Bank constitutions for federal monetary unions, European Economic Review 38, p.774)

More recently, Hefeker (2003) examines the optimal institutional structure for a federal central bank, such as the ECB. In particular, the focus is on the conditions under which individual regions favour a monetary union to be structured in accordance with regional or common influences, or a combination of the two.
2.4.1 Extensions to the Monetary Policy Games Literature

Using a macroeconomic framework with a basis in Barro and Gordon (1983a) and Backus and Driffill (1985), Sibert (2003) constructs a dynamic model of reputation building when monetary policy is made by a two member committee. Members serve two-period overlapping terms, and a policy-maker’s type is her own private information. The model analyses how some of the institutional features of central banks influence incentives to maintain a reputation, inflation and welfare. Implicit to the model is the assumption that unanticipated inflation provides a welfare gain - this is because assuming nominal wage contracts, real wages fall and employment rises. All players are endowed with rational expectations, and the private sector updates its beliefs using Bayes’ rule. Societal welfare is given by

\[ W = \frac{1}{2} \pi^2_t + \pi_t - \pi_t^e \]

where \( \pi_t \) denotes period \( t \) inflation and \( \pi_t^e \) is the public’s expectation of period \( t \) inflation. The social welfare function is common knowledge, and the public know that a policymaker may be one of two types, hawks and doves. Hawks are assumed to care only for inflation, whereas doves wish to maximize societal welfare given in (2.11). For any given meeting, the senior policy maker always votes for her preferred level of inflation: hawks vote for zero inflation whereas doves for \( \pi = 1 \). When votes are not in accord with each other - that is, when the junior policy maker disagrees with her senior - the chosen rate of inflation is assumed to be an exogenous compromise rate of \( 0 < \pi < 1 \). Essentially, the task facing the public is to determine the policy-makers’ types: however, because a policymaker’s type is her private information, doves may behave as hawks in a ploy to build a reputation for inflationary toughness.

Sibert firstly examines the incentives of opportunistic policy makers to build a reputation when they are members of a committee, as opposed to setting policy unitarily. As a member of a group, a policy maker has less influence in setting policy than if setting policy alone, and ceteris paribus, both the associated current benefit from voting to inflate the economy and the cost of her reputational loss are less. If the weight society places on the future is not overly high, it is optimal for MPC members to engage in building a reputation. However, the opposite holds when society cares sufficiently about the future and reputation building is

\[^{45}\text{The terminology is analogous to the distinction between hard-noses and wets in Backus and Driffill (1985).}\]
not difficult. When members disagree and the rate of compromise inflation is such that a dissenting opportunistic policy maker achieves half her welfare gain from inflation, the expected welfare associated with committees is higher. This is because compromise causes inflation to be smoother and welfare is concave in inflation. Committees thus produce smoother inflation paths than single policy makers.

The second part of the paper focusses on the incentives for a dove to engage in reputation building when votes are published (i) immediately after voting has taken place and (ii) with a lag. When votes are published with a lag the incentive for an opportunistic policy maker to vote against inflation lessens, which decreases expected welfare. With a lag, the actions of previous committee members have a marked effect on an opportunistic policy maker’s propensity to vote against inflation. If a previous junior policy maker voted for inflation, this increases the likelihood of a subsequent junior of the same type voting against inflation. Further, opportunistic policy makes always vote to inflate if the period following a vote against inflation by an opportunistic policy maker.

A third part of the paper examines the effects of apportioning senior policy makers more influence in setting compromise inflation than juniors. This is found to have the effect of reducing expected inflation. Junior policy makers are more incentivised to engage in reputation building, as their vote will be more important in the subsequent period. Indeed, because the vote of a junior opportunistic policy maker receives less weighting, the cost of voting for zero inflation is also less, with a higher future expected gain in welfare. Placing more weight on the senior policy maker is found to increase expected welfare as long as juniors sometime vote to inflate. Similar findings are also reported in Mihov and Sibert (2002), who develop a dynamic model of reputation building when monetary policy is set by a two member committee.

2.4.2 Alternative Approaches to Decision Making by a Monetary Policy Committee

In Cothren (1988) monetary policy is modelled as game between players of an MPC. Policy is determined by majority rule in a committee of \( n > 1 \) odd members, each serving for \( n \) period terms. No two agents serve coincident terms. The results are similar to Barro and Gordon (1983a), even though policy is set by
finately lived agents and wage setters do not feature as game participants. Building on Alesina (1987), Waller (2000) examines the extent to which a policy board magnifies or lessens policy uncertainty in a model where political parties must bargain over who to appoint to a monetary policy committee. Simulations indicate that delegating monetary policy to an independent yet accountable policy board results in more stable and predictable monetary policy than would be produced by elected leaders.\footnote{Waller (2000), p.306.} Faust (1996) shows how the historical development of the US Federal Reserve and present structure of the FOMC arises ‘naturally’ in a monetary economy. This is achieved using an OLG framework with heterogeneous agency, a device which makes the identification of winners and losers from surprise inflation possible. Monetary growth is chosen by \textit{majority will}. Policy is shown to not always result in excessive inflation, a result in line with results from the time-consistency literature [Barro and Gordon (1983a), Kydland and Prescott (1977)], even though the framework is somewhat different.

Meade and Stasavage (2004) model the benefits of transparency in MPC decision making. Specifically, they investigate whether publishing detailed records of deliberations make members of a monetary policy committee more disinclined to cast dissenting votes. Drawing on literature which models the behaviour of group members when career concerns are present, their set-up contrasts the incentives of MPC members to dissent when deliberations occur in public and private settings. Meade and Stasavage model a three member MPC faced with a binary choice, comparable to the decision to raise interest rates or leave them unchanged. Each member receives an informative private signal about the state of the economy, meaning that the committee is more likely to make a correct policy decision when members accurately reveal their information.

Berk and Bierut (2003) address the implications for interest-rate setting when a subset of members of a monetary policy committee meet prior to a meeting and are able to reach an agreement \textit{before} voting takes place. In their analysis, committee size, voting rules and skill levels of committee members are all allowed to vary. Committee size is determined to be far less important than the skill levels of members in producing interest-rate inertia. Indeed, interest-rate setting by committee is not necessarily more likely hallmarked by policy inertia, as recently suggested by Blinder (1998). Member’s skill levels, however, are determined to be critical determinants of quality of decisions.
Gerlach-Kristen (2002) appeals to techniques used in *Bayesian estimation* to assess the benefits of deliberation amongst members of a monetary policy committee. Using a reduced form backward looking Phillips curve and IS relation to describe the economy\(^{47}\) she finds that monetary policy committees help reduce the uncertainty surrounding monetary policy decisions. Ultimately, the reduction in uncertainty leads the monetary authorities to respond more aggressively to changes in the rate of inflation. Specifically, the economy is described by the relation

\[
\pi_{t+1} = \pi_t - a_t r_t + e_{t+1}
\]

where \(\pi\) denotes inflation, \(t\) is a time suffix, \(r\) is the real interest-rate and \(e\) is a normally distributed stochastic error. Uncertainty is modelled by allowing the coefficient \(a_t\) to vary randomly from period to period, so the effect on monetary policy is not uniform. As \(a_t\) is not directly observable, the first two moments of the parameter are estimated by the single policy-maker as \(a_t = N(\mu_1, \sigma_1^2)\). Gerlach-Kristen shows that the single policy-maker's reaction to inflation is contingent on their assessment of \(\mu_1\) and \(\sigma_1^2\). As \(\sigma_1^2\) increases so too does uncertainty. The greater the value of \(\sigma_1^2\) the less aggressively monetary policy reacts to inflation.

In a monetary policy committee if (i) members communicate their uncertainty to each other through revealing the moments of their distributions over \(a_t\) and (ii) Bayesian updating is used to aggregate members' views,\(^{48}\) the uncertainty surrounding the policy decision lessens, and monetary policy is shown to react less aggressively to inflation. I now turn to the jury-games literature.

### 2.5 Jury Games Literature

The literature on jury games owes much to an important paper by Austen-Smith and Banks (1996), which re-examines CJT from a game-theoretic perspective. They cogently argue that when members' preferences are outcome orientated, rational members of a jury or committee would not necessarily vote the same way in isolation as they would in a group. The framework developed by Austen-Smith and Banks (hereafter ASB) is a very general one, which serves as the starting point for a number of subsequent papers [see Wit (1998), Feddersen and Pesendorfer (1996), McLennan (1998), Coughlan (2000), Dharmalala and McAdams (2001),

\(^{47}\)The model is based on Martin and Salmon (1999).

\(^{48}\)The concepts discussed here are found in Maybeck, P. S. (1979), Ch. 1, and Griffiths *et al* (1993), Ch. 24.
Mukhopadhyaya (2004) and Persico (2004)]. ASB define three different types of voting:

1. **Sincere voting**: each individual $j$ votes in the same way, irrespective of whether she is acting alone or a member of a group.

2. **Informative voting**: each individual $j$ votes solely on the basis of a signal which is her own private information.

3. **Rational voting**: Given the voting strategy of everyone else, individuals vote to maximize their expected payoffs. Each individual $j$'s voting rule effectively comprises a Nash equilibrium.\(^{49}\)

Using the distinctions listed above, ASB draw attention to the fact that for Condorcet's argument to hold requires that sincere voting is a Nash Equilibrium of a voting game under majority rule. Start with the framework used previously to describe naive CJT. A jury of $J$ individuals denoted $j = \{1, 2, ..., J\}$ is asked to choose between the guilt and innocence of a defendant at a trial. $j$ is assumed to be an odd number, and the set of alternatives is characterized by $\Phi = \{G, I\}$. $G$ denotes Guilty and $I$ denotes Innocent. Each member $j$ must vote to either acquit (A) or convict (C) the defendant, a decision which is made on the basis of a private signal, $a_j$ (acquit) or $c_j$ (convict), where $Pr(c_j | G) = p_G \in (\frac{1}{2}, 1)$ and $Pr(a_j | I) = p_I \in (\frac{1}{2}, 1)$. On the basis of their respective signals, jurors cast their votes simultaneously, and the alternative which receives at least half of the the votes - $h \geq \frac{J+1}{2}$ - is adopted. It is also assumed that the prior probability of a defendant being guilty or innocent is given by $Pr(G) = Pr(I) = \pi = \frac{1}{2}$. Further, all members of the committee are assumed to share identical preferences, namely, they all want to make the correct decision. This entails that all committee members prefer to choose A when $I$ is true and choose C when $G$ is true.\(^{50}\)

\(^{49}\)Similarly, for a monetary policy committee, the past behavior of the economy may lead to the prior belief amongst MPC members that the need to raise, loosen or leave interest rates unchanged is equiprobable.

\(^{50}\)This assumption is not a straightforward as it seems. Certainly, it is hard to think of circumstances any juror would choose to acquit when all of the evidence suggested a person was guilty. Voting guilty perhaps obviously constitutes the 'correct' decision in this context. However, in other situations defining the 'correct' decision is not so clear-cut. Dharmapala and McAdams (2001) consider a legislature where all members would choose to ban smoking if it was shown to be harmful. Yet although smoking has been shown to be harmful, many people hold the view that it should not be banned, as individuals should be permitted to make an informed decision. It is noted that the negative externalities associated with smoking - particularly inhaling second-hand smoke - make this argument increasingly harder to justify.
utility is outcome oriented, so that for each individual $j \in \{1, 2, \ldots, J\}$,

$$u_j(C, G) = u_j(A, I) = 1 \quad \text{and} \quad u_j(A, G) = u_j(C, I) = 0$$

(2.13)

Using Bayes' rule, individuals update their probabilities that a given state is true, which is captured by

$$\Pr(G|c_j) = \frac{\pi p_G}{\pi p_G + (1 - \pi)(1 - p_I)}$$

(2.14)

$$\Pr(I|c_j) = \frac{(1 - \pi)(1 - p_I)}{\pi p_G + (1 - \pi)(1 - p_I)}$$

(2.15)

$$\Pr(G|a_j) = \frac{(1 - \pi)p_I}{\pi(1 - p_G) + (1 - \pi)p_I}$$

(2.16)

$$\Pr(I|a_j) = \frac{\pi(1 - p_G)}{\pi(1 - p_G) + (1 - \pi)p_I}$$

(2.17)

Implying that

$$E[u_j(C, \cdot)|c_j] > E[u_j(A, \cdot)|c_j] \iff \pi p_G > (1 - \pi)(1 - p_I)$$

(2.18)

$$E[u_j(A, \cdot)|a_j] > E[u_j(C, \cdot)|a_j] \iff \pi(1 - p_G) > (1 - \pi)p_I$$

(2.19)

Bayes' rule shows how agents update prior beliefs in the light of new information. An agent's subjective expectation can be modelled as the conditional statistical expectation

$$P(A|B)P(B) = P(B|A)P(A)$$

which can be manipulated to yield

$$P(A) = \frac{P(A|B)P(B)}{P(B|A)}$$

or

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

For the more general case we have

$$P(A_1|B) = \frac{P(B|A_1)P(A_1)}{P(B|A_1)P(A_1) + P(B|A_2)P(A_2) + \ldots + P(B|A_n)P(A_n)}$$

where

$$P(B|A_1)P(A_1) + P(B|A_2)P(A_2) + \ldots + P(B|A_n)P(A_n) = P(B)$$

or more succinctly

$$\sum_{i=1}^{n} P(B|A_i)P(A_i) = P(B)$$
Using this basic framework, ASB proceed to define the conditions under which it is rational to vote sincerely, informatively or both. Given the framework outlined above, for certain parameter values, the jury theorem as originally articulated by Condorcet emerges as a special case of ASB's general framework, where it is shown that rational voting is not only sincere, but informative too. This occurs where (i) majority voting is the optimal method of aggregating members' private signals and (ii) where

\[
\frac{p_G}{1-p_I} > \frac{\pi}{1-\pi} > \frac{1-p_G}{p_I} \tag{2.20}
\]

Setting \( \Pr(c_j|G) = p_G = \Pr(c_j|I) = p_I = p \), and assuming both states \( G \) and \( I \) are equally likely, (2.20) becomes

\[
\frac{p}{1-p} > 1 > \frac{1-p}{p} \quad p \in \left(\frac{1}{2}, 1\right) \tag{2.21}
\]

When (2.21) is not met, sincere voting under majority voting is not rational. It does not constitute a Nash equilibrium. This leads them to conclude that

"A satisfactory rational choice foundation for the claim that majorities invariable do better than individuals has yet to be derived."

When all other members of a committee vote sincerely, ASB demonstrate that any one individual has an incentive to vote against the advice of her private information. Even when members share common goals, individuals are incentivised to vote strategically because their vote only makes a difference when (i) it is pivotal and (ii) the information contained in other members' private signals is relevant to her decision. In ascertaining whether to vote \( C \) or \( A \), each individual \( j \) is only concerned whether she is pivotal, in the sense that her vote is the decisive factor in determining the choice of the group as a whole. Such a structure is responsible for endogenously generating heterogeneous policy preferences amongst members.

Subsequent papers have elaborated on the results in ASB. Wit (1998) argues that ASB neglect mixed-strategy equilibria, demonstrating that the results of naïve CJT are sustainable in equilibrium. To quote Wit,

"...a rational choice foundation for the claim that majorities invariably 'do better than individuals' is derived for the Austen-Smith and Banks model."

\[^{52}\text{p.34.}\]
\[^{53}\text{p.365.}\]
Although the mixed-strategy game is characterised by multiple equilibria, it is possible to select a unique equilibrium for each parameter vector, by for instance, eliminating weakly dominated strategies. The emerging equilibria reinforce Condorcet's original conjecture that groups perform better than individuals. McLennan (1998) is a generalization of Wit. He shows that when sincere voting results in the probability of a group making the correct decision monotonically converging to one as \( n \) tends to infinity, such outcomes are supported by Nash equilibria. In an important paper, Feddersen and Pesendorfer (1998) compare the implications of strategic voting for jurors under different decision rules. Contrary to the conventional wisdom, they find that under unanimity rule, the probability of an \( n \) member jury convicting an innocent defendant monotonically increases in \( n \). For this reason, it constitutes an 'exceptionally bad rule'\(^54\). This result is in stark contrast with the results for non-unanimous rules, including simple majority rule. Consequently, if mistrials are to be avoided, then the requirement that a unanimous decision be reached by jurors in trials should be dropped. Coughlan (2000) extends the set-up in Feddersen and Pesendorfer by considering real-world features of jury trials, and allows for (i) the prospect of mistrial and (ii) communication amongst jurors. When either of these features is incorporated into the set-up, it no longer obtains that unanimous verdicts are inferior to those of the non-unanimous variety.

Further extensions to the ASB framework have also been developed. Mukhopadhyaya (2003) and Persico (2004) both construct models where costly information acquisition results in some jury members free-riding on the signals of others. This is in sharp contrast to ASB and previous contributions cited herein, all of which assume that members' signals are obtained at no cost. Mukhopadhyaya (hereafter M) retains the ASB framework, but restricts attention to the case where sincere and informative voting is rational.\(^55\) Decision outcomes are shown to be function of the amount of effort put into the decisions by individual members, the game being of the 'contribution' variety proposed by Rasmusen (2001). As a public good, costly information acquisition is under-supplied. Consequently, for given parameter configurations, an increasing jury size is associated with less accurate decisions. This generally occurs both in the presence of perfect and imperfect signals.\(^56\) Persico (2004) focuses on the design of voting rules, with a view to

\(^{55}\)Refer to equation (2.20).
\(^{56}\)i.e. when Pr(\(c_j|G\)) = \(p_G\) = Pr(\(a_j|I\)) = \(p_I\) = 1.
determining optimal committee design. A well designed committee it is argued, provides (i) a good incentive for individual members to pay attention to the evidence upon which any decision is to be based and (ii) facilitates the efficient gathering of information by committee members. Persico shows the propensity for a committee to meet such criteria is a function of committee size and the respective voting rule employed by the committee. For any given committee size \( n \), voting rules which require larger pluralities to reach a decision are optimal if and only if members' private signals are sufficiently accurate. Consider the case of unanimity rule - construe this as a special case of where the size of a plurality required to overturn a decision is as large as the committee itself, \( n \). The noisier members' private signals, the less certainty surrounding the which alternative is correct. In turn, this decreases the likelihood that any member \( j \) will have a bearing on the outcome. Under unanimity, this occurs only when \( n - 1 \) members have the same signal. Consequently, members are less likely to invest in attaining information due to the expectation that their vote will not impact on the group decision. This finding is not dependent on the cost of information and other preferences. In terms of committee size, Persico makes much the same point as M: if members' incentives for acquiring information decrease with an increasing committee size, there is an argument for keeping committee sizes small.

However, the game-theoretic literature on committee decision making suffers from the same criticisms that can be levelled at naive CJT. In relation to monetary policy, Gerling et al (2003) attest that much of the literature does

"...not seem to perfectly relate to the institutional set-up which governs actual monetary policy decisions. One may just think of the literature that studies strategic voting in a set up where there is no communication among committee members. In monetary policy committees communication certainly plays a major role."\(^57\)

In spite of such criticisms, some normative conclusions can be drawn from the jury-games literature. In Persico and M, when information is costly to acquire, a small committee is preferable to a larger one. This is because it is more likely to make a correct decision. This suggests that MPCs should not be too big. Secondly, unanimity rule is not preferable as a means of reaching a decision (Feddersen and Pesendorfer (1998), Persico (2003)), as it leads to inefficient information aggrega-

\(^{57}\) p.40.
tion, especially in the presence of a noisy signal. Majority rule is perhaps more optimal as decision mechanism than unanimity for an MPC.

## 2.6 Evidence Based Literature

### 2.6.1 Studies of Bank of England MPC voting behaviour

Due to the BoEMPC being in its infancy, empirical studies of *insider-outsider* behaviour are, as one might reasonably expect, uncommon. Breedon and Castle (2002), Budd (1999) and Matthews (1999) all address the issue of individual voting behaviour, but are best described as detailed commentaries. A notable exception is Gerlach-Kristen (2003, 2004). Gerlach-Kristen (2003) provides a detailed breakdown of *insider-outsider* behaviour based on the MPC's voting record for the period June 1997-April 2003. Her analysis evidences significant differences in the *dissent* voting behaviour of insiders and outsiders over the sample period. However, although she suggests highly plausible reasons as to why insider-outsider behaviour may differ, her analysis is brief. In a subsequent paper, Gerlach-Kristen (2004) shows that the voting record of the MPC can be used to predict future changes in monetary policy. Using ordered logit analysis, results are shown to be robust to inclusion of variables pertaining to market participants’ expectations of future interest rates. Further, publication of Minutes of MPC meetings is seen to increase the transparency of monetary policy, as market participants are seen to respond to the voting information contained in voting record. However reaction functions are not estimated for *insiders* and *outsiders* separately, something which is pursued in Chapter 5 of this thesis.

### 2.6.2 Studies of other Monetary Policy Committees

There exist a considerable number of studies examining the voting behaviour of members of the United States *Federal Open Market Committee* (FOMC). The FOMC is a much older institution than its British counterpart, and has a correspondingly longer voting record. Indeed, that the FOMC voting record spans decades, as opposed to just over six years, means that one should perhaps not be surprised to that such studies are relatively abundant, when compared to say, studies of BoEMPC voting behaviour.\(^{58}\) Meade and Sheets (2002) categorize the literature on FOMC voting as falling into two distinct categories - work moti-

\(^{58}\)Canterbery (1967) and Yohe (1966) are the seminal contributions.
vated by the 'partisan theory of politics' and work falling in the 'reaction function' genre. Belden (1989), Havrilesky and Schweitzer (1990) and Gildea (1990) exemplify studies which fall into the former class. In Belden (1989), the record of dissenting votes from minutes of FOMC meetings is analysed with a view to identifying the political and economic factors affecting dissent. Bank presidents are shown to dissent more often than Board members, with members of the Board preferring to dissent on the side of ease. Further, the level of dissent is shown to vary under different FOMC Chairmen and uncertainty about the economic and financial results of policy actions. A key conclusion of her study is the suggestion that dissent behaviour is a function of the appointments procedure to the FOMC: Bank presidents are said to dissent for tighter policy more often than Board members because the nature of the appointments procedure makes them more independent of central government. Havrilesky and Schweitzer (1990) posit that dissent voting is a function of the career backgrounds and experiences of FOMC members. They report estimates obtained from binary probit analysis which favour the hypothesis that FOMC members with career experiences and backgrounds 'closer' to central government prefer to cast dissenting votes on the side of ease, whilst those members whose experiences are relatively further from of central government are more likely to dissent on the side of tightness. Specifically, Havrilesky and Schweitzer (1990) estimated a regression of the form

$$Z_j = x'_j \beta + u_j$$  \hspace{1cm} (2.22)

where $Z_j$ is a binary variable capturing a dissenting votes on the side of ease $[Z_j = 0]$ and on the side of tightness $[Z_j = 1]$ respectively. $x'_j$ is a matrix of explanatory variables containing information pertaining to both the type of member responsible for casting the vote and their career backgrounds and experiences.

Variables to proxy for an FOMC member’s ‘career proximity’ to central government based on members’ career characteristics, were constructed by calculating the difference between the mean yearly experience for that characteristic for a given

\[ f(u_j) = \frac{e^{u_j}}{(1 + e^{u_j})^2} \]
meeting and the number of years experience for that individual. However, two major criticisms can be levelled at these studies. First is the charge that macroeconomic variables are not used to explain individual voting behaviour. In this respect, omitted variable bias is a potential cause for concern in these studies. Second, many studies restrict their datasets to include dissenting votes only, thereby ignoring any potential extra information embodied in non-dissenting votes which may shed further light on partisan behaviour. It is worth noting here that analysis of the FOMC voting record shows that dissenting votes typically comprise a small proportion of all votes cast at FOMC meetings. For example, Meade and Sheets (2002) report that over the period 1978-2000, of 2403 votes cast, only 198 were classified as dissenting in nature. This amounts to about 8% of all votes cast. Chappell, Havrilesky and McGregor (1993, 1995) are notable for addressing both of these issues, and look for evidence of partisanship by estimating reaction functions for FOMC members based on both members' career characteristics and economic conditions using all votes. Their methodology has the advantage of making use of all of the information contained in members votes, as well as enabling a test of partisanship based on career experiences and backgrounds whilst controlling for economic conditions. Chappell, Havrilesky and McGregor (1995) find that where partisan behaviour does arise, it is invariably attributable to the appointments procedure, concluding that

"...experience in government, particularly at the Federal Reserve Board, is associated with significantly stronger preferences for monetary ease...Governors, who are presidential appointees, are more inclined are more inclined to advocate easier policies than are District Bank Presidents. Among Bank Presidents there is notable variation by Banks, and among Governors, there are systematic differences related to the partisan affiliation of the appointing President."  

Tootell (1991a,b), Meade and Sheets (2002) and Chappell and McGregor (1998) can be said as falling into the 'reaction function' camp. Such studies model

---

61 More formally, Havrilesky and Schweitzer constructed the variable \( \bar{x}_{h,m,t} = x_{h,m,t} - \bar{x}_{m,t} \), where \( \bar{x}_{h,m} \) is the difference in the mean value for a given career characteristic \( m \) across all FOMC members present at a given meeting in period \( t \), and member \( h \)'s individual value for characteristic \( m \). Therefore, just as the composition of the FOMC changes through time, so do the mean career characteristics of its members.

62 i.e. votes cast in agreement with the majority at each FOMC meeting.

63 This is a detail acknowledged by Havrilesky and Schweitzer (1990).

the voting behaviour of FOMC members a function of the economic environment. Using a multinomial logit framework to estimate FOMC members’ reaction functions, Tootell (1991b) fails to find evidence in support of the hypothesis that the “FOMC policy votes of Federal Reserve Bank presidents are more ‘conservative’ than those of their Board Governor counterparts”. The log-likelihood equation ratio test fails to reject the hypothesis that the coefficients of bank presidents are identical to those of governors. In other words, the voting behaviour of Reserve Bank Presidents is no different to Board members. Further, in a related paper Tootell (1991a) also fails to find support for the hypothesis that District Bank presidents set policy according to regional, and not national economic conditions. In both papers Tootell (1991a,b) uses forward looking variables in the form of Greenbook estimates of GDP growth and inflation as covariates - this is “because monetary policy affects the economy only with lags, the FOMC’s expectations of GNP growth and inflation can be used to determine its votes.” Contrary to these findings, Meade and Sheets (2002) find evidence in support of the hypothesis that District Bank presidents set monetary policy with regional economic conditions in mind. However, their results were obtained using ordered probit as opposed to the multinomial logit estimation. In Andersson et al (2001), the authors find that the voting record of members of the Swedish Riksbank’s Executive Board have a bearing on investors’ expectations of future movements in the repo-rate. In a dynamic setting, the minority view of Executive Board members is found to slightly impact domestic short-term interest rates, signaling that markets adjust monetary policy expectations in line with the minority view. The magnitude of the response is determined to be close to estimates reported for the BoEMPC reported in Gerlach-Kristen (2004). The result of selected FOMC studies are shown in TABLE 2.1 and TABLE 2.2.

### 2.7 Experimental Literature

Blinder and Morgan (2000) and Lombardelli et al (2002) provide experimental support to a growing contention that delegating monetary policy to a committee is preferable to a single central banker: simply put, groups make better decisions

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65 Allen et al (1997) employ the multinomial logit model to estimate FOMC reaction functions under different Chairmen for the period 1970-1985. Results indicate that the FOMC reacted quite differently when setting interest rates under Arthur Burns, William Miller and Paul Volcker respectively. This study does not rely on the FOMC voting record, instead using the decision made by the FOMC each period as the dependent variable. Given the relative infancy of the MPC, a similar study for the UK is as yet infeasible.
than individuals. Blinder and Morgan set out to test the old adage that ‘two heads are better than one’ and designed an experiment with the formulation of monetary policy specifically in mind. Students at Princeton University - all of whom had previously had some exposure to macroeconomics - were asked to play a monetary policy game. Subjects were presented with a computer-simulated economy which was prone to random shocks. Details of the underlying specifications on the model were elusive to participants, although the probability distribution governing the likelihood of a stochastic shock was common knowledge. The objective of monetary policy was to stabilize the economy in the face of such shocks through appropriate adjustments to the interest-rate. Participants were given responsibility for the conduct of policy (i) acting alone and (ii) as part of five member committee. Committees were found to make better decisions than individuals, but required no more information to reach them. Further, decisions made by committees took no longer than those taken by individuals. To sum up Blinder and Morgan’s findings,

“If groups make better decisions and require no more information to do so, then two heads - or in this case, five - are indeed better than one. Society is, in that case, wise to assign many important decisions, like monetary policy, to committees.” (p.44)

Lombardelli et al (2004) replicate the Blinder and Morgan study using economically literate undergraduate and postgraduate students from the London School of Economics. Participants were required to play a simple monetary policy game, setting the interest-rate policy both on an individual basis, and collectively as members of five member committees. As in Blinder and Morgan, policy set by committee was found to be superior to that when set by players acting alone, and according to Lombardelli et al, attributable to the ability of players to pool information and learn from one other. In short, their results strongly reinforce the findings of Blinder and Morgan.

2.8 Conclusions

This chapter has reviewed a wide array of literature which is of relevance to decision making by monetary policy committees. Several avenues of enquiry have been pursued. I began by turning to history. The work of the Marquis de Condorcet in the eighteenth century demonstrates that the study of how groups reach decisions is not a new phenomenon, especially when one considers that the paradox
of voting and the eponymous Jury Theorem are over three hundred years old. The paradox of voting has been intensively studied, whereas CJT only began to receive considerable attention following an important paper by Austen-Smith and Banks (1996). I then presented empirical evidence which confirmed the near ubiquity of MPCs as vehicles for setting the interest rate. Monetary Policy Committees were shown to differ considerably in terms of size, member composition, members’ voting rights and the procedure by which decisions are made. The conclusions from the theoretical literature are mixed. CJT implies not only that a group of individuals should be better at setting monetary policy than a single policy maker, but that the more one increases the size of an MPC, the more likely it is to make a correct decision. This represents a particularly dubious claim, especially given that from a common sense perspective, expanding the size of an MPC indefinitely could only hinder policy making.

The section on Theory Based Literature pulled together contributions including extensions to the monetary policy games literature, the jury games literature and contributions models geared specifically towards how MPCs make decisions. The findings were manifold, although not always in agreement with each other. Committees produce smoother inflation paths than unitary agents (Sibert (2003), Gerlach Kristen (2004)) and it is preferable for votes to be published immediately, as opposed to with a lag (Sibert (2003)). Whereas the Jury Theorem suggests that an MPC should be as large as possible, once the assumption of sincerity is unsheathed (Austen-Smith and Banks (1996)), this is no longer the case, especially when information acquisition is not costless (Mukhopadaya (2004)). This leads to the suggestion that the optimal size of an MPC is smaller rather than larger. If one views an MPC as a network of individuals, then assuming that extracting members’ signals is computationally too burdensome to process, it may be apposite to model MPC decisions using a boundedly-rational approach, where information is treated as new in each period (DeGroot (1974), DeMarzo et al (2003)). This latter point shows how from a methodological perspective, one does not have to adopt a fully rational approach to modelling MPC decision making behaviour.

In Empirical Based Literature studies of MPC voting behaviour were reviewed, particularly those which examine the voting behaviour of members of the United States Federal Open Market Committee (FOMC). The literature suggests that it is not just economic conditions which determine how an MPC member
votes. Factors such as career experiences, a member's type (i.e. Board Governor or Bank President) and career incentives come into play. Further, it was shown that the voting record can be used as a predictor of future interest-rate changes (Andersson et al. (2001), Gerlach-Kristen (2004)). Lastly, experimental evidence suggests that committees make better decisions than individuals, implying that delegating monetary policy to a committee works not just in theory but in practice too. I now turn to Part III, which develops theoretical models of monetary policy committee voting behaviour.
<table>
<thead>
<tr>
<th>Study</th>
<th>Genre</th>
<th>Econometric methodology</th>
<th>Variables</th>
<th>Estimation Period</th>
<th>Aim</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belden (1989)</td>
<td>Partisan theory of</td>
<td>Paired t-test</td>
<td>The record of dissenting votes from FOMC meetings; interest rate</td>
<td>1970:2-1987:11</td>
<td>Four questions were posed: (1) Are policy preferences of reserve bank presidents differ from those of members of the Board? (2) Does uncertainty about the economic and financial results of policy actions affect the level of dissent? (3) Is there a difference in the pattern of dissent under different chairmen? (4) Is there effective political influence on monetary policy makers? (5) The data do not provide support for the political business cycle hypothesis nor for legislative control over policymakers. (p.440-441)</td>
<td></td>
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<tr>
<td>Havrilesky and Schweizer (1990)</td>
<td>Partisan theory of</td>
<td>Binary probit analysis</td>
<td>The record of dissenting votes from FOMC meetings; interest rate; FOMC member career characteristics</td>
<td>1960-1983</td>
<td>To develop and test a theory that predicts the voting of individual FOMC members who dissent on the side of tightness or ease, based on FOMC member career characteristics. The theory predicts that the more proximate the member's career characteristics are to central government, the greater the number of his or her dissenting votes on the side of ease. (p.197)</td>
<td>The analysis provides support for the theory that career characteristics have significance bearing on individual FOMC member voting behaviour.</td>
</tr>
<tr>
<td>Havrilesky and Gildea (1991)</td>
<td>Partisan theory of</td>
<td>Binary probit analysis</td>
<td>The record of dissenting votes from FOMC meetings; interest rate; FOMC member career characteristics</td>
<td>1960-1983</td>
<td>Rejoinder to Belden (1989). HG argue that Belden omits three influences on FOMC behaviour which could explain her findings, namely (1) Career and background of FOMC members (2) the state of the economy (3) the explicit appointment procedure for FOMC members.</td>
<td>Rejoinder to Belden (1989). HG argue that Belden omits three influences on FOMC behaviour which could explain her findings, namely (1) Career and background of FOMC members (2) the state of the economy (3) the explicit appointment procedure for FOMC members.</td>
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### Selected FOMC studies (continued)

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<th>Econometric methodology</th>
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<th>Estimation Period</th>
<th>Aim</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toossi (1991b)</td>
<td>Reaction</td>
<td>Multinomial logit</td>
<td>US federal funds rate; data on current/contemporaneous regional economic conditions; Greenbook estimates of real GNP growth, implicit price deflator growth and unemployment; voting data for District Presidents, Board members and Chairmen.</td>
<td>1965-1985</td>
<td>To determine whether the FOMC policy votes of Federal Reserve Bank presidents are more &quot;conservative&quot; than those of their Board governors counterparts. (p.5)</td>
<td>&quot;District Bank presidents set policy dependent on national, not their regional conditions.&quot; (p.3)</td>
</tr>
<tr>
<td>Allen et al (1997)</td>
<td>Reaction</td>
<td>Multinomial logit</td>
<td>US federal funds rate; Greenbook estimates of both real GNP growth and implicit price deflator growth; ARMA(1,1) forecasts of unemployment rate; number of months of experience of FOMC Chairmen; number of months in office of FOMC governors.</td>
<td>1970:2 - 1985:12</td>
<td>Federal Reserve policymakers vote on one of three policy choices: tighter, looser or unchanged monetary policy. Allen et al model this decision as a function of unemployment, real growth and inflation and the experience of the Board of FOMC governors and Chairmen. This is done with a view to discerning if the FOMC reacted differently to policy under different FOMC Chairmen.</td>
<td>The FOMC reacted differently to its three policy objectives: growth, inflation and unemployment under each of the three chairs when the three policy variables and two experience variables of the chair were included in the model. (p.36)</td>
</tr>
<tr>
<td>Meade and Sheets (2002)</td>
<td>Reaction</td>
<td>Ordered logit</td>
<td>FOMC voting records of Board members and regional Reserve Bank presidents; interest rate; FOMC member career characteristics and regional affiliations; regional unemployment data; national measures for industrial production, output gap (calculated using HP filter), monthly inflation rate, CPI data (monthly year on year estimates).</td>
<td>1978-2000, 214 meetings</td>
<td>The authors look for &quot;...systematic evidence that policymakers have cast their votes according to economic developments in their region rather than focusing exclusively on developments in the national economy.&quot; (p.11)</td>
<td>Policymakers at the Fed consider regional unemployment when formulating monetary policy. Regional developments are more important for FOMC Board members than for Reserve Bank presidents.</td>
</tr>
</tbody>
</table>

**TABLE 2.2.**
Part III

Monetary Policy and Theories of Committee Voting Behaviour
Chapter 3

Monetary Policy Committees and the Free-Rider Problem

“Success is dependent on effort.” Sophocles, 496-406 BC.

3.1 Introduction

Groups of individuals are responsible for making important decisions in an array of bodies and organisations in society. Consider, for example, the role of a jury. In criminal trials, juries have the task of determining the guilt or innocence of a defendant, and it is frequently argued they are less likely to make howling errors such as convicting innocents or acquitting the guilty, than would any individual in isolation.\(^1\) In much the same way that juries are a prominent feature of judicial systems across the world, so too are monetary policy committees, albeit in the sphere of economic policy making. As is the case for a jury, it is imperative for a monetary policy committee to make the correct policy choice, and arguments for the institution of monetary policy committees are no different that those advocated for juries. For instance, delegating monetary policy to a committee is often justified on the grounds that “two heads are simply better than one.”\(^2\) On this assertion, a policy maker in isolation is less likely to make the correct policy choice than would a committee.

This chapter builds on recent work in the jury-games literature where jurors’ private signals cannot be acquired costlessly, incentivising individuals to free-ride on the signals of others. It examines the consequences of such a feature for mon-

\(^1\) Consequently, the institution of juries and their associated propensity for making correct decisions increase social welfare through engendering confidence in the legal system. It is unarguable that like juries, MPCs make decisions which affect social welfare - consider how an MPC choosing an inappropriate policy stance may have lasting macroeconomic consequences.

etary policy decision making by committee and the individuals that comprise it. In the analysis I reassess the basic result in a recent paper by Kaushik Mukhopad-
haya (2003), henceforth M, that when jurors acquire costly signals about a de-
fendant’s guilt, the probability of reaching a correct verdict may in fact decrease as jury size increases. The result is contrary to the Condorcet Jury Theorem [Condorcet (1785), Grofman (1978), Miller (1986), Boland (1989), Karotkin and Paroush (2003)], which shows that as the size of a group increases, its judgmental competence approaches perfection. M’s result obtains because under costly information acquisition, as the size of the group increases, individuals have more incentive to free-ride on the signals of others. That is, individuals are incentivised to expend less effort in paying attention to their own private signals as group size grows. As a consequence, the probability of a group making a correct decision under majority rule is decreasing in group size. This result is shown by M to hold under both a perfect and imperfect costly signal. The underlying theoretical framework is consistent with Austen-Smith and Banks (1996), henceforth ASB, although the parameter values are restricted throughout to the case where rational voting is sincere and informative. This occurs when the optimal voting mechanism is simple majority rule. Under such conditions, and assuming costless information acquisition, the model exhibits the properties of naïve CJT, albeit in a rational voter context.\textsuperscript{3,4}

Given that a key motivation of this chapter is to draw out the implications of

\textsuperscript{3}The set-up of the game is such that sincere voting is rational and informative (Austen-Smith and Banks (1996)). Jurors’ decisions are effectively determined by their respective signals. This occurs under conditions where majority rule is both the aggregation rule of choice and the optimal procedure for aggregating members’ information. Sincere voting is informative if

\[
\frac{qG}{1 - qI} > \frac{\pi}{1 - \pi} > \frac{1 - qI}{qG}
\]

and

\[
\left(\frac{qG}{1 - qI}\right)^{JNL} \left(\frac{qG}{1 - qI}\right)^{J_{L+1}} > \frac{\pi}{1 - \pi} > \left(\frac{1 - qG}{qI}\right)^{J_{NL+1}} \left(\frac{qG}{1 - qI}\right)^{J_{L}}
\]

Setting \(\pi = \frac{1}{2}\) and setting \(qG = qI = q \in (\frac{1}{2}, 1)\), rewrite (3.2) as

\[
\frac{q}{1 - q} > 1 > \frac{1 - q}{q}
\]

\textsuperscript{4}Many key contributions in the jury-games literature succumb to the criticism of assuming costless signals. Wit (1998), Feddersen and Pesendorfer (1996), McLennan (1998), Coughlan (2000), are notable for neglecting the consequences of costly signal acquisition. In this sense, the contributions from Mukhopadhyaya (2004) and Persico (2004) are noteworthy for redressing this imbalance.
free-riding for a monetary policy committee, the assumption of simple majority rule à la ASB is particularly apposite: as noted by Fry et al (2000), SMV is the statutorily prescribed decision mechanism for a considerable number of real-world monetary policy committees, such as the body responsible for setting the repo-rate at the Bank of England.\(^5\) Perhaps more crucially, it is not implausible to associate free-riding with members of an MPC. Goodfriend (1999) suggests that when members of a relatively large MPC like the FOMC realise their individual influence may be small, they may free-ride on the preparations of those members who are “more expert, interested or responsible for monetary policy, such as the Chairman and the Board Staff.”\(^6\) Free-riding is undesirable as it potentially reduces the size of the committee, and is all but undetectable. This is because free-riders are able to contribute seemingly astute statements which in practice merely echo the views of more dominant members. Free-riders thus masquerade behind the preparations and opinions of others. The benefits associated with a heterogeneous committee - such as a wide range of views - are hence greatly reduced.

Underpinning M’s analysis, three particular assumptions are of note, which when applied to members of an MPC rather than a jury read as follows: (i) the optimal MPC size should maximize the probability of an accurate decision; (ii) each MPC member’s payoff when no individual pays any attention is zero, which is denoted as \(\phi(0) = 0\) and (iii) although M presents the solutions for a wide range of equilibria, he ignores a kind of equilibrium which is neither completely mixed nor a pure strategy equilibrium.\(^7\) Call this unreported class of equilibrium asymmetric mixed-strategy equilibrium. Asymmetric-mixed-strategy equilibrium has out of \(n\) MPC members, \(k\) playing the symmetric mixed-strategy \(a^*(k : c, q)\) and the remaining \(n-k\) members paying no attention with probability 1. This effectively means that \(n-k\) players shirk.

The first assumption, motivated by the Condorcet Jury Theorem, turns out to be equivalent to the maximization of expected benefits of accurate verdicts less expected costs of inaccurate verdicts (type I and type II errors), given M’s assumption that the accurate verdicts yield payoffs equal to 1 and inaccurate ver-

---

5A simple majority of members is all that is required for a decision to be made in many MPCs: in Fry et al, of 79 countries where monetary policy is delegated to a committee, just under half - specifically, 36 committees - reach a decision through the application of a formal voting procedure, typically SMV.


7The jurors, for instance, play a symmetric mixed-strategy equilibrium in a binary-decision, information gathering game - pay attention or don’t pay attention.
diets yield zero payoffs. But if such welfaristic interpretation is to be imposed, the implicit social objective in M would still be incomplete as it ignores MPC members’ information gathering costs. Since information gathering costs are likely to vary with MPC size, *a priori* it is not clear that the MPC size that maximizes the probability of an accurate decision would necessarily maximize the expected social welfare of verdict decisions (net of the information gathering costs). Similarly, it is not clear how social welfare would change with the increase in MPC size. These issues are addressed.

M justifies the second assumption by claiming that a positive valued $\phi(0)$ “would bias results toward more free-riding, but would not qualitatively change the findings”. This claim is not straightforward. M notes that in a jury, the increased free-riding tendency is definitely true for any given number of jurors, hence each juror pays attention with a lower probability for both small and large juries. Yet whether this necessarily implies a relatively greater reduction (due to positive $\phi(0)$) in the probability of reaching a correct verdict for larger juries is unclear. The same logic is assumed to carry over to members of a monetary policy committee, and the implications of such an assumption for the question of optimal MPC size should be properly examined. Indeed, M assumes that if nobody pays attention, an incorrect decision is reached with payoff zero to each juror. This simplistic assumption is questionable. Even with a perfect signal, when jurors pay no attention they might still harbour a guess as to the innocence or guilt of the defendant. In particular, jurors might be guided by their priors. If nature chooses the state innocent with probability $\frac{1}{2}$ and guilt with equal probability, the expected utility from not paying attention for either state would be $\frac{1}{2}$. M writes

“In the real world, jurors can pay attention and still reach a wrong decision. This means that having one attentive juror does not guarantee reaching a correct decision.” (p.29)

M does not consider that when guided by their priors, jurors can pay no attention and *still* reach a correct decision, and even having one inattentive juror does not guarantee reaching a wrong decision. Likewise, even having one inattentive MPC member does not guarantee reaching a wrong policy decision.

---

9$\phi(0)$ can be positive if the defendant is declared guilty with probability $\frac{1}{3}$, when the number of signals indicating guilt equals the number of signals indicating innocence.
10This is similar to the concept of minimal competence [Miller (1986)].
With respect to the third assumption, ruling out possible asymmetric mixed-strategy equilibria, where some individuals play mixed strategies and others play pure strategies (i.e., pay no attention), would have been more acceptable if one can show that the symmetric equilibrium would Pareto dominate the asymmetric equilibria. However, M does not consider developing this avenue of investigation, and only briefly acknowledges the possibility of such equilibria. This possibility is therefore also examined for an MPC.

The chapter proceeds as follows. I begin by 'relocating' the setting of the game from a jury to a monetary policy committee (MPC). Rather than having to choose between finding a defendant innocent or guilty, members of an MPC must determine whether to inflate (I) or not inflate (NI) the economy.\(^{11}\) I then explicate the core findings in M, contrasting equilibria derived under the conflicting assumptions of $\phi(0) = 0$ and $\phi(0) = \frac{1}{2}$. Indeed, the assumption that $\phi(0) = 0$ is shown to penalize no attention by all MPC members, effectively biasing the pure strategy and mixed-strategy equilibrium towards paying attention, under both perfect and imperfect signals. Further, it is noted that some of the results reported by M are replicated for completeness. Equilibrium solutions are presented for both perfect and imperfect signals, specifically asymmetric pure-strategy Nash equilibria and symmetric pure-strategy Nash equilibria, symmetric mixed-strategy Nash equilibria and finally, asymmetric mixed-strategy Nash equilibria. With respect to the latter solution concept, it is shown that asymmetric mixed-strategy equilibria exist, and the best such equilibrium (in terms of the probability of reaching a correct monetary policy decision) for any given MPC size is equivalent to a symmetric equilibrium corresponding to a smaller MPC. Therefore, by varying the MPC size and comparing across the best asymmetric equilibria, it is determined that the probability of making the correct policy choice is maximized for a particular MPC size and this probability will remain unchanged with further increases in MPC size. Thus if one focuses on the best asymmetric equilibrium, M's main result about larger juries strictly lowering the probability of accuracy - or in the context of this chapter, larger monetary policy committees - is somewhat mitigated.\(^{12}\) Importantly, the asymmetric equilibria neither Pareto dominate, nor are Pareto dominated by, the symmetric equilibrium of M. Asymmetric equilibria are essentially no less compelling as a plausible description of equilibrium. I now

\(^{11}\)The restriction to a binary choice is no different to the choice faced my the monetary authorities in much of the policy games literature.

\(^{12}\)This remains true whether $\phi(0) = 0$ (Mukhopadhaya's assumption) or for $\phi(0)$ positive.
turn to examination of the case of a perfect signal.

### 3.2 Play Under a Perfect Signal

The so-called ‘civic duty’ game of Rasmusen (2001) underpins the theoretical framework. In this set-up, players observe a crime in progress. Witnesses to the crime have the opportunity of calling the police, with the prospect that having been notified, the police may catch the perpetrator in *flagrante delicto*. If nobody pays attention - or rather, nobody phones the police - then there is obviously no benefit to anyone. Assuming nobody else intervenes, or the police arriving at the scene by chance, the criminal will get away. Here, the ‘cost’ is associated with the act of reporting the crime to the police whilst the crime is in progress. I apply this framework to *n* risk-neutral members of a monetary policy committee, essentially presenting an ‘MPC duty’ game. Players are confronted with a binary choice: namely, the state of the world is that the economy needs *Inflating* or *Not Inflating*, \{I, NI\}. The outcome of MPC deliberations is that inflation is *Required* or *Not Required*, \{R, NR\}. The uncertainty about the true state is denoted by a common prior probability \( p = \frac{1}{2} \) that the true state is \( NI \). Each member’s payoffs over outcomes and states - which are the same as society’s payoffs\(^{13}\) - are \( U(R, I) = U(NR, NI) = 1 \) and \( U(R, NI) = U(NR, I) = 0 \). This says that a payoff of 1 is received from making the correct policy decision, and a payoff of 0 is received for an incorrect policy decision. For example, \( U(R, I) \) is the utility from inflating the economy \( I \) when inflation is required \( R \), \( U(R, NI) \) is the utility from not inflating the economy \( NI \) when inflation is required \( R \), and so on.

During the course of MPC deliberations a member who pays attention receives a private signal \( S_0 \) or \( S_1 \) about the true state of the world where \( Pr[S_1|I] = Pr[S_0|NI] = q = 1 \). In other words, the signal is perfect.\(^{14}\) MPC members choose an alternative by majority voting, and there is a cost associated with paying attention. In the case of a tie, the decision to inflate or not inflate is chosen with probability \( \frac{1}{2} \). With these assumptions, sincere and informative voting is rational.\(^{15}\) MPC members who do not pay attention observe and follow the majority voting of the informed members. The specific voting rule to be used will be unimportant, as

\(^{13}\)Or the mechanism designer’s payoffs.

\(^{14}\)It is noted here that under an imperfect signal - discussed later - it is assumed that \( q \in (\frac{1}{2}, 1] \). This is equivalent to assuming that if MPC members pay attention, they can do no worse that making a decision based on flipping a fair coin.

\(^{15}\)I.e., expected utility maximizing voting in accordance with the signal received.
the jurors share their information costlessly before they vote. To help shape ideas, consider the two player normal form game under a perfect signal, as depicted by the payoff matrix shown in Figure 3.1. Letting $A$ and $NA$ stand for Attention and No Attention respectively, let

$$ a < b - c < b $$

where $a$ is the payoff when neither member pays attention (denoted as $\phi(0) = a$), $b$ is the payoff to the column (row) player from paying no attention when the row (column) member pays attention, $c$ is the cost associated with paying attention, and $b - c$ is the payoff to the row (column) player from paying attention when the column (row) player pays no attention. The terms $\sigma$ and $(1 - \sigma)$ denote the probabilities of paying Attention and No Attention respectively, and it is further assumed that $a$, $b$ and $c$ are all non-negative. Under this structure, it is clear that there exists asymmetric pure-strategy Nash-equilibria under which one player pays attention whilst the other does not. In other words, an equilibrium occurs which is characterised by the column (row) player free-riding on the attentive behaviour of the row (column) player. However, because this chapter is concerned with how a monetary policy committee - which typically consists of more than two individuals - makes decisions, all further analysis focuses on the $n$ player game.

### 3.2.1 Asymmetric and Symmetric Pure-Strategy Nash Equilibria

Assuming the condition given in (3.4) holds, when all players adopt pure strategies the game is characterised by $n$ asymmetric pure-strategy Nash equilibria, where only one player is paying attention. Yet this solution lacks a focal point. It is not clear how MPC members are able to determine who the attentive individual is, and assuming that all members share the same characteristics, no clear candidate emerges. However it is noted that for $c \in [b-a, b)$, there exists a unique symmetric pure-strategy Nash equilibrium under which no member pays attention. It is in
no member’s interest to expend effort in acquiring a signal: guessing is preferable
to investing time in costly signal acquisition. This occurs when the condition in
(3.4) is contravened such that \( b - c < a < b \), or put another way, when the cost
of paying attention is greater than the the payoff from paying no attention when
another member pays attention, \( b \), less \( \phi(0) = a \), the payoff to members when
nobody pays attention (i.e. if \( c > b - a \)).

3.2.2 Symmetric Mixed-Strategy Equilibrium

In the case of an \( N \) player game, \( M \) obtains the *symmetric mixed-strategy equi-
librium*. This is achieved through application of the *payoff-equating method*. To
achieve this, initially impose the condition that \( \sigma_i = \sigma \), for \( i = (1, 2, ..., N) \) play-
ers. The probability of a single committee member choosing not to pay attention
is \( (1 - \sigma) \). Therefore, the probability that none of the remaining \( N - 1 \) committee
members pays attention is given by \( (1 - \sigma)^{N-1} \). This implies that the probability
of one or more members choosing to pay attention is given by \( 1 - (1 - \sigma)^{N-1} \). For
any player \( i \) - this can be either the *Row* player or the *Column* player - the utility
from playing \( A \) is given by:

\[
U(A) = (1 - (1 - \sigma)^{N-1})(b - c) + (1 - \sigma)^{N-1}(b - c)
\]

with a corresponding utility for playing \( NA \) given by

\[
U(NA) = (1 - (1 - \sigma)^{N-1})b + (1 - \sigma)^{N-1}a
\]

In a mixed-strategy equilibrium, members are indifferent between choosing *Attention (A)* and *No Attention (NA)*.

\[
U(A) = U(NA)
\]

which equals

\[
(1 - (1 - \sigma)^{N-1})(b - c) + (1 - \sigma)^{N-1}(b - c) = (1 - (1 - \sigma)^{N-1})b + (1 - \sigma)^{N-1}a
\]

Simplifying the expression yields

\[
c = (1 - \sigma)^{N-1}(b - a)
\]
Solving for $a$ gives the mixed-strategy equilibrium:

$$\sigma^*(n; c) = 1 - \left(\frac{c}{b-a}\right)^{\frac{N-1}{N}} \quad (3.10)$$

To obtain the probability, $\Phi(n; c)$, that an MPC of size $N$ reaches a correct decision plug $\sigma^*(n; c)$ into

$$\Phi(n; c) = 1 - (1 - \sigma^*)^N \quad (3.11)$$

Simple manipulation now yields

$$\Phi(n; c) = 1 - \left[1 - \left(1 - \left(\frac{c}{b-a}\right)^{\frac{N-1}{N}}\right)^N\right] \quad (3.12)$$

And ultimately

$$\Phi(n; c) = 1 - \left(\frac{c}{b-a}\right)^{\frac{N-1}{N}} \quad (3.13)$$

Note that the set-up considered by $M$ is just a special case where $a = 0, b = 1$ and $c \in (0, 1)$, an assumption which is scrutinised in the rest of this chapter. Specifically, the two assumptions $\phi(0) = 0$ and $\phi(0) = \frac{1}{2}$ are compared, the latter being equivalent to a game where $a = \frac{1}{2}, b = 1$ and $c \in (0, 1)$. This latter assumption says that in a monetary policy setting, it is possible for MPC members to pay no attention, flip a coin, and arrive at a correct decision with probability $\frac{1}{2}$. In setting $\phi(0) = 0$, M's approach misses something important: a trial setting is quite different from Rasmusen's original 'civic duty' game. Assuming abstaining is not permitted, a group of inattentive MPC members may still arrive at a correct decision by guessing. This strengthens the argument for $\phi(0) = \frac{1}{2}$. Guided by her priors, if it is common knowledge that nature chooses the state Inflate or Not Inflate with equal probability $\frac{1}{2}$, the expected utility for any MPC member $j = (1, 2, ..., J)$ not paying attention when no other member pays attention is $\frac{1}{2}$. This implies that assuming $\phi(0) = 0$, the probability of an MPC member paying attention and of reaching a correct decision is given by

$$\sigma^*_{\phi(0)=0}(n; c) = 1 - c^{\frac{N}{N-1}} \quad (3.14)$$

and

$$\Phi_{\phi(0)=0}(n; c) = 1 - c^{\frac{N}{N-1}} \quad (3.15)$$
(A) Probability of paying attention, \( \sigma \), under a perfect signal for \( n = 1, 2, \ldots, 12 \). \( c = 0.1 \) and 0.3. \( \Phi(0)=0 \) compared with \( \Phi(0)=1/2 \).

(B) Probability of making a correct decision, \( \Phi^* \), under a perfect signal for \( n = 1, 2, \ldots, 12 \). \( c = 0.1 \) and 0.3. \( \Phi(0)=0 \) compared with \( \Phi(0)=1/2 \).

Panel 3.1.
Accordingly for $\phi(0) = \frac{1}{2}$ it follows that

$$\sigma^*_\phi(0)=\frac{1}{2} (n; c) = 1 - (2c)^{\frac{1}{n-1}}$$

(3.16)

and

$$\Phi_{\phi(0)=\frac{1}{2}} (n; c) = 1 - (2c)^{\frac{n}{n-1}}$$

(3.17)

The results in (3.14) and (3.15) lead to the following propositions:

**Proposition 1:** If one attentive MPC member is enough to always reach a correct decision, a larger MPC is less likely to make a correct decision than a smaller MPC in the symmetric mixed-strategy equilibrium of the $n$-player game.

**Proof of Proposition 1:** In the mixed-strategy Nash equilibrium of the game with $n(n > 1)$ MPC members, the probability of paying Attention is $\sigma^*(n; c) = 1 - c^{\frac{1}{n-1}}$ for $\phi(0) = 0$ [equation (3.14)] and $\sigma^*(n; c) = 1 - (2c)^{\frac{1}{n-1}}$ for $\phi(0) = \frac{1}{2}$ [equation (3.16)]. The mixing probability $\sigma^*$ of paying attention monotonically decreases in $n$ under each assumption regarding $\phi(0)$. The greater the number of serving MPC members, the smaller the probability that each of them pays attention. The probability of an MPC reaching a correct decision is $\Phi(n; c) = 1 - c^{\frac{1}{n-1}}$ for $\phi(0) = 0$ [equation (3.15)] and $\Phi(n; c) = 1 - (2c)^{\frac{1}{n-1}}$ for $\phi(0) = \frac{1}{2}$ [equation (3.17)]. Both $\Phi_{\phi(0)=0} (n; c)$ and $\Phi_{\phi(0)=\frac{1}{2}} (n; c)$ are monotonically decreasing in $n$. An MPC is therefore less likely to reach a correct decision when the number of members is large. QED.

With the alternative assumption that $\phi(0) = \frac{1}{2}$, **Proposition 1** still holds, albeit larger MPCs are even less likely to make correct decisions than if $\phi(0) = 0$. For comparison, these probabilities are plotted in PANEL 3.1 (A) and (B). PANEL 3.1 (A) shows how the probability of any given individual paying attention monotonically decreases as MPC size, $n$, increases. Effectively, the larger the MPC, the more incentive a player has to free-ride on the signals of others. As the cost of paying attention increases - plotted here for values of $c = 0.1$ and 0.3 - so too does the likelihood of not paying attention. Further, *ceteris paribus*, replacing the assumption $\phi(0) = 0$ with $\phi(0) = \frac{1}{2}$ has the effect of increasing the likelihood of members free-riding on the signals of others. This demonstrates how assuming $\phi(0) = 0$ has the effect of biasing members towards paying attention. In PANEL 3.1 (B) the corresponding probabilities of reaching a correct decision under a perfect signal are plotted, all monotonically decreasing in MPC size. As $c$ increases, the probability of making a correct decision, holding all other parameter
values fixed, declines. Additionally, changing the assumption $\phi(0) = 0$ to $\phi(0) = \frac{1}{2}$ has, ceteris paribus, the effect of lowering the probability of making a correct decision, as members are incentivised to put in less effort when acquiring their signals.

## 3.3 Play Under an Imperfect Signal

The game under an imperfect signal is now developed. Unlike the case of a perfect signal where $q = 1$, each MPC member who pays attention receives a private signal $S_0$ or $S_1$ about the true state of the world where $Pr[S_1|G] = Pr[S_0|NG] = q \in (\frac{1}{2}, 1]$. To begin with, turn to the sequence of play.

### 3.3.1 Sequence of Play

The sequence of play characterising the game is stylised in Figure 3.2. At the outset of the game, nature decides that a priori, the economy is just as likely to require inflation as no inflation. This is common knowledge amongst all players. MPC members are then confronted with choosing between Attention and No Attention. Should an individual be indifferent between the two alternatives, she is assumed to pay attention. MPC members who decide to be attentive then receive a private signal. Note here that some attentive committee members cannot pay 'more' attention than other attentive MPC members. They either pay attention or not at all. On the basis of their respective signals, members cast their votes simultaneously, and the alternative which receives at least half of the votes is adopted. In the event of a tie, the correct decision is chosen with probability $\frac{1}{2}$. Finally, members receive their payoffs, with a one for a correct verdict, a zero for an incorrect one. Should the member have chosen to pay attention, the cost of doing this is deducted from her payoff. A payoff of zero is received by all committee members if nobody decides to pay attention.

### 3.3.2 Asymmetric Pure-Strategy Nash Equilibria

Under an imperfect signal, $k^*$ out of $n$ MPC members pay attention in asymmetric pure-strategy Nash equilibria. It turns out that $k^*$ is not a function of MPC size, $n$; rather, it is endogenously determined by $c$ and $q \in (\frac{1}{2}, 1]$. Now define $b(m; k, q)$ as "the binomial probability that out of $k$ independent signals, $m$ ($m \leq k$) are
**Figure 3.2:**

Sequence of events in the MPC Duty Game:

\( \Pr(Final \ Decision|Individual \ Decision, \ State \ of \ the \ World) \) represents the probability of an MPC choosing the correct decision, conditional on a member’s individual decision and the state of the world.
correct, given the precision of the signal, $q^m$.\textsuperscript{16} This entails that

$$b(m; k, q) = \binom{k}{m} q^m (1 - q)^{k-m}$$  \hspace{1cm} (3.18)

Now denote $\phi(k)$ as the probability of an $n$ person MPC reaching a correct decision when precisely $k \geq 1$ members pay attention as

$$\phi(k) = \sum_{m=\frac{k+1}{2}}^{k} b(m; k, q), \text{ if } k \text{ is odd}$$  \hspace{1cm} (3.19)

and

$$\phi(k) = \sum_{m=\frac{k}{2}+1}^{k} b(m; k, q) + \frac{1}{2} b(k/2; k, q), \text{ if } k \text{ is even}$$  \hspace{1cm} (3.20)

and

$$\phi(k) = \sum_{m=\frac{k}{2}+1}^{k} \binom{k}{m} q^m (1 - q)^{k-m} + \frac{1}{2} \binom{k}{k/2} q^{k/2} (1 - q)^{k/2}$$

The additional term $\frac{1}{2} b(k/2; k, q)$ in (3.20) corresponds to the probability of a tie between correct and incorrect signals.\textsuperscript{17} (3.19) and (3.20) are in fact mathematical representations of CJT. They show that in the limit, as the number of attentive members tends to infinity, the probability of an MPC arriving at a correct verdict equals one. This result can be ascertained through appealing to a normal approximation to the binomial distribution for large $k$, namely

$$\lim_{k \to \infty} \phi(k) = \lim_{k \to \infty} \Pr \left( z > \frac{k/2 - kq}{\sqrt{q(1-q)k}} \right) = 1$$  \hspace{1cm} (3.21)

Now denote the benefit to the $k^{th}$ member from paying attention when $k - 1$ members pay attention, gross the cost of paying attention as $B(k, q)$. Specifically, this benefit is equal to an increase in the probability that the MPC delivers a correct verdict:

$$B(k, q) = \phi(k) - \phi(k - 1)$$  \hspace{1cm} (3.22)

\textsuperscript{16}M, p.31.

\textsuperscript{17}This calculates the probability that at least $\frac{k}{2}$ (i.e. half) of all attentive jury members reach the correct decision.
Explicitly deriving $B(k, q)$ is somewhat cumbersome. It is important here to
distinguish between MPCs of even and odd size - it turns out that the solution for
$B(k, q)$ is different for odd and even sized committees. For an odd committee, it
can be shown that

$$ B(k, q) = \left( q - \frac{1}{2} \right) b\left(\frac{k-1}{2}; k-1, q\right) $$

$$ = (q - \frac{1}{2}) \left( \frac{k-1}{k-2} \right) q^{\frac{k-3}{2}} (1-q)^{1-\frac{k-1}{2}} $$

for $k > 1$ and $B(k, q) = q$ for $k = 1$. In the case where $k > 1$, $B(k, q)$ is positive
and decreasing in $k$ as $k$ increases in increments of two. For an even sized MPC
$B(k, q) = 0$. Proof of these results are provided in the appendix to this chapter in
Lemma 1. The $k$th MPC member is pivotal under circumstances where her
vote is tie-breaking (when $k$ is odd, $k > 1$) or tie-inducing (when $k$ is even). Yet
$B(k, q)$ needs a little further qualification. Under even $k$, the $k$th member benefits
from tie-inducing behaviour when the vote is changed from a majority of incorrect
votes. A benefit loss is achieved by inducing a tie when the majority of votes are
correct. Given that $q \in (\frac{1}{2}, 1]$, the signal received by the $k$th member is more
likely to be correct than not. However, it is more likely for a committee member
to revert to tie-inducing behaviour when the majority of signals are correct
than incorrect. On those occasions where the $k$th member is pivotal, the payoff
changes by $\frac{1}{2}$. When $q = \frac{1}{2}$, the benefit loss is exactly compensated for by the
benefit gain. The benefit gain to the $k$th juror when precisely $k-1$ members pay
attention for odd $k > 1$ is attributable to the rise in probability corresponding to
making a correct decision when the $k$th member's vote is tie-breaking. When $k$
is odd, $B(k, q)$ monotonically decreases in $k$:¹⁸ this is because as the number MPC
members paying attention increases, the likelihood of a tie arising falls.

Now consider the net benefit to a member from being attentive. This is defined
by $B(k, q) - c$ conditional on $k$ out of $n$ members being attentive. Denote $k^*(c, q)$
as the size of the largest group of MPC members enjoying a positive net benefit
from being attentive. It follows that for $k^*(c, q)$,

$$ B(k^*, q) - c \geq 0 $$

¹⁸Note that for odd $k$, $k$ is assumed here to increase in increments of two.
and

\[ B(k^* + 2, q) - c < 0 \]  

(3.25)

The mathematical properties of \( B(k, q) \) are such that a unique \( k^*(c, q) \geq 1 \) exists for all \( c \in (0, q) \) and \( k^*(c, q) \) is decreasing in \( c \), the cost of paying attention. These properties lead to the asymmetric pure-strategy equilibria in the MPC Duty Game, and the following proposition:

**Proposition 2:** For any \( n > 1 \), \( q \in (\frac{1}{2}, 1] \) and \( c \in (B(n, q), q) \) there exist asymmetric pure-strategy equilibria in which \( k^*(c, q) \in (0, n) \) members pay attention. In the equilibria, \( k^*(c, q) \) is odd and it does not depend on the size of the MPC, \( n \).

The proof of this proposition is straightforward.

**Proof of Proposition 2:** An asymmetric pure-strategy equilibrium does not exist for an even number of attentive MPC members, as the net benefit from being attentive is zero. This is because when \( B(k, q) = 0 \), it necessarily follows that \( B(k, q) - c < 0 \) for positive \( c \). Thus \( k^* \) is odd, and is independent of MPC size, \( n \). The condition that \( c \in (B(n, q), q) \) ensures \( k^* \in (0, n) \). QED.

**Figure 3.3** depicts the net benefit to the \( k \)th member corresponding to \( B(k, 0.65) \). For odd \( k \), \( B(k, q) \) monotonically decreases in \( k \); for even \( k \), \( B(k, q) \) equals zero. Both these results are independent of jury size. For odd \( k \), the unique asymmetric pure-strategy equilibrium obtains where \( k \) is at its maximum value, namely \( k^* = \max(k = 1, 3, 5... , n) > c \). **Figure 3.3** depicts how when \( c = 0.1 \) only a single member is attentive in equilibrium, irrespective of MPC size: \( k^* = 1 \). The implication of this result is that (i) in even sized MPCs, all but one member should acquire signals and (ii) when \( n \) is odd, all members should acquire signals. With increasing MPC size, \( n \), the distance between the unique asymmetric pure-strategy equilibrium widens, as does the optimal number of attentive members. Put another way, individuals serving on larger MPCs are more predisposed to free-riding than those serving on smaller MPCs: the problem of free-riding intensifies as \( n \) increases. Yet as \( n \) increases in size, the decrease in the the probability of making a correct decision approaches \( 1 - \phi(k^*) \). In the limit, it obtains that

\[
\lim_{n \to \infty} \Phi(k) = 1 - \phi(k^*)
\]  

(3.26)

\[
= 1 - q
\]  

(3.27)
In the case where \( B(k, 0.65) \), it follows that \( 1 - \phi(k^*) = 1 - q = 1 - 0.65 = 0.35 \).

### 3.3.3 Symmetric Pure-Strategy Nash Equilibria

Focus now turns to symmetric pure-strategy Nash equilibria. It is determined that its existence is a function of MPC size, \( n \), the signal precision, \( q \in (\frac{1}{2}, 1] \), and \( c \), the cost of being attentive. When all other members are inattentive, the net benefit from paying attention is \( B(k, q) - c = q - c \). Further, when \( c > q \), a symmetric pure-strategy NE exists in which all players are inattentive.\(^{19}\) In the case where all \( n - 1 \) members are attentive, the benefit to the \( n \)th member from paying attention is characterised as

\[
B(n, q) > 0 \quad \text{if } n \text{ is odd} \quad (3.28)
\]

and

\[
B(n, q) = 0 \quad \text{if } n \text{ is even} \quad (3.29)
\]

Yet there does exist a symmetric pure-strategy NE in which all members are attentive, as asserted in the following statement (M, p.34):

**Proposition 3:** For any \( n, q \in (\frac{1}{2}, 1] \), and \( c \in (0, q) \), there exists a symmetric

\(^{19}\)Similarly, recall how for a perfect signal there exists a symmetric pure-strategy NE in which nobody pays attention, for \( \phi(0) = \frac{1}{4} \), if \( c \in (\frac{1}{2}, 1] \).
pure-strategy NE in which everybody pays attention iff the MPC size, \( n \), is odd, and \( n \leq k^*(c, q) \).

**Proof of Proposition 3**: The proof follows from Lemma 1, and the definition of the size of the largest attentive group of MPC members, \( k^*(c, q) \), presented previously. According to Lemma 1, for odd \( n \neq k^*(c, q) \), the net benefit to the \( n \)th member from paying attention is nonnegative, whilst for other MPC sizes it is negative. \( \text{QED.} \)

Symmetric pure-strategy Nash equilibria are shown for \( n = 3, q = 0.65 \) in **FIGURE 3.4**. In the absence of all other \( n - 1 \) MPC members paying attention, the net benefit to the \( n \)th member from being attentive is negative - \( B(k, q) < 0 \) when \( c > 0.65 \). This is depicted by the black line, which crosses the horizontal [cost \((c)\) axis at 0.65. Compare this to the case where all 3 members are attentive, as depicted by the grey line, \( B(3, 0.65) - c \). For values of \( c > 0.068 \), there exists no benefit for any member to pay attention; when \( c \leq 0.068 \), all members pay attention. Specifically, the symmetric pure-strategy Nash equilibria where all members pay attention are characterised by the condition that \( B(k, q) - c \geq 0 \). Secondly, the equilibria is further qualified by the condition that for any given positive cost \( c \leq q \), small MPC sizes exist where all members are attentive. Finally, for even sized MPCs, for any \( c \geq 0 \), no symmetric pure-strategy Nash equilibria exist. Thus for odd \( n \), members are more likely to all be attentive when information is (i) not costly and (ii) MPC size is small. Yet for even \( n \), there will always be one inattentive member. Normatively speaking, MPCs should not only be small and characterised by cheap information acquisition, but should contain an odd number of members too. The latter statement holds because if the social planner’s objective is to choose an MPC which maximizes the probability or reaching a correct decision, the optimal MPC size is defined by \( n = k^*(c, q) \).

### 3.3.4 Symmetric Mixed-Strategy Nash Equilibrium

In this section the solution for the symmetric mixed-strategy Nash equilibrium under an imperfect signal for \( n \) MPC members is derived for the alternative assumptions \( \phi'(0) = 0 \) and \( \phi'(0) = \frac{1}{2} \).\(^{20}\) In focusing on the symmetric mixed-strategy equilibrium two things are established: (i) with the probability of reaching a correct policy decision as the primary social objective,\(^{21}\) the more plausible assumption

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\(^{20}\)Much of the analysis presented in sections 3.3.4 - 3.3.7 is the product of joint work with Professor Paul Levine and Professor Parimal Bag.

\(^{21}\)Equivalent to reaching a correct verdict, as in M.
of \( \phi(0) = \frac{1}{2} \) adds to the argument that the MPC size should be restricted; (ii) a broader social objective by considering the information gathering costs would also strengthen M's suggestion about the jury size restriction, and hence MPC size restriction. While both points (i) and (ii) accentuate the basic findings of M, it is shown that arriving at the second conclusion (point (ii)) is not intuitively that obvious, especially for \( \phi(0) = \frac{3}{4} \). Thus, while the assumption that \( \phi(0) = 0 \) turns out not to matter in the core recommendation of MPC size restriction, to fully understand the underlying economic reasons it would be better to assume \( \phi(0) = \frac{1}{2} \) instead. Proceeding sections demonstrate how if the MPC members coordinate on any one of a number of (equally plausible) asymmetric equilibria other than the symmetric equilibrium, the probability of accuracy reaches a maximum for a particular MPC size and remains unchanged with larger MPCs, thus mitigating M's result somewhat. However, the case for limiting the MPC size gains additional grounds if one shifts the focus from maximizing the probability of reaching a correct verdict to the maximization of the overall social surplus, measured by the expected benefits of MPC decisions less the expected costs of acquiring signals.

In the \( n \) player game, the mixed-strategy Nash-equilibrium solution \( \sigma^* \in (0, 1) \) is derived through applying the pay-off equating method used to determine (3.10) and (3.13) under a perfect signal. Begin by denoting \( II \) as the net benefit to an attentive MPC member when all other members adopt the mixed-strategy, \( \sigma \). \( II \) is equivalent to the change in probability of making a correct decision when
an additional MPC member collects a signal over every possible realisation of the number of attentive MPC members (which follows the binomial distribution with probability of success \( \sigma \)) and net of cost \( c \). Specifically, the net benefit to an MPC member of paying attention when every other member plays a mixed-strategy ‘attention’ with probability \( \sigma \) and ‘no attention’ with probability \( 1 - \sigma \) is given by

\[
\Pi = \Pi(n, \sigma; c, q) = \sum_{k=1}^{n} b(k - 1; n - 1, \sigma) B(k, q) - c
\]  

(3.30)

In the case of odd and even \( n \), (3.30) is written as

\[
\Pi(n, \sigma; c, q) = \sum_{k=1,3,...}^{n} b(k - 1; n - 1, \sigma) B(k, q) - c \quad \text{if } n \text{ is odd;}
\]

(3.31)

and

\[
\Pi(n, \sigma; c, q) = \sum_{k=1,3,...}^{n-1} b(k - 1; n - 1, \sigma) B(k, q) - c \quad \text{if } n \text{ is even.}
\]

Under the assumption of \( \phi(0) = 0 \), \( \Pi \) is expressed as

\[
\Pi(n, \sigma; c, q)_{\phi(0)=0} = \left( q - \frac{1}{2} \right) \sum_{m=0}^{\left\lfloor \frac{n-1}{2} \right\rfloor} \frac{(n - 1)!(\sigma q)^m(\sigma(1-q))^{m}(1-\sigma)^{(n-1-2m)}}{(m!)^2(n-1-2m)!}(1-\sigma)^{(n-1)} - c
\]

(3.32)

where \( \frac{(1-\sigma)^{(n-1)}}{2} \) exists as a result of the assumption that if all members are in receipt of no signal, they enjoy a zero payoff, as opposed to \( \frac{1}{2} \) received in the event of a tie. Accordingly, assuming \( \phi(0) = \frac{1}{2} \) implies that \( \Pi \) can be rewritten as

\[
\Pi(n, \sigma; c, q)_{\phi(0)=\frac{1}{2}} = \left( q - \frac{1}{2} \right) \sum_{m=0}^{\left\lfloor \frac{n-1}{2} \right\rfloor} \frac{(n - 1)!(\sigma q)^m(\sigma(1-q))^{m}(1-\sigma)^{(n-1-2m)}}{(m!)^2(n-1-2m)!}(1-\sigma)^{(n-1)} - c
\]

(3.33)

and the term \( \frac{(1-\sigma)^{(n-1)}}{2} \) becomes superfluous. It is clear from (3.32) and (3.33) that the net benefit to members under \( \phi(0) = 0 \) is higher than for \( \phi(0) = \frac{1}{2} \). For example, consider the case where \( n = 2 \): \( \Pi(n, \sigma; c, q)_{\phi(0)=0} = q - q\sigma \), whereas \( \Pi(n, \sigma; c, q)_{\phi(0)=\frac{1}{2}} = q - q\sigma - \frac{(1+\sigma)}{2} \). In the case where \( \sigma = 0 \), \( \Pi(n, \sigma; c, q)_{\phi(0)=0} \) differs from \( \Pi(n, \sigma; c, q)_{\phi(0)=\frac{1}{2}} \) by exactly \( \frac{1}{2} \), as is illustrated in PANEL 3.2. This is a result which extends to all \( n \geq 2 \).

The unique symmetric mixed-strategy Nash equilibrium \( \sigma^*(n; c, q) \in (0, 1) \) is
obtained by solving
\[ \Pi(n, \sigma; c, q) = 0, \]  
(3.34)
for \( \sigma \), which is equivalent to equating the cost and benefit from paying attention in the net benefit function.\(^{22}\) Due to the complexity of the net benefit function, it is not possible to derive an explicit solution for \( \sigma \). Instead, it has to be estimated numerically, holding \( q, c, \) and \( n \geq 1 \) at exogenously specified values. The probability of the MPC making a correct decision is then given by
\[ \Phi = \Phi(n; c, q) = \sum_{j=0}^{n} b(j; n, \sigma^*(n; c, q)) \phi(j). \]  
(3.35)

Note that if \( \phi(0) \neq 0 \), then the summation must include a \( j = 0 \) term, unlike the case considered in \( M \).

Note that (3.35) applies to \( k \geq 1 \). When no members pay attention and receive no signals \( M \) assumes that the payoff is zero; i.e., \( \phi(0) = 0 \). As stated at the outset, an alternative assumption is that they vote according to their prior of \( \frac{1}{2} \) so that \( \phi(0) = \frac{1}{2} \). Note here that \( b(0; 0, q) = \frac{0!}{0!0!} q^0 (1 - q)^0 = 1 \) so that with this assumption (3.35) still applies with \( k = 0 \), treating zero as even. It is now useful to recall (3.22), namely \( B(k, q) = \phi(k) - \phi(k-1) \) which defines the benefit to the \( k \)th MPC member from paying attention when exactly \( k-1 \) other members pay attention gross of the cost of paying attention. Further, recall the result given in \textit{Lemma 1}, reproduced below:
\[ B(k, q) = \begin{cases} 0, & \text{if } k \text{ is even;} \\ (q - \frac{1}{2})b((k - 1)/2; (k - 1), q), & \text{if } k \text{ is odd.} \end{cases} \]  
(3.36)

Assuming \( \phi(0) = 0 \) as in \( M \) then (3.36) does not hold for \( k = 1 \) and \( B(1, q) = 1 \). However, under \( \phi(0) = \frac{1}{2} \), (3.36) holds for \( k = 1 \) as well. In what follows the consequences of both assumptions regarding \( \phi(0) \) are pursued.

\[^{22}\text{In other words, for the case of } \Pi(n, \sigma; c, q)_{\phi(0)=0} \text{ set} \]

\[
\begin{align*}
\text{Benefit from paying attention} & = (q - \frac{1}{2}) \sum_{m=0}^{\left\lceil \frac{n-1}{2} \right\rceil} \frac{(n - 1)! (\sigma q)^m (\sigma (1 - q))^m (1 - \sigma)(n-1-2m)!}{(m!)^2 (n - 1 - 2m)!} + \frac{(1 - \sigma)^{n-1}}{2} \\
\text{Cost of paying attention} & = c \\
\end{align*}
\]

and derive a solution for \( \sigma \). In the case of \( \Pi(n, \sigma; c, q)_{\phi(0)=\frac{1}{2}} \), the expression \( \frac{(1 - \sigma)^{n-1}}{2} \) is omitted from the benefit term on the LHS of the equality.

72
Panel 3.2 uses MATLAB to show the net benefit to the \( n^{th} \) MPC member from paying attention given \( n-1 \) jurors pay no attention for \( \sigma \in [0, 1] \), \( n = \{2, 3, 6, 12\} \), \( q = 0.7 \) and \( c = 0.1 \). Panel 3.2 (A) essentially reproduces the results shown in M (figure 4) for \( \phi(0) = 0 \), and Panel 3.2 (B) compares the results for \( \phi(0) = \frac{1}{2} \). If anything, this demonstrates the extent to which the assumption that \( \phi(0) = 0 \) is not innocuous: it heavily penalizes no attention by all MPC members and so biases the mixed equilibrium towards paying attention. Panel 3.3 (A) and (B) show numerical results for \( \sigma^* \) and \( \Phi \) using MATLAB. Results are reported for parameter values \( c = 0.1 \) and \( q = 0.75 \). The result is that in (A), whereas with \( \phi(0) = 0 \) group accuracy is maximized at an MPC size \( n = 3 \), with \( \phi(0) = \frac{1}{2} \) accuracy increases monotonically as \( n \) decreases from \( n = 12 \) to \( n = 1 \). Using MPC accuracy as the measure of social benefit then sees the alternative assumption regarding \( \phi(0) \) further undermine the Condorcet Jury Theorem. In a later section, CJT is further undermined when different MPC sizes are ranked using social efficiency as a measure.

### 3.3.5 Asymmetric Mixed-Strategy Nash Equilibria

As stated at the outset of the chapter, M ignores another kind of equilibrium which is neither completely mixed nor a pure strategy equilibrium. Explored here, this unreported class of equilibrium is referred to as asymmetric mixed-strategy equilibrium, the existence of which is demonstrated numerically. Asymmetric-mixed-strategy equilibrium has out of \( n \) MPC members, \( k \) playing the symmetric mixed-strategy \( \sigma^*(k : c, q) \) and the remaining \( n-k \) members paying no attention with probability 1. This effectively means that \( n-k \) players shirk. Such an equilibrium exists because MPC members who pay no attention are essentially absent from the game, whilst the remaining MPC members play symmetric mixed-strategy equilibrium amongst themselves. Using the result in (3.35) the probability of making a correct decision is then

\[
\Phi(k; c, q) = \sum_{j=0}^{k} b(j; k, \sigma^*(k; c, q))\phi(j),
\]

and the net payoff for each attentive member is \( \Phi - c \) and for each non-attentive member \( \Phi \). The condition for an asymmetric mixed strategy equilibrium is that the net payoff when the \( (k+1)^{th} \) member pays attention must be less than when

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23 It is possible to reproduce the results given in M who uses various values of \( q \). However, I confine myself to one intermediate value, \( q = 0.75 \).
(A) Net benefit to the \( n \)th MPC member from paying attention when \( n-1 \) members pay no attention with probability \( \sigma \) as \( n \geq 1 \) increases. \( \eta = 0.7 \), \( c=0.1 \) and \( \phi(0)=0 \)

(B) Net benefit to the \( n \)th MPC member from paying attention when \( n-1 \) members pay no attention with probability \( \sigma \) as \( n \geq 1 \) increases. \( \eta = 0.7 \), \( c=0.1 \) and \( \phi(0)=1/2 \)

Panel 3.2.
(A) Symmetric mixed-strategy Nash equilibrium, $\sigma^*$, with an imperfect signal, as $n$ increases. $q = 0.75$, $c = 0.1$. $\phi(0) = 0$ compared with $\phi(0) = 1/2$

(B) Probability of an MPC arriving at a correct decision, $\Phi$, with an imperfect signal as $n \geq 2$ increases. $q = 0.75$, $c = 0.1$. $\phi(0) = 0$ compared with $\phi(0) = 1/2$

Panel 3.3.
she does not; i.e.,

$$\Phi = \sum_{j=0}^{k} b(j; k, \sigma^*(k; c, q)) \phi(j) > \sum_{j=0}^{k} b(j; k, \sigma^*(k; c, q)) \phi(j + 1) - c. \quad (3.38)$$

(3.38) says that the probability of a correct decision when only \( k \) members pay attention with probability \( \sigma^* \) must exceed the increased probability when one more member pays attention net of the cost of doing so. Write this as

$$\Delta \Phi \equiv \sum_{j=0}^{k} b(j; k, \sigma^*(k; c, q)) \phi(j + 1) - \sum_{j=0}^{k} b(j; k, \sigma^*(k; c, q)) \phi(j) < c. \quad (3.39)$$

Panel 3.4 (A) shows that this condition, \( \Delta \Phi < c \), is satisfied for \( q = 0.75 \) and \( c = 0.1 \). Under each alternative assumption regarding \( \phi(0) \), the value of \( \Delta \Phi \) lies below the cost line, which is plotted for \( c = 0.1 \). This holds as the number of attentive members \( k \) increases from 1 through 12. The net payoff is therefore negative in both cases, as \( \Delta \Phi - c < 0 \). It has therefore been shown numerically that alongside the symmetric equilibria (SE), there exist asymmetric mixed-strategy equilibria (AE) for which \( k = 2, 3, \ldots \) of out \( n \) members play a mixed-strategy with probability \( \sigma^*(k; c, q) \) of paying attention at a fixed \( c \), and the remaining \( n - k \) pay no attention with probability 1 and zero cost. Now in an AE, the overall probability of accuracy stops increasing in MPC size as more inattentive members are added. But which equilibrium, SE or AE, is more plausible?

### 3.3.6 Choice of Symmetric or Asymmetric Equilibria

For an MPC of size \( n \) there are now \( n \) possible equilibria to choose from, one SE and \( n - 1 \) AE equilibria with \( k = 1, 2, \ldots, n - 1 \) attentive members. An AE equilibrium with \( 1 < k \leq n - 1 \) attentive members, \( AE(k) \) say, is essentially equivalent to a SE with MPC size \( k \), \( SE(k) \) say. The probability of accuracy and the costs incurred by the MPC members are identical in \( AE(k) \) and \( SE(k) \). Thus Panel 3.3 (A) and Panel 3.3 (B) for \( SE(n) \) also apply to asymmetric equilibria as well.

Yet can the Pareto dominance of any of these equilibria be established? Consider the two groups of members, non-attentive and attentive. For the former they incur no attention costs and so prefer equilibria that maximize the probability of accuracy, \( \Phi \). From Panel 3.3 (B) this occurs when 3 members pay attention if \( \phi(0) = 0 \) and when 1 member pays attention if \( \phi(0) = \frac{1}{2} \). Now consider the atten-
tive members. PANEL 3.4 (B) plots their expected utility as the size of the group \( k \) increases. Two opposite effects are at work here: as \( k \) increases the probability of paying attention first rises and falls monotonically with \( k \) for the case \( \phi(0) = 0 \) as is seen in PANEL 3.3 (B) (since the SE(\( k \)) is equivalent to AE(\( k \)) and falls monotonically for the case \( \phi(0) = \frac{1}{2} \). However, this effect that reduces the utility of the attentive member is more than cancelled out by a reduction in attention costs owing to the free-rider effect. The net results is that the utility of attentive members rises as \( k \) increases reaching a maximum at \( k = n \), the symmetric equilibrium. I conclude from this that the Pareto-dominance of any of the multiple equilibria cannot established.

### 3.3.7 Social Efficiency

I now return to symmetric equilibria and examine the question of social efficiency. PANEL 3.5 (A) plots the expected social cost of a symmetric equilibrium with \( n \) members defined as \( C = no^*c \). For \( \phi(0) = 0 \), as MPC size falls then expected social costs fall and as has been seen the expected accuracy of the MPC rises. This provides a further argument for limiting the size of an MPC. However the same figure shows that this result is sensitive to the assumption regarding \( \phi(0) \). If it is assumed that \( \phi(0) = \frac{1}{2} \) then the improvement in accuracy of the MPC comes at an increasing social cost as MPC size decreases from \( n = 12 \) to \( n = 3 \), but a further decrease in size sees social cost falling as before.

PANEL 3.5 (B) assesses the net benefit of reducing MPC size by plotting the expected social surplus \( \Phi - C \) against MPC size. Whereas for \( \phi(0) = 0 \) the probability of accuracy is maximized at \( n = 3 \), social surplus is maximized at \( n = 1 \). Social efficiency considerations therefore adds weight to the case for a smaller MPC. The alternative assumption regarding \( \phi(0) \) further undermines the Condorcet Jury Theorem (for this numerical example). Again social surplus rises monotonically as \( n \) decreases and suggests that, owing to the free-rider problem, any MPC may yield less benefit than a decision arrived by a single policy maker.

### 3.4 Conclusions

In this chapter I set out to examine the implications of delegating monetary policy to a committee where it is possible for members to free-ride on the signals of others. I relocated and extended Kauship Mukhopadhyaya's analysis of free-riding in...
(A) Condition for an Asymmetric mixed strategy Nash equilibrium with $k$ out of $n$ MPC members playing $\sigma^*$, and the remaining $n-k$ paying no attention, as $k \geq 1$ increases. $q = 0.75$, $c = 0.1$. $\phi(0) = 0$ compared with $\phi(0) = 1/2$

(B) Expected Utility of an Attentive MPC member in Asymmetric Equilibrium with $k$ out of $n$ members playing $\sigma^*$, and the remaining $n-k$ paying no attention, as $k \geq 1$ increases. $q = 0.75$, $c = 0.1$. $\phi(0) = 0$ compared with $\phi(0) = 1/2$

Panel 3.4.
(A) Expected social cost for Symmetric Equilibria as \( n \geq 1 \) increases. \( q = 0.75, c = 0.1. \) \( \phi(0) = 0 \) compared with \( \phi(0) = 1/2 \)

(B) Benefit-cost measure for Symmetric Equilibria as \( n \geq 1 \) increases. \( q = 0.75, c = 0.1. \) \( \phi(0) = 0 \) compared with \( \phi(0) = 1/2 \)

Panel 3.5.
juries to the case of an MPC faced with making a binary choice, thereby creating a ‘MPC Duty Game’.

In particular, I investigated the assumption regarding the payoffs for \( \phi(0) \) when no MPC members pay attention. In an MPC, the increased free-riding tendency is definitely true for any given number of members, hence each member pays attention with a lower probability for both small and large monetary policy committees. Yet whether this necessarily implied a relatively greater reduction (due to positive \( \phi(0) \)) in the probability of making a correct policy choice for larger MPCs was unclear. The first numerical result demonstrated that whereas under \( \phi(0) = 0 \) MPC accuracy is maximized at an MPC size \( n = 3 \), under \( \phi(0) = \frac{1}{2} \) accuracy increases monotonically as \( n \) decreases from \( n = 12 \) to \( n = 1 \). Using MPC accuracy as the measure of social benefit then sees the alternative assumption regarding \( \phi(0) \) strengthen the result under \( \phi(0) \).

The second numerical result shows that using social surplus as the criterion for comparing different MPC sizes further strengthens the result under \( \phi(0) \), in that with both assumptions regarding \( \phi(0) \), social surplus is maximized at an MPC size \( n = 1 \). Finally, the existence of asymmetric equilibria for which the probability of an MPC making correct decisions does not decline with MPC size was demonstrated. None of the \( n \) multiple equilibria Pareto-dominated. This result means the case for a smaller MPC suggested by the SE results needs to be qualified, since a large committee of size \( n \) can achieve the same social welfare as a smaller one of size \( k < n \) in a possibly more plausible equilibrium with only \( k \) attentive members. Of course if one were to include additional social costs incurred even by an inattentive member (expenses etc.) the case for a smaller MPC would remain.

The results suggest that large monetary policy committees, such as the ECB Governing Council, should be reduced in size substantially. Unlike Condorcet’s eponymous Jury Theorem under costless information acquisition, it is not desirable to increase the size of an MPC indefinitely. This is because in the presence of free-riding, the accuracy of making a correct decision is generally decreasing. A practical measure to dissuade members from engaging in such activity - thereby increasing the accuracy of the decision - might be to make MPC members individually accountable for their behaviour. Such scrutiny, which may require MPC members to justify their voting decisions in front of a government committee, is already practised in the UK, where MPC members come under the scrutiny of a
Parliamentary select committee.
3.A Appendix to Chapter 3

3.A.1 Lemma 1: For an odd sized MPC $B(k, q) = (q - \frac{1}{2}) b\left(\frac{k-1}{2}; k-1, q\right)$; for an even sized MPC $B(k, q) = 0$

Odd $k$

By definition

$$B(k, q) = \phi(k) - \phi(k - 1)$$

$$= \sum_{m=\frac{k+1}{2}}^{k} b(m; k, q) - \sum_{m=\frac{k+1}{2}}^{k-1} b(m; k - 1, q) + \frac{1}{2} b\left(\frac{k-1}{2}; k-1, q\right)$$

(3.40)

The first term may be rewritten as

$$\sum_{m=\frac{k+1}{2}}^{k} b(m; k, q) = \sum_{m=\frac{k+1}{2}}^{k-1} b(m; k, q) + b(k; k, q)$$

(3.41)

It is also noted that for the first term,

$$b(m; k, q) = q^m (1 - q)^{k-m} \frac{k!}{(k-m)! m!}$$

$$= q^m (1 - q)^{k-m} \frac{(k-1)!}{(k-1-m)! (m-1)!} \times \left[ \frac{k}{(k-m)m} \right]$$

$$= q^m (1 - q)^{k-m} \frac{(k-1)!}{(k-1-m)! (m-1)!} \times \left[ \frac{1}{(k-m)} + \frac{1}{m} \right]$$

$$= q \frac{(k-1)!}{(m-1)!(k-m)!} q^{m-1} (1 - q)^{k-m}$$

$$+ (1-q) \frac{(k-1)!}{(k-1-m)! m!} \left( \frac{k-1}{m} \right) q^m (1 - q)^{k-1-m}$$

$$= q b(m-1; k-1, q) + (1-q) b(m; k-1, q)$$
Therefore $\sum_{m=k^{\frac{1}{2}}}^{k} b(m; k, q)$ may be re-expressed as

\[
\sum_{m=k^{\frac{1}{2}}}^{k} b(m; k, q) = \sum_{m=k^{\frac{1}{2}}}^{k-1} [qb(m - 1; k - 1, q) + (1 - q)b(m; k - 1, q)] + qb(k - 1; k - 1, q) \tag{3.43}
\]

Where it is noted that

\[
qb(k - 1; k - 1, q) = q \frac{(k - 1)!}{(k - 1)!} q^{k-1}(1 - q)^0 = q^{k - 1} = b(k; k, q)
\tag{3.44}
\]

In other words, $qb(k - 1; k - 1, q) = b(k; k, m)$ is merely the last term of the summation in $\sum_{m=k^{\frac{1}{2}}}^{k} b(m; k, q)$. This makes it possible to rewrite $B(k, q)$ as

\[
B(k, q) = \sum_{m=k^{\frac{1}{2}}}^{k-1} [qb(m - 1; k - 1, q) + (1 - q)b(m; k - 1, q)] +qb(k - 1; k - 1) - \sum_{m=k^{\frac{1}{2}}}^{k-1} b(m; k - 1, q) - \frac{1}{2} b\left(\frac{k - 1}{2}; k, q\right) \tag{3.45}
\]

Expanding out $\sum_{m=k^{\frac{1}{2}}}^{k-1} [qb(m - 1; k - 1, q) + (1 - q)b(m; k - 1, q)]$ in the expression above yields

\[
B(k, q) = \sum_{m=k^{\frac{1}{2}}}^{k-1} qb(m - 1; k - 1, q) - \sum_{m=k^{\frac{1}{2}}}^{k-1} qb(m; k - 1, q) + \sum_{m=k^{\frac{1}{2}}}^{k-1} (b(m; k - 1, q) + qb(k - 1; k - 1)) \tag{3.46}
\]

\[
- \sum_{m=k^{\frac{1}{2}}}^{k-1} b(m; k - 1, q) - \frac{1}{2} b\left(\frac{k - 1}{2}; k, q\right) \tag{3.47}
\]
Noting that
\[ \sum_{m=\frac{k-1}{2}+1}^{k-1} qb(m-1; k-1, q) - \sum_{m=\frac{k-1}{2}+1}^{k-1} qb(m; k-1, q) = qb(\frac{k-1}{2}; k-1, q) \] (3.48)

and
\[ \sum_{m=\frac{k-1}{2}+1}^{k-1} \left( b(m; k-1, q) - \sum_{m=\frac{k-1}{2}+1}^{k-1} b(m; k-1, q) = 0 \right) \]

This leaves
\[ B(k, q) = qb(\frac{k-1}{2}; k-1, q) - \frac{1}{2} b(\frac{k-1}{2}; k, q) \]
\[ = \left( q - \frac{1}{2} \right) b(\frac{k-1}{2}; k-1, q) \] (3.49)

Even \( k \)

By definition
\[ B(k, q) = \phi(k) - \phi(k-1) \]
\[ = \sum_{m=\frac{k}{2}+1}^{k} b(m; k, q) - \sum_{m=\frac{k-1}{2}}^{k-1} b(m; k-1, q) + \frac{1}{2} b(\frac{k}{2}; k, q) \] (3.50)

The first term is re-written as
\[ \sum_{m=\frac{k}{2}+1}^{k} b(m; k, q) = \sum_{m=\frac{k}{2}+1}^{k-1} b(m; k, q) + b(k; k, q) \] (3.51)

It is also noted that following (3.42) and (3.44),
\[ b(m; k, q) = qb(m-1; k-1, q) + (1 - q)b(m; k-1, q) \]

and
\[ qb(k-1; k-1, q) = b(k; k, q) \]
Using (3.42) it is possible to re-express $\sum_{m=\frac{k}{2}+1}^{k} b(m; k, q)$ as

$$\sum_{m=\frac{k}{2}+1}^{k} b(m; k, q) = \sum_{m=\frac{k}{2}+1}^{k-1} [gb(m - 1; k - 1, q) + (1-q)b(m; k - 1, q)]$$

$$+ qb(k - 1; k - 1, q)$$

(3.52)

In other words, $qb(k - 1; k - 1, q) = b(k; k, m)$ is merely the last term of the summation in $\sum_{m=\frac{k}{2}+1}^{k} b(m; k, q)$. This makes it possible to rewrite $B(k, q)$ as

$$B(k, q) = \sum_{m=\frac{k}{2}+1}^{k-1} [gb(m - 1; k - 1, q) + (1-q)b(m; k - 1, q)]$$

$$+ qb(k - 1; k - 1) - \sum_{m=\frac{k}{2}}^{k-1} b(m; k - 1, q)$$

$$+ \frac{1}{2} b\left(\frac{k}{2}; k, q\right)$$

(3.53)

Expanding out $\sum_{m=\frac{k}{2}+1}^{k-1} [gb(m - 1; k - 1, q) + (1-q)b(m; k - 1, q)]$ in the expression above yields

$$B(k, q) = \sum_{m=\frac{k}{2}+1}^{k-1} gb(m - 1; k - 1, q) - \sum_{m=\frac{k}{2}+1}^{k-1} gb(m; k - 1, q)$$

$$+ \sum_{m=\frac{k}{2}+1}^{k-1} b(m; k - 1, q) + qb(k - 1; k - 1, q)$$

(3.54)

$$- \sum_{m=\frac{k}{2}}^{k-1} b(m; k - 1, q) + \frac{1}{2} b\left(\frac{k}{2}; k, q\right)$$

(3.55)

Noting that

$$\sum_{m=\frac{k}{2}+1}^{k-1} gb(m - 1; k - 1, q) - \sum_{m=\frac{k}{2}+1}^{k-1} gb(m; k - 1, q) = gb\left(\frac{k}{2}; k - 1, q\right)$$

$$- gb(k - 1; k - 1, q)$$

(3.56)
and

\[ \sum_{m=\frac{k}{2}+1}^{k-1} (b(m; k-1, q) - \sum_{m=\frac{k}{2}}^{k-1} b(m; k-1, q) = -b(\frac{k}{2}; k-1, q) \]

permits re-expression of \( B(k, q) \) as

\[
B(k, q) = q b(\frac{k}{2}; k-1, q) - q b(k-1; k-1, q)
+ q b(k-1; k-1, q) + \frac{1}{2} b(\frac{k}{2}; k, q)
= q b(\frac{k}{2}; k-1, q) + \frac{1}{2} b(\frac{k}{2}; k, q)
\]

However, in the case of the third term it follows that setting \( \frac{k}{2} = m \) and appealing to the result from (3.42) gives

\[
\frac{1}{2} b(\frac{k}{2}; k, q) = \frac{1}{2} \left[ q b(\frac{k}{2} - 1; k - 1, q) + (1 - q) b(\frac{k}{2}; k - 1, q) \right] \tag{3.57}
\]

This leaves

\[
B(k, q) = q b(\frac{k}{2}; k-1, q) - b(\frac{k}{2}; k-1, q)
+ q b(k-1; k-1, q)
\]
\[+ \frac{1}{2} \left[ q b(\frac{k}{2} - 1; k - 1, q) + (1 - q) b(\frac{k}{2}; k - 1, q) \right] \tag{3.59}
= q b(\frac{k}{2}; k-1, q) - b(\frac{k}{2}; k-1, q)
\]
\[+ (1 - q) b(\frac{k}{2}; k - 1, q) \tag{3.60}
= 0 \tag{3.62}\]
Chapter 4

Consensus Formation in Monetary Policy Committees

4.1 Introduction

In this chapter I develop a *boundedly-rational* model of how monetary policy committees are able to reach decisions on the interest-rate. I draw upon Morris DeGroot's (1974) characterization of consensus formation in groups and DeMarzo, Vayanos and Zweibel’s (2003) model of belief convergence in social networks. Given the role of consensus formation in real-world MPCs, both models, which share common features, are of relevance to the modelling of MPC decisions. Implicit to each approach is the use of Markov chains as a heuristic by which agents of a group or network update their beliefs in successive periods, a procedure hereafter referred to as *Markovian Updating* (MU). It provides a dynamic mechanism by which MPC members align their views through the deliberation process. Within this framework, it is demonstrated how members of an MPC are able to reach agreement even when (i) not all members listen to each other in the course of deliberations and (ii) views of members are initially diverse. The extent to which members of a group listen to each other is modelled using a *transition matrix*, the configuration of which determines whether members are able to agree with each other, and if so, the nature of any such agreement. To compliment the analysis, I also use *graph-theoretic representation* to depict how members of a monetary policy committee are connected to each other.

The model I develop potentially explains how members of the United States FOMC, ECB *Governing Council* and Bank of England MPC are able to reach an agreement on the interest-rate. I suggest, for example, that it is capable of explaining the stylised facts of Bank of England MPC member voting behaviour.

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In particular, the voting record of the BoEMPC suggests that on a meeting by meeting basis, policy preferences of outsiders exhibit significantly more heterogeneity than those of insiders. To quote Edmonds (1999) insiders behave as if they are a "cohesive homogeneous group."\(^2\) Outsiders, by contrast constitute a more disparate grouping. The model potentially explains this behaviour. It is also applicable to FOMC voting behaviour. Recent studies of FOMC decision making have characterised its Chairman as a monetary policy 'dictator'. Chappell et al (2002) report a disproportionately large influence of the Chairman in relation to final policy decisions when compared with other FOMC members. Again, the general model developed herein plausibly reproduces this phenomenon.

The plan of the chapter is as follows. I initially proceed by presenting some 'stylised facts' of monetary policy committee voting. When presenting these facts, I draw on Blinder and Wyplosz's (2005) classification of real-world monetary policy committees into three distinct varieties - those which are (i) autocratically-collegial, (ii) genuinely-collegial and (iii) individualistic. It is noted that this classification is particularly useful when rationalising the results of model simulations presented towards the end of the chapter. I then proceed to outline the models of DeGroot (henceforth DG) and DeMarzo, Vayanos and Zweibel (henceforth DVZ). In much that same way DVZ suppose that newspapers sway readers toward their views over time - even when the political affiliation of a newspaper is common knowledge - some members of a monetary policy committee sway other members to their views, even when all member's views are commonly known. A framework is provided which is able to account for why some MPC members listen to some of their colleagues, but not others. I rationalise this in terms of amongst other factors, the career concerns of MPC members and the precision of members' information. Further, I account for why members of an MPC might hold different views regarding the appropriate policy stance. This, I suggest is attributable to the theoretical leanings of MPC members and their perception of how the economy works. All of these claims are supported by empirical evidence, whether in the form of MPC voting records or comments or statements made by members of MPCs past and present. I now turn to the empirics.

\(^2\)Edmonds (1999), p.3.
4.2 Some Stylised Facts of MPC Voting

I begin by presenting some stylised facts of member voting behaviour for the United States FOMC, the ECB Governing Council and the Bank of England MPC. Blinder and Wyplosz's (2005) characterisation of real-world monetary policy committees into three distinct types is integral to the analysis, and it is notable that according to their classification, none of the three committees discussed here are of the same type. Most pertinently, the classification method of Blinder and Wyplosz - hereafter BW - identifies the characterising structures of each committee, in addition to rationalising the different patterns of voting behaviour corresponding to each one. It explains, for instance, why different monetary policy committees experience different levels of dissent.

It is noted however that the first two types of committee I define fall in a more general class of collegial committees, according to which the decision reached by an MPC is supported by all members: the policy decision is seen as embodying the collective wisdom of the committee, and its members hold that any differences of opinion must be second to the common good - otherwise the authority of the committee is diminished.3 This is true for committees which reach a decision by taking a formal vote and those which reach a consensus. For those committees where a formal vote is taken, it is typified by a unanimous decision, or near unanimity. Dissenting votes are thus considered unusual. So-called autocratically-collegial, genuinely-collegial and individualistic monetary policy committees are now defined and related to their respective real-world counterparts, the US FOMC, ECB Governing Council and Bank of England MPC.4

3Consider for example the comments of Chairman Burns from September 20, 1977 when the FOMC was badly split by seven votes to five in favour of the first policy directive:

"Well let's stop and deliberate it. I think that would be a very unfortunate vote. It would mean that this would excite a great deal of discussion that would not bring honour or credit to the Committee and therefore I think we must seek to accommodate one another. I don't think that our differences are very large. Let's try again. Does anyone have a proposal to make, one of the dissenters?" (Emphasis added. Cited from Chappell et al (2002), pp5-6.)

4BW also suggest there exists a natural ordering to their classification of committee types in terms of closeness to the unitary decision maker of economic theory. As one moves further down the ranking, so too does the power and influence of any single committee member, such as the Chairman. In terms of closeness to a single policy maker - consider the atypical institutional arrangement at the Reserve Bank of New Zealand where the decision on the interest rate rests solely with the Governor - the order of closeness is autocratically-collegial MPC, genuinely-collegial MPC and finally an individualistic MPC.
4.2.1 Autocratically-Collegial MPCs

In an *autocratically-collegial committee*, the chairman is a virtual monetary policy 'dictator'. The interest-rate decision is effectively the Chairman's choice. He may make a decision prior to the meeting, and merely notify his colleagues at its outset. Alternatively, he might take on board the views of other committee members during the meeting, then announce his decision and expect everyone to close ranks. BW class the US FOMC under Alan Greenspan as an *autocratically collegial committee*, an assertion which is borne out by the recent FOMC voting record. Between 2000 – 2004, of 43 FOMC meetings and 473 votes cast excluding those of the chairman, only six were classed as dissenting.\(^5\) Further work by Chappell *et al* (2002) reconfirms this result. They report that even though the FOMC places a very high value on reaching a consensus, the Chairman exercises 40-50% of the voting weight in committee decisions. In similar vain, Maisel (1973) argues that although the Chairman may be influenced by other FOMC members, *any* policy preferred by him is likely to be adopted.

4.2.2 Genuinely-Collegial MPCs

Members on a *genuinely-collegial committee* may openly disagree strongly about the best policy stance in the course of MPC deliberations but in the end compromise on a committee decision. Once a compromise is reached, and the decision is announced, all committee members present a united front in public, ensuring that any disagreements are left in the board room. Essentially, each member effectively assumes ownership of the decision. The ECB Governing Council is an example of such a committee. Although minutes of ECB Governing Council meetings are not published, it is well known that no formal vote is taken by its members - rather, all members reach a consensus,\(^6\) with all members’ opinions reportedly converging on a single interest-rate.\(^7\) This assertion has a basis in numerous answers provided by the President of the ECB, Wim Duisenberg, to questions fielded at the routine ECB press conferences which follow monetary policy decisions made by the Governing Council. Remarks made on February 3\(^{rd}\) 2000 reflect this:

\(^5\)As the Chairman tables the motion, he is assumed not to dissent.
\(^6\)I thank Nick Vidalis and Marco Catenaro at the ECB for helpful discussions relating to this matter.
\(^7\)This is in spite of ECB statutes stating that decisions taken by the GC on the short term interest rate are to be taken using the mechanism of simple majority rule. Simple majority rule is outlined in Definition 4.
“First, there was no formal vote. Again...it was a consensus decision.”

(emphasis added)

Similar comments were made on June 8th 2000:

“We had an intensive discussion, a prolonged discussion, which was very useful, and, in the end, resulted in a consensus on what we had to do.”

(emphasis added)

### 4.2.3 Individualistic MPCs

On an individualistic committee, members not only openly disagree strongly about the best policy stance in the course of MPC deliberations, but actively cast a vote which reflects their position. Such a committee is assumed to make decisions through the application of SMV, with a unanimous decision being neither expected nor sought. The Bank of England MPC is the archetypal case of an individualistic committee. The rate of dissent is certainly higher on the Bank of England MPC than the FOMC. Meade and Sheets (2002) report that over the period 1978-2000 inclusive, only 198 out of 2403 votes cast by FOMC members were dissenting. This amounts to about 8% of all votes cast. Contrast this with the voting behaviour of Bank of England MPC members. For the first five years of the MPC, 106 out of 642 votes cast - approximately 16.1% - were dissenting.Crudely put, MPC members are twice as likely to dissent than FOMC members.\(^8\) However, it is noted here that on an individualistic MPC, the prospect of a majority of members not being able to reach agreement is emphatically not an option: irrespective of any differences over the appropriate interest-rate for the economy, MPC members are compelled to

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\(^8\) Comparison with other committees is also of interest. Nobuyuki Nakahara (2002), member of the Policy Board of the Bank of Japan, attributes differences in the dissent voting behaviour of members of the monetary policy committees of the Bank of England and Bank of Japan to individual accountability, attesting:

“I heard that Dr. DeAnne Julius, a former member of the Monetary Policy Committee of the Bank of England, said that when members are not individually accountable, they lose the incentive to make public their position at the voting stage even if they had voiced opposing views during the debate, and that it will become easier for the majority, which would include the most influential individual, to carry the vote. To avoid this situation, the parliament holds individual hearings. Although the connection is not clear, since April 1998, deputy governors, though they are chosen from the staff of the Bank of England, are known to have cast eleven minority votes on eight occasions. As for the Bank of Japan, it was revealed at a recent parliamentary session that there had never been a division of views of the governor and two deputy governors.” (emphasis added)
reach a decision, albeit via a winning majority as opposed to unanimity. Clearly, failure to reach a decision in the form of no winning majority emerging would have damaging consequences for the credibility of monetary policy.\footnote{It is inconceivable that a monetary policy committee would announce to the public that “our members are unable to reach a collective decision about the level of the interest-rate. Come back again tomorrow.”} I now turn to the model.

### 4.3 The Model

Envisage a monetary policy committee of \( m \) members with responsibility for setting the interest-rate. Prior to the start of the meeting (and the deliberation process), each MPC member weights the opinions of other members, \textit{including himself}. More formally, let, \( p_{j,k} \) denote the weight placed on member \( k \)'s opinion by the \( j^{th} \) member. For each member the sum of weights equals one

\[
\sum_{j=1}^{m} p_{j,k} = 1
\]

(4.1)

where

\[
0 \leq p_{j,k} \leq 1 \quad \forall \ j, k \in \{1, 2, \ldots m\}
\]

(4.2)

This determines the elements of an \( m \times m \) transition matrix, where each row corresponds to respective members' allocation of weights.

\[
P = \begin{bmatrix}
p_{1,1} & p_{1,2} & \cdots & p_{1,m-1} & p_{1,m} \\
p_{2,1} & p_{2,2} & \cdots & p_{2,m-1} & p_{2,m} \\
\vdots & \vdots & \ddots & \vdots & \vdots \\
p_{m-1,1} & p_{m-1,2} & \cdots & p_{m-1,m-1} & p_{m-1,m} \\
p_{m,1} & p_{m,2} & \cdots & p_{m,m-1} & p_{m,m}
\end{bmatrix}
\]

(4.3)

I call the configuration of \( P \) the \textit{influence structure} of the group. \( P \) is informative because it indicates the extent to which all members of the group are \textit{influenced} by each other. Specifically, I define \( p_{j,k} \), the weight placed on member \( k \)'s opinion by the \( j^{th} \) member, as the \textit{direct influence} of \( k \) on \( j \). Accordingly, \( k \) is said to have no \textit{direct influence} on \( j \) if \( p_{j,k} = 0 \). However, if \( p_{j,k} = 0 \), it is still possible for \( k \) to influence \( j \). Even when member \( j \) is not \textit{directly} influenced by \( k \), \( k \) bears influence
on \( j \) if \( k \) influences a member \( l \) who directly influences \( j \). Call this the indirect influence of \( j \) on \( k \).\(^{10}\) Moreover, \( k \) still exerts influence on \( j \) if \( k \) influences a member \( l \) who indirectly influences \( j \), and so on. This example illustrates that for some weighting allocations the nature of influence running to and from members may become highly complex, with the chain of influence amongst members being deeply intertwined. By way of a further definition if a member \( j \) neither directly nor indirectly influences member \( k \), then that member is not influenced by \( k \). Further, if any two members \( j \) and \( k \) do not influence each other, they they do not communicate with each other. More generally, in the same way that \( m \) individuals do not communicate with each other an analogous situation arises for groups of individuals. If there are two groups, \( J \) and \( K \) where no member of either group communicates with each other then group \( J \) does not communicate with group \( K \). This logic extends to the case of \( m > 2 \) groups.

### 4.3.1 Interest-Rate Preferences

Corresponding to \( P \) is a belief vector containing members' interest-rate preferences prior to the deliberation process. This vector contains the interest rates members would choose to set were they given individual responsibility for monetary policy. Denote the transpose of this vector as

\[
[i_0]^\top = [i_{1,0}, \ldots, i_{m,0}] \quad (4.4)
\]

where numbers given in subscripts \( M, N \) correspond to the respective interest-rate preferences for members \( M = \{1, \ldots, m\} \) and the stage of the deliberation process \( N = \{1, 2, \ldots, n\} \) which is also denoted in the square bracket \([N]\). Members' revised views after the first period of discussions are calculated by pre-multiplying the vector \([i_0]\) by \( P \), yielding

\[
[i_1] = [i_0]^\top P \quad (4.5)
\]

The transpose of this vector is given by

\[
[i_1]^\top = [i_{1,1}, \ldots, i_{m,1}] \quad (4.6)
\]

Consensus is reached by an iterative process. Following the first round of deliberations members' original interest-rate preferences will have changed from \( i_{1,0}, \ldots, i_{m,0} \) to revised estimates given by \( i_{1,1}, \ldots, i_{m,1} \). If a majority of members' revised rates

\(^{10}\)We note here that \( k \)'s influence on \( l \) may be either direct or indirect in nature.
have not converged to the same interest-rate in the first period, then the process of revision continues until it does. Revised opinions are calculated up to the $n^{\text{th}}$ period as

$$
\begin{align*}
|^{[1]} & = p|^{[0]} = p^1|^{[0]} \\
\vdots & = \quad \vdots \\
|^{[n]} & = p|^{[n-1]} = p^n|^{[0]}
\end{align*}
$$

(4.7)

where $P^n$ is the matrix $P$ raised to the $n^{\text{th}}$ power, $n = 1, 2, ... n$. The mechanism by which members revise their opinion might best be best viewed as a discrete iterative process that only ceases when all members reach a consensus.\textsuperscript{11} With each iteration, members revise their judgement of the interest-rate given their weighting of others' opinions.

### 4.3.2 Informational Criterion

An alternative criterion to allocating weights in the influence matrix is to assume that MPC members weight members according to informational criterion as opposed to perceived career concerns. I now envisage a setting where MPC members must estimate the appropriate interest-rate for the economy, $i^*$, in order to achieve some pre-determined policy objective, such as hitting an inflation target.\textsuperscript{12} The approach taken follows elements of DVZ, particularly with respect to the structure of the influence matrix, or to use their terminology, listening matrix. Members are essentially faced with reaching agreement on a single issue.\textsuperscript{13} It is assumed that individual $i$'s estimate of parameter $i^*$ prior to the deliberation process (i.e. at time $t = 0$) is given by the noisy signal

$$
i_i^0 = i^* + \epsilon_i, \quad \epsilon_i = iid(0, \sigma^2)
$$

\textsuperscript{11}In the case of SMV, it might only be necessary for a sufficient number of MPC members to reach a consensus amongst themselves for a majority decision to be reached.

\textsuperscript{12}Such as the institutional arrangement at the Bank of England.

\textsuperscript{13}This is unlike the DVZ set-up, where there were many issues.
Further, member $j$ is assigned initial precision $\pi_{ij}^0$ by individual $i$, namely

$$\pi_{ij}^0 = \text{var}_i [\varepsilon_j]^{-1} \quad (4.9)$$

According to this structure, $\lim_{t \to \infty} = 0$. In other words, the greater the variance associated with $j$'s information, the smaller the associated precision. It is noted that in their original paper, DVZ assume introduce a binary variable $q_{i,j}$ where

$$q_{i,j} = \begin{cases} 
1, & \text{if } i \text{ listens to } j; \\
0, & \text{if } i \text{ does not listen to } j.
\end{cases} \quad (4.10)$$

I assume that because MPCs are composed of members who meet face to face on a regular basis, it is not feasible to suppose that members cannot listen to each other. Therefore I impose the assumption that $q_{i,j} = 1$ for all members. Unlike DG, the weight which members of a committee place on the opinions of others is determined by members' precisions, with the precision assigned to another member's information being a member's subjective assessment. This may emanate from a member's disclosure of private information, $\Lambda_{t,j}$. Only certain members of the committee have information which is worth listening to, and the more useful the information the smaller the variance. Information deemed useless is assigned an infinitely large variance.

More formally, for an $m$ member monetary policy committee, let the weight given by a member $c$ to the information of a member $k$ be given by $\pi_{c,k}^0 / \sum_{j=1}^{m} \pi_{c,j}^0$. The sum of these weights is necessarily one, and in line with DG, these weightings are then assigned to an $m \times m$ matrix $T$, where the weighting $\pi_{c,j}^0 / \sum_{j=1}^{m} \pi_{c,j}^0$ corresponds to the element in the $c^{th}$ row and $k^{th}$ column. Matrix $T$ thus has the characteristics of a transition matrix, the elements in each row being non-negative and summing to unity. For completeness, $T$ is more explicitly expressed as

$$T = \begin{bmatrix}
\frac{\pi_{1,1}^0}{\sum_{j=1}^{m} \pi_{1,j}^0} & \cdots & \frac{\pi_{1,m}^0}{\sum_{j=1}^{m} \pi_{1,j}^0} \\
\frac{\pi_{2,1}^0}{\sum_{j=1}^{m} \pi_{2,j}^0} & \cdots & \frac{\pi_{2,m}^0}{\sum_{j=1}^{m} \pi_{2,j}^0} \\
\cdots & \cdots & \cdots \\
\frac{\pi_{m,1}^0}{\sum_{j=1}^{m} \pi_{m,j}^0} & \cdots & \frac{\pi_{m,m}^0}{\sum_{j=1}^{m} \pi_{m,j}^0}
\end{bmatrix} \quad (4.11)$$
Updating occurs in a similar fashion to DG, only in this instance the belief vector containing members’ interest-rate preferences prior to the deliberation process is populated by noisy estimates of \( i^* \). Again, this vector contains the interest rates members would choose to set were they given *individual* responsibility for monetary policy. Information pertaining to individuals’ initial signals is then communicated to each other through a *social network*, and members update their views in contiguous deliberative rounds. Updating in the first round takes place according to by post-multiplying the listening matrix by member’s initial interest-rate beliefs. First round revisions are thus explicitly defined as

\[
\begin{align*}
\mathbf{r}_1 &= \left[ \begin{array}{ccc}
\frac{\pi_{1,1}^0}{\sum_{j=1}^m \pi_{1,j}^0} & \ldots & \frac{\pi_{1,m}^0}{\sum_{j=1}^m \pi_{1,j}^0} \\
\frac{\pi_{2,1}^0}{\sum_{j=1}^m \pi_{2,j}^0} & \ldots & \frac{\pi_{2,m}^0}{\sum_{j=1}^m \pi_{2,j}^0} \\
\vdots & \ddots & \vdots \\
\frac{\pi_{m,1}^0}{\sum_{j=1}^m \pi_{m,j}^0} & \ldots & \frac{\pi_{m,m}^0}{\sum_{j=1}^m \pi_{m,j}^0}
\end{array} \right] \times \left[ \begin{array}{c}
\mathbf{i}_1^0 \\
\mathbf{i}_2^0 \\
\vdots \\
\mathbf{i}_m^0
\end{array} \right] \\
&= \left[ \begin{array}{c}
\sum_{j=1}^m \frac{\pi_{1,j}^0}{\sum_{j=1}^m \pi_{1,j}^0} \cdot \mathbf{i}_1^0 \\
\vdots \\
\sum_{j=1}^m \frac{\pi_{m,j}^0}{\sum_{j=1}^m \pi_{m,j}^0} \cdot \mathbf{i}_m^0
\end{array} \right] \\
&= \left[ \begin{array}{c}
\mathbf{r}_1^0 \\
\vdots \\
\mathbf{r}_m^0
\end{array} \right] \tag{4.12}
\end{align*}
\]  

As is the case with the DG model, if members’ revised rates have not converged to the same interest-rate in the first period, the revision process continues until it does with agents treating the information in each round as new and independent.
Up to the $n^{th}$ period revised opinions are calculated as

$$I^{[1]} = T I^{[0]} = T^1 I^{[0]}$$

$$I^{[2]} = T I^{[1]} = T^2 I^{[0]}$$

$$\vdots$$

$$I^{[n]} = T I^{[n-1]} = T^n I^{[0]}$$

where $T^n$ is the matrix $T$ raised to the $n^{th}$ power.

### 4.3.3 Graph Theoretic Representation of Direct and Indirect Influence

The nature of direct and indirect influence in the model can be depicted using graph-theoretic representation. In terms of graph theory, a graph is a structure comprised of nodes, which represent members of a group, and lines connecting the nodes together, known as edges.\(^\text{14}\) Edges are directed - giving them the appearance of arrows - which means that it is possible to capture the direction of influence running from member to member. For example, a directed edge running directly from member $j$ to member $k$ indicates that $j$ is directly influenced by $k$. Put another way, element $p_{j,k} \in (0,1]$. However, if $k$ is also directly influenced by $j$, both members will be connected by an arrow, $\leftrightarrow$, which runs in both directions.

Figure 4.0 gives simple examples of possible influence structures. Diagram (i) can be construed as a special case of a one member committee where that member listens only to himself. The unidirectional arrow running from the node to itself is thus used to show that $j$ directly influences himself. A member directly influencing himself is represented using a unidirectional arrow running from a node to itself. This is illustrated in (i) for the case of a member $j$. For this member $p_{jj} = 1$ - (ii) depicts a two member group comprised of $j$ and $k$, who do not communicate with each other - both members effectively ignore each other, listening to their own opinion only. Therefore, $p_{jk}, p_{kj} = 0$ and $p_{jj}, p_{kk} = 1$. Parts (iii) and (iv) depict two member groups where individuals are influenced directly by each other. In (iii) member $j$ is directly influenced by $k$, although $k$ ignores $j$, choosing to

\(^{14}\) Sometimes nodes and edges are referred to as vertices and arcs respectively.
listen to himself only. Therefore $p_{jj}, p_{kj} = 0$ and $p_{jk}, p_{kk} = 1$. In (iv) both group members listen to themselves and are directly influenced by each other. Therefore it must follow that $p_{jj}, p_{kj}, p_{jk}, p_{kk} \in (0,1)$. The final example, (v) depicts the nature of indirect influence amongst a three member group, and shows that although $j$ is indirectly influenced by $k$, the opposite cannot be said to be true. The example demonstrates that with only a three member network, the nature of relationships between its members can be complex.

The notions of direct and indirect influence can also be mapped to standard concepts in the theory of Markov chains. A transient state has a steady-state probability of zero. In Figure 4.0 (iii) $j$ is equivalent to a transient state: once $j$ reaches $k$ it is impossible to get back. A transient set contains a group of states all of which have steady-state values of zero. A recurrent set contains a set of states such that once the system enters it, it always makes transitions within the set and never leaves it. In Figure 4.0 (v) $l$ and $k$ form a recurrent set. Once $j$ enters, it is impossible to return. An absorbing state is a special case of a recurrent set which contains only one state. This is the case in Figure 4.0 (iii) - $k$ is an absorbing state. If the entire system is a is a recurrent set, then it is called ergodic. Figure 4.0 (iv) is an example of an ergodic system. If a system is not ergodic, then there may be more than one recurrent set in the system. Figure 4.0 (v) is therefore not ergodic - it contains one recurrent set ($k$ and $l$) and a transient state ($j$), and is characteristic of an absorbing chain.

### 4.4 Diverse Interest-Rate Preferences

Each MPC member is assumed to have a preferred interest rate which is non-negative and continuous, and predominantly based on all currently available economic information. More formally, write that

$$
i_{j,t}^* \in \{0 \leq i < \infty\} = f(\Omega_t, \Lambda_{t,j}, M_j)$$

Equation (4.15) represents member $j$'s choice of interest-rate $i_j$ as a function of group information known to all committee members in the current period, $\Omega_t$, plus information specific to that individual member, $\Lambda_{t,j}$. Refer to member specific information as member $j$'s private information. This general framework reflects

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15 In practice however, the values from which a member will choose from are likely to be constrained to a small finite set of values.
real-world features of monetary policy decision making. For example, in the case of the Bank of England, $\Omega$ may be construed as embodying information contained in internal Bank forecasts and the numerous economic analyses presented to MPC members at pre-MPC meetings by bank staff. This information is common knowledge to all MPC members.\footnote{Much of this information is not in the public domain. For example, the monthly report on regional developments presented at pre-MPC meetings by the Bank of England’s regional agencies is unavailable to the public at large. In this sense, the information forming MPC members’ common information set is still exclusive to the monetary authorities.} The existence of private information, $\Lambda_{j,t}$, emanates from the fact that different members will invariably be both exposed to and receptive to different sources of information during their time on the MPC.\footnote{In the case of European monetary union, a member $j$ of the ECB’s governing council may not divulge private information which, if it becomes common knowledge, may lead to other committee members taking an interest rate decision detrimental to member $j$’s economy.} In addition to the role of information, it is supposed that MPC members may have different views of how the economy works, and to put it crudely, different models of the economy in their heads.\footnote{Sushil Wadhwani (2002) is an example of an MPC member to openly express doubts about the efficacy of the suite of Bank of England models used in the forecast of inflation and GDP. These forecasts, which form the basis of the Bank’s Inflation Report, are purportedly integral to decisions on the interest rate, and are supposed to represent the ‘collective judgement’ of the MPC.} Thus, even when members are presented with
the same economic facts, they may still prescribe conflicting courses of action for
the economy - different members may treat the same information differently. In
light of this, $M_j$ denotes a member $j$'s model of the economy. The framework
embodied in (4.15) is also assumed to extend to the United States FOMC and
the ECB Governing Council. However, having arrived at a view as to the most
appropriate interest-rate, members must now arrive at a collective decision. The
mechanism which captures this process is described in the following section.

4.4.1 Weighting the Opinions of MPC Members

Given $\Omega_t, \Lambda_{t,j}$ and $M_j$ there is no guarantee that members $j = \{1, 2, \ldots, J\}$ will
prescribe the same interest-rate for the economy. Indeed, prior to the deliberation
process, members may initially hold different views. In this framework, (4.15)
accounts for such diverse interest-rate preferences. Where differences in opinion
arise, some mechanism exists which brings about a group consensus or sufficient
agreement leading to a majority of votes being cast in favour of one particular
course of action. Having formed an opinion on the interest-rate, members are
assumed to reach an agreement on the interest-rate using the iterative procedure
outlined in (4.7). A key issue, however, is MPC members’ criteria for allocating
weights. Some weighting allocations will lead to no consensus being reached. Yet
for the FOMC, ECB Governing Council and Bank of England Monetary Policy
Committee, failure to reach a decision is emphatically not an option - a course of
action must be agreed upon. Such results are in a sense not plausible.

4.4.2 Allocating Weights to Members’ Opinions

A clear obstacle in applying this model lies in the allocation of weights of others’
opinions. Weights are not determined arbitrarily, but determined by (i) career

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19This has a clear analogy with jury deliberations. Even when presented with exactly the
same evidence in a trial, jurors arrive at different conclusions as to the innocence or guilt of a
defendant. Although this may be due to some jurors having a lower threshold of doubt than
others, it is not implausible to assume that members may use different lines of reasoning than
their fellow jurors or attach different levels of importance to the same piece of evidence. In
much the same way, committee members may not weight all economic information in the same
way when arriving at a decision about monetary policy. Evidence that this occurs is given by
Goodhart (1999), stating that

"What...is the current sign of the output gap? As evidenced by our differing votes,
we in the MPC can and do see the same underlying data having different implications
for that gap." (pp.247-248)

---

20Failure to reach a decision would severely damage the reputation on the monetary authorities.
concerns, a view which is not entirely new to the literature and (ii) the precision of members' information, as exemplified by the general approach of DVZ. In relation to (i), consider Havrilesky and Schweitzer's (1990) proposal that dissent voting is a source of disutility for individuals serving on the US FOMC. When differences in opinion arise, the presence of career concerns can lead a member to 'revise' their view and subsequently vote with individuals who are perceived to have a bearing on his or her career path. Lawrence Roos, president of the St. Louis Federal Reserve Bank pays testament to this view, forging a clear link between dissent voting behaviour and career concerns:

“If one is a young, career oriented president who's got a family to feed he tends to be more moderate in his opposition to governors.”

The message here seems to be that even when views on the interest-rate are divergent, social forces come into play thus bringing about agreement amongst committee members. Accordingly, members are more likely to pay attention to members of a similar type as they may have to work with them in the future - perhaps even long after their time on serving on the committee has ended. Disagreement now may hamper future prospects of promotion, and although members care about the objectives of the committee, they also care about future career advancement. In this sense, the way a member 'performs' on an MPC is not just measured as their ability to hit an inflation target, so to speak, but judged according to their propensity to agree with members of his or her type.

This may be particularly true for insiders serving on the Bank of England MPC. As stated in the section in individualistic MPCs, the voting record for the first five years of the MPC, demonstrates that approximately 16.2% of members' votes were dissents. Essentially, MPC members are twice as likely to dissent than FOMC members. Yet this statistic can be broken down further. Bank insiders were on the winning side of a monetary policy decision 93.6% of the time, compared with outsiders for whom the figure was 73.9%. In other words, insiders are far less likely to dissent than outsiders, although when insiders dissent, they do so on the side of monetary tightness, whereas outsiders do so on the side of

21 cf. Havrilesky and Schweitzer (1990), p.3. Also considered is the opinion of Henry Wallich, a member of the Board of Governors:

"It is not a pleasant thing to have to keep dissenting...One dissents less often than you would think. After all you are a member of a group and you want to get along with the other members."
monetary ease. These results form the focus of further analysis in Chapter 6. Yet an equally compelling finding is that *insiders* were in agreement with each other more so than *outsiders*. To quote Edmonds (1999) insiders behaved as if they were a "cohesive homogeneous group."\(^{22}\)

To substantiate this claim, I develop the following measure, \(\Theta_j\), which corresponds degree of agreement between *insiders* and *outsiders* respectively, at the average MPC meeting. Let this be expressed as

\[
\Theta_j = \frac{1}{T} \sum_{t=1}^{T} \frac{\sigma_{j,t}}{\bar{i}_{j,t}}, \quad j = I, O
\]

where \(I\) and \(O\) denote insiders and outsiders respectively; \(\sigma_{j,t}\) denotes the standard deviation of the desired interest-rate for members of group \(j\) in meeting \(t\), and \(\bar{i}_{j,t}\) the corresponding mean interest-rate for each group in meeting \(t\). The term \(\frac{\sigma_{j,t}}{\bar{i}_{j,t}}\) is no more than the coefficient of variation in meeting \(t\). Lastly, let \(T\) stand for the total number of meetings included in the sample. Essentially, I calculate the *coefficient of variation* of interest rate preferences for each group at each meeting, and then take the group average across all meetings in the sample, to proxy for the measure of agreement within each group at the *average meeting*. Accordingly, the smaller the value of \(\Theta_j\), the lower the level of variability in interest-rate preferences expressed by members at each meeting. A value of \(\Theta_j = 0\) would suggest that insiders were on average in perfect agreement with each other in every MPC meeting. The coefficient of variation associated with outsider preferences over the interest-rate - \(\Theta_O = 1.508\) - is somewhat higher than those of insiders, for whom \(\Theta_I = 0.563\). The policy preferences of outsiders at the average meeting are more diverse that those of *insiders*, who on average, have more of a tendency to agree with each other at each MPC meeting.\(^{23}\) Indeed, insiders were in total agreement with each other in 56 out of 74 meetings (i.e. when \(\frac{\sigma_{I,t}}{\bar{i}_{I,t}} = 0\)). For outsiders, the number was in only 31 meetings (i.e. when \(\frac{\sigma_{O,t}}{\bar{i}_{O,t}} = 0\)). These results are plotted in *Figure 4.3*.

\(^{22}\)Edmonds (1999), p.3.

\(^{23}\)Further, the finding that *insiders* are more likely to agree with each other more than *outsiders* has important ramifications for the way the MPC is perceived. It is commonplace in the financial press and media to portray insiders and outsiders as two distinct groups, each with well defined objectives and goals. These results serve to partially dispel this myth.
Whereas insiders may be seen to have well defined goals and form a homogeneous cohesive group, outsiders form more of a disparate grouping. I suggest that such observed voting behaviour arises due to *insiders* being incentivised to pay more attention to each other than outsiders. In the context of the model, this leads to insiders only weighting the policy preferences of fellow insiders in the course of MPC deliberations, which can be explained by the presence of career concerns.\(^{24,25}\) As insiders have a 5-4 in-built majority over outsiders one might reasonably posit that if *insiders* voted together as a group - essentially weighting only the opinions of other insiders - they would dominate decisions on the MPC, regardless of any opposition from their externally appointed counterparts. *This* may be because, as Buiter (1999) points out, the appointment of *insiders* to the MPC emanates from their positions in the hierarchy of the Bank. Given the fact that insiders enjoy a numerical majority on the MPC, it is reasonable to suppose that were an ‘institutional consensus’ to develop - which is likely in an organisation like the Bank, which has a strong internal culture and sense of ‘corporate identity’ - *insiders* would dominate MPC decisions by dint of their inbuilt majority. Put another way,

‘...every organisation develops, in short order, an in-house view, an orthodoxy, a conventional wisdom, which it becomes increasingly difficult to challenge’ (Buiter (1999), p.13.)

For this reason Buiter suggests that it would be apposite for the committee to have a majority of *outsiders*, or rather, individuals who do not hail from a single organisation.\(^{25}\) In the event of a split decision, the Governor of the Bank in his role as Chairman of the MPC has a casting vote.
is what is seen in practice.

4.5 Unanimous versus Majority Consensus

I now define two types of consensus which can be reached by a committee: unanimous consensus and majority consensus. A unanimous consensus occurs where members’ opinions all converge on the same interest-rate. Contrast this with a majority consensus, where at least half of all elements in the belief vector converge to the same point estimate in the limit. The former category is most immediately applicable to autocratically-collegial and genuinely-collegial monetary policy committees - in both of these committees, the ability to reach a deliberative outcome characterised by all members being in agreement with each other. Unanimity is highly valued, and thus consciously sought. As a real-world example of unanimous consensus, recall the remarks of Wim Duisenberg at an ECB press conference following the monetary policy decision made by the Governing Council on February 3rd 2000:

"First, there was no formal vote. Again... it was a consensus decision."

(emphasis added)

The statement implies that all members of the ECB Governing Council were agreed on the same interest-rate. Therefore its members can be said to have reached a unanimous consensus. A unanimous consensus might also apply to an individualistic committees where all members vote in favour of the Chairman’s policy proposal, such as the August 2002 meeting of the Bank of England MPC - all members voted in favour of the proposition that the Bank’s repo-rate should be maintained at 4%. However, a majority consensus is more likely to be characteristic of the decisions reached by individualistic committees, where agreement amongst all members is not sought or expected. As previously attested, the nine member Monetary Policy Committee of the Bank of England is such a body, and this is borne out in the previous section.

4.5.1 Convergence to a Unanimous Consensus

A unanimous consensus is reached if all elements in the belief vector converge to the same value in the limit as \( n \to \infty \). More formally, consensus is achieved by all MPC members if

\[
\lim_{n \to \infty} i_{jn} = i_{jn}^* \quad \forall \ j = 1, 2, ..., m.
\]
This only occurs where there is a \((1 \times m)\) row vector \(\pi = [\pi_1, \ldots, \pi_m]\) such that for \(j = (1, 2, \ldots, m)\) and \(l = (1, 2, \ldots, m)\),

\[
\lim_{n \to \infty} p_{j,l}^{(n)} = \pi_l
\]  

(4.18)

where \(p_{j,l}^{(n)}\) is an element belonging to the transition matrix \(P^n\) from row \(j\) and column \(l\). In other words, for an \(m\) member committee, \textit{unanimous consensus} is achieved when the elements of \(P^{n \to \infty}\) converge on a distribution characterised by \(m\) identical rows; in any given column, the elements will be identical. Further, in keeping with the properties of a transition matrix, the elements will be non-negative and sum to unity, specifically

\[
\sum_{j=1}^{m} \pi_j = 1
\]  

(4.19)

### 4.5.2 Convergence to a Majority Consensus

A \textit{majority consensus} is reached if at least half of all elements in the belief vector converge to the same value in the limit as \(n \to \infty\). More formally, consensus is achieved amongst a majority of MPC members if

\[
\lim_{n \to \infty} i_{j,n} = i_{j,n}^* \quad \forall j \neq k, \quad k = \{1, 2, \ldots, \frac{m-1}{2}\}
\]  

(4.20)

where

\[
\lim_{n \to \infty} i_{k,n} \neq i_{j,n}^* \quad \forall k
\]  

(4.21)

This will only occur when there is a vector \(\pi_j = [\pi_1, \ldots, \pi_m]\) such that for \(j, l = (1, 2, \ldots, m)\),

\[
\lim_{n \to \infty} p_{j,l}^{(n)} = \pi_l, \quad j, l \neq k
\]  

(4.22)

where \(p_{j,l}^{(n)}\) is an element belonging to the transition matrix \(P^n\) from row \(j\) and column \(l\). In other words, for an \(m\) member committee, \textit{majority consensus} is achieved when the elements of \(P^{n \to \infty}\) converge on a distribution characterised by \(j \geq \frac{m+1}{2}\) identical rows, unlike \textit{unanimous consensus}, all that is required here is for a majority of columns, the elements will be identical. As was specified for unanimous consensus, under \textit{majority consensus} the elements in each row will be non-negative and sum to unity.

\footnote{To keep the analysis simple, odd \(m\) is assumed.}
4.6 Conditions for Reaching a Consensus

In specifying the conditions for reaching a consensus I develop theorems whose corresponding proofs have a basis in the theory of Markov chains. Such proofs can be found in standard reference texts on stochastic processes, probability theory, matrix theory and finite Markov chains.\(^{27}\) It is assumed throughout that no two members share the same initial policy preferences. This implies that each element of the belief vector is unique.\(^{28}\) Conditions under which unanimous consensus is achieved are now stated.

4.6.1 Unanimous Consensus

Proposition 1: A unanimous consensus will be reached by the committee if the influence matrix \(P\) is irreducible and aperiodic.

The following definition is introduced:

**Definition 1:** A transition matrix is irreducible if and only if for every \((j, k)\) there exists a natural number \(q\) such that

\[
p^q_{j,k} \in (0, 1)
\]

In other words, if all elements in the influence matrix are positive for some power \(q\), it has a unique long-run stationary distribution. In other words, although the transition matrix \(P^{\text{top}}\) may contain some zeros, members are sufficiently connected such that every member listens to every other member either directly or indirectly. When the matrix is raised to some power \(q\), all of the elements in the listening matrix become strictly positive but less than unity. It is crucial to note here that no \(p^0_{j,k} = 1\), which would imply periodicity or an absorbing class. By (4.23) all

\(^{27}\)See for example Doob (1953), Feller (1968), Karlin (1969), Parzen (1962), Berman and Plemmons (1979), Kemeny and Snell (1960) and Theil (1972).

\(^{28}\)This is an important assumption, and has ramifications for the conditions under which consensus will be reached. Here, the work of Berger (1981) is of particular importance. In a follow up paper to DG, Berger corrects DG's assertion regarding the necessary conditions for reaching a consensus. Simply put, whereas DG asserts that whether a consensus can be reached depends only on the influence matrix, \(P\), Berger shows how it is also dependent on the initial (time \(t = 0\)) composition of the belief vector, \(\mathbf{1}^0\). For example, assume that prior to the deliberation process all elements of the belief vector are equal, that is \(i_{1,0} = i_{2,0} = \ldots = i_{m-1,0} = i_{m,0}\), \(n = 1, 2, \ldots, \infty\). The make-up of \(P\) is hence irrelevant and a unanimous consensus is reached as \(\mathbf{1}^0 = P\mathbf{1}^0 = \mathbf{1}^0\). Given that the concern of this paper is to determine how members of an MPC reach agreement under initially diverse interest rate preferences, I do not consider this prospect.
recurrent states of the Markov chain communicate with each other and are aperiodic. A transition matrix with such properties is sometimes called regular.

Proof of Proposition 1: See Appendix.

The concept of irreducibility has an equivalent graph theoretic interpretation. If the digraph corresponding to the matrix $P$ is strongly connected, then it is irreducible. Strongly connected asserts that for any ordered pair $(P_i, P_j)$ of vertices there exists a sequence of paths leading from $P_i$ to $P_j$. Monetary policy committees whose members are strongly connected will necessarily reach a consensus. Simulated examples of strongly connected MPCs are provided in proceeding sections. I now introduce the following further proposition relating to unanimous consensus.

Proposition 2: A unanimous consensus will be reached by the committee if any member $j$ is influenced only by himself, and influences all other members, either directly or indirectly. Members' beliefs will necessarily converge to those of member $j$.

Proof of Proposition 2: See Appendix.

Such a member $j$ is akin to monetary policy dictator of the variety assumed to yield influence in autocratically-collegiate MPCs.

4.6.2 Majority Consensus

In this section I restrict myself to the case where there are two distinct groups of members on a monetary policy committee. This set-up is analogous to the institutional arrangement at the Bank of England, and in line with the terminology popularly used to describe members of its monetary policy committee, I refer to them as insiders and outsiders. This leads to Proposition 3.

Proposition 3: If there exists two distinct groups of members within a monetary policy committee who do not communicate with each other, and each group forms an aperiodic recurrent class, for an $m$ member committee, a majority consensus will be reached by the group with the largest number of members.

Proof of Proposition 3: See Appendix.
The intuition underlying Proposition 3 is easy to understand. It says that if insiders and outsiders listen only to members of their own type (thereby assigning zero weight to the views of those members not of their type) insiders will be neither directly nor indirectly influenced by outsiders, and vice versa. By assuming that insiders and outsiders each form an aperiodic recurrent class, it follows that members in each group will reach a consensus amongst themselves. In the presence of initially diverse interest rate preferences, it is still possible for members to reach a unanimous consensus if the consensus rate of interest for both converges on the same rate. As a special case, this is demonstrated in the appendix, and follows the proof of Proposition 3. Insiders are assumed to listen only to insiders, with the equivalent being true for outsiders.

4.6.3 Failure to Reach a Consensus

I now introduce the following proposition, which underscores the importance of listening to other MPC members when views are initially diverse.

Proposition 4: If no MPC member is directly or indirectly influenced by any other member, a consensus will never be reached.

Proof of Proposition 4: See Appendix.

This result follows because in each stage of the deliberation process each member only updates his beliefs on the basis of listening to himself. Consequently, a given member’s beliefs remain unchanged from period to period. This result suggests that MPCs should be populated by people who are willing to listen to the views of others. A committee comprised of ‘egoists’ will never reach agreement because in not weighting the opinions of others, members are unable to budge from their initial positions on the interest-rate. If the assumption of initial belief diversity is relaxed (i.e. some members share the same interest rate preferences prior to the deliberation process), a majority consensus will be reached if at least half of, but not all members share the same initial belief. When all members share the same initial belief a unanimous consensus is achieved. In either case there is no need to deliberate.
4.6.4 Periodic Behaviour

Not all irreducible Markov chains thus have the property of ergodicity, and it is possible for a Markov chain to be both irreducible and periodic. Assuming initially diverse interest rate preferences, periodicity implies that \( \lim_{n \to \infty} P \) is not characterised by a unique stationary distribution. A periodic Markov chain with \( n \) eigenvalues of modulus 1 has period \( n \). In terms of the listening matrix \( P \), this implies that members may be only be directly or indirectly influenced by other members at regular intervals (i.e. every \( n^{th} \) interval). From an intuitive perspective, such behaviour is unappealing. Periodicity implies that members constantly switch to listening to different members at different stages of the deliberation process. I nevertheless introduce the following proposition:

**Proposition 5:** Under initially diverse interest rate preferences and assuming periodicity, neither a unanimous nor majority consensus will be achievable when states are periodic.

**Proof of Proposition 5:** See Appendix.

It is noted that the results for Proposition 5 do not extend to the case where the influence matrix \( P \) is characterised by \( m \) sets of cyclic recurrent classes. Under such conditions, it is possible that (i) there exist some linear combination of opinion weights and initial beliefs ensuring that \( l^{[1]} = l^{[2]} = ... = l^{[n]} \) (unanimous consensus) or (ii) a majority of members beliefs converge on the same interest rate for \( l^{[n]} \), \( n = 1, 2, ... \infty \) with the composition of the majority switching regularly in sync with the period of the cycle (majority consensus). Illustrative examples of such behaviour proceeds the proof of Proposition 5 in the appendix. I now turn to the simulations.

4.6.5 Speed of Convergence to a Consensus

I have not yet touched on the speed at which beliefs will converge. In any transition matrix which is irreducible and aperiodic (therefore entailing that a unanimous consensus is reachable) the absolute value of the largest eigenvalue will equal unity, with the corresponding moduli of all other eigenvalues being smaller than one. Indeed, eigenvalue analysis may be used to check whether convergence occurs, and a sufficient condition for reaching a unanimous consensus characterised by a unique stationary distribution is given by the case where all other \( m - 1 \) eigenvalues have
moduli strictly less than one. The rate with which convergence is achieved is related to the second largest eigenvalue in absolute value. Define this as

\[ \delta(P) = \max\{|\lambda| : \lambda \in \sigma(P), \lambda \neq 1\} \] (4.24)

where \( \sigma(P) \) is the set of all eigenvalues in \( P \). \( \delta(P) \) declines geometrically with each iteration. For some transition matrices, it is possible that the roots may be complex. Calculating the absolute value of a complex number is given by the square root of its modulus. Therefore, for any complex eigenvalue \( \lambda_j = a \pm bi \), its absolute value can be defined as

\[ |\lambda_j| = \sqrt{|a^2 + b^2|} = (a^2 + b^2)^{1/2} \] (4.25)

Should the second largest eigenvalue \( \lambda_2 \) be complex, the convergence towards the stationary distribution is of the damped oscillatory type. Further, if two influence matrices \( \tilde{P} \) and \( \tilde{P} \) are compared such that \( \delta(\tilde{P}) < \delta(\tilde{P}) \), then consensus will be reached more quickly under \( \tilde{P} \) than for \( \tilde{P} \). It is noted that the largest eigenvalue of any transition matrix always is always a unit root. The presence of more than one eigenvalue of modulus 1 does not necessarily imply that a unanimous consensus has not been reached, as this will also depend on the initial elements of the belief vector. In the case of a majority consensus, there will be at least two eigenvalues with moduli equal to 1.

It is possible to use \( \delta(P) \) to determine the number of iterations until consensus is reached. A 'rough and ready' estimate is given by the formula

\[ \xi = \frac{\log 0.008}{\log(\delta(P))} \] (4.26)

where \( \xi \) is the number of iterations (i.e. deliberative rounds) and logarithms are to base 10.

### 4.7 Simulation Results

Panels 4.1-4.4 show various influence structures for MPCs. Panel 4.1 (a) shows the influence network for a five member monetary policy committee where each member places positive weight on the opinions of all members, including himself. In line with the institutional arrangements at the Bank of England, two
types of members are specified—*insiders* and *outsiders*. Further, the committee comprises three of the former type and two of the latter type. Specifically, MPC members’ ideal interest rates are captured by the belief vector $l^{i,0}$:

$$l^{i,0} = \begin{bmatrix} 4.5 \\ 4.4 \\ 4.3 \\ 4.2 \\ 4.1 \end{bmatrix}$$

and opinion weights in the transition matrix $P$ are allocated such that

$$P = \begin{bmatrix} 0.8 & 0.05 & 0.05 & 0.05 & 0.05 \\ 0.05 & 0.8 & 0.05 & 0.05 & 0.05 \\ 0.05 & 0.05 & 0.8 & 0.05 & 0.05 \\ 0.05 & 0.05 & 0.05 & 0.8 & 0.05 \\ 0.05 & 0.05 & 0.05 & 0.05 & 0.8 \end{bmatrix}$$

In $P$, rows 1-3 contain the opinion weights pertaining to insiders, and the remaining two rows contain outsiders’ allocation of weights. Further, assume that the insider in the first row is the Governor, who also assumes the role of committee Chair. The general configuration of (4.28) applies to all simulations. In this example, a unanimous consensus is achieved as all members have a direct influence on each other. The MPC is strongly connected, with the influence matrix thus being irreducible and aperiodic. Corresponding numerical parameters for the opinion matrix are also shown. The speed of convergence, $\delta(P) = 0.75$. Using (4.26) it is determined that the group reaches a consensus after approximately $\xi = \frac{\log 0.008}{\log 0.75} = 16.78$ deliberative rounds. Such an influence structure structure may correspond to that at the European Central bank, and more generally, genuinely collegiate monetary policy committees.

In Panel 4.1 (b), each member only listen to himself. By application of Proposition 4, because no MPC member is directly or indirectly influenced by any other member a consensus will never be reached. It is notable that the group

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29 Alternatively, one could consider the distinction between Board members and Bank Presidents on the Federal Open Market Committee or National Central Bank Governors and Board members sitting on the European Central Bank’s Governing Council.

30 As is the case with the MPC, it is supposed that *insiders* comprise the majority of members.
would reach a majority or unanimous consensus if a majority of or all committee members were endowed with same initial interest rate beliefs (i.e. if the assumption of initially diverse beliefs is relaxed). No agreement is otherwise reached, as is borne out in the example.

In PANEL 4.2 (c), each member only weights the opinion of a single member other than himself. No two members weight the opinion of the same member, and $P$ is irreducible and periodic with period 5. From Proposition 5, neither unanimous nor majority consensus are reachable, and associated transition matrix has no stationary distribution. This configuration has little intuitive appeal, as members’ beliefs follow a cyclical pattern switching abruptly from period to period. However, it is notable that unanimous consensus is reachable if and only if the elements of the belief vector are initially equal. A majority consensus is possible if a majority of elements in belief vector are equal, although the composition of the majority will switch from period to period following a cycle. PANEL 4.2 (d) depicts a monetary policy committee of insiders and outsiders who do not communicate with each other. The example shows that even when both groups ignore each other consensus is still reachable, even under initially diverse interest rate preferences. It constitutes the special case of Proposition 3, as elaborated on in the proof given in the appendix.

In PANEL 4.3 (e), four members weight only the opinion of a single member, in this case the Governor. As the Governor only weights his own opinion, the interest rate converges to his preferred rate. A unanimous consensus is thus reached. This is an example of an absorbing chain, the proof of which is given in Proposition 2. The example corresponds to a structure like the FOMC, which is an example of an autocratically collegiate committee. Here, all members weight the opinion of the Governor, but he does not reciprocate, opting to weight his own opinion only. In PANEL 4.3 (f) members are partitioned into two groups - insiders and outsiders. However, if two members - one from each group - both communicate with each other, a unanimous consensus is reached. This is because from Proposition 1, the influence matrix is both aperiodic and irreducible.

The final two simulations shown in PANEL 4.4 depict possible states of affairs for an individualistic MPC. Both examples are geared specifically towards the institutional nuances of the Bank of England Monetary Policy Committee, and reproduce the stylised facts of voting behaviour associated with its members.
**Panel 4.1:**

Interest Rate Convergence Paths for a 5 Member MPC
Panel 4.2.
Interest rate convergence paths for a 5 member MPC (continued)
**Panel 4.3:**

Interest Rate Convergence Paths for a 5 Member MPC (continued)
PANEL 4.4.
INTEREST-RATE CONVERGENCE PATHS FOR A 5 MEMBER COMMITTEE OF PRAGMATISTS
AND EGOISTS
In line with Proposition 3, insiders and outsiders are seen to reach a consensus amongst themselves. However, it is assumed that outsiders initially prefer lower interest rates than outsiders. When insiders vote together as a group, they are seen to dominate decisions on the MPC, regardless of any opposition from their externally appointed counterparts. Insiders reach a majority consensus, because they restrict themselves to only weighting the opinions of members of their own type. Further, the policy outcome is typified by an interest-rate which is higher than would be chosen by outsiders.\(^3\)

The two examples also illustrate the importance of listening to others in the course of MPC deliberations. (g) can be viewed as comprising a committee of 'pragmatists', whereas (h) comprises a committee of 'egoists'. Begin by assuming that the belief vector containing member's ideal interest rates is identical to that in (4.27). Members of committee (h) weight their own opinions more heavily than members of committee (g). We have that

\[
P^{\text{Pragmatists}} = \begin{bmatrix}
0.8 & 0.1 & 0.1 & 0 & 0 \\
0.01 & 0.8 & 0.1 & 0 & 0 \\
0.1 & 0.1 & 0.8 & 0 & 0 \\
0 & 0 & 0 & 0.8 & 0.2 \\
0 & 0 & 0 & 0.2 & 0.8
\end{bmatrix}
\]

and

\[
P^{\text{Egoists}} = \begin{bmatrix}
0.9 & 0.05 & 0.05 & 0 & 0 \\
0.05 & 0.9 & 0.05 & 0 & 0 \\
0.05 & 0.05 & 0.9 & 0 & 0 \\
0 & 0 & 0 & 0.9 & 0.1 \\
0 & 0 & 0 & 0.1 & 0.9
\end{bmatrix}
\]

where \(P^{\text{Pragmatists}}\) and \(P^{\text{Egoists}}\) correspond to the matrices in simulations (g) and (h) respectively. Compared to \(P^{\text{Pragmatists}}\), the influence matrix \(P^{\text{Egoists}}\) is notable in as far as all MPC members weight their own opinions more heavily, at the cost

\(^3\)I suggest that if career concerns are present amongst members of the BoEMPC, and manifest themselves in much the same way as described by Lawrence Roos for members of the FOMC, it is not entirely incredulous to suggest that insiders will weight the opinions of insiders more heavily than outsiders. This fosters the prediction that insiders will be on the winning side of MPC decisions than outsiders, which is seen in practice. It would thus account for why Edmonds (1999) was able to observe that "the Bank representatives [insiders] have formed into a cohesive homogenous group".(p.12)
of the opinions of their peers. Members are less open to the opinions of others, so to speak: less pragmatic, and more egoistic. Because egoists by definition weight their own opinions more heavily than pragmatists, reaching a majority consensus takes longer. In the examples in PANEL 4.4, both committees still choose the same interest-rate, albeit it takes longer for members to arrive at a decision. This is borne out by eigenvalue analysis. Firstly, because the influence matrix is characterised by two disjoint communicating classes, both matrices have two eigenvalues with moduli equal to 1. In (g) and (h) it follows that

\[ \delta(P_{\text{Insiders}}^{\text{Pragmatists}}) < \delta(P_{\text{Insiders}}^{\text{Egoists}}) \]  

and

\[ \delta(P_{\text{Outsiders}}^{\text{Pragmatists}}) < \delta(P_{\text{Outsiders}}^{\text{Egoists}}) \]

Egoistic insiders reach a consensus amongst themselves after \( \xi = \log_{0.008} 0.86 \approx 30 \) deliberative rounds, whereas their pragmatic counterparts do so after \( \xi = \log_{0.008} 0.78 \approx 14 \) rounds. The same applies to outsiders, for whom members of the egoistic variety reach a consensus after \( \xi = \log_{0.008} 0.90 \approx 22 \) rounds, in contrast to \( \xi = \log_{0.008} 0.90 \approx 9 \) rounds for pragmatists.

### 4.8 Conclusion

This chapter has adopted a bounded-rational approach to decision making by monetary policy committees. It has sought to account for the deliberation process by demonstrating how MPC members' views align when interest rate preferences are initially diverse. If members share initially diverse views, communication amongst MPC members is crucial in forging consensus. I showed how consensus may be achieved under a variety of different assumptions, and provided a formal mechanism which potentially explains how autocratically collegiate, genuinely collegiate and individualistic committees are able to reach a decision. The model potentially explains the process by which members of an MPC are persuaded to budge from their initial interest rate positions. In practice, MPCs do reach an agreement, which suggests that members do listen to each other and modify their beliefs in the course of deliberations. I suggest that this may be due to career concerns, members' subjective assessments of other's information, and the internal culture of an MPC.

An overriding conclusion which emerges from the analysis is that it is possible
to populate MPCs with people who hold very different views about the economy and still reach an agreement. Secondly, and perhaps more obviously, MPCs should be populated by people who are willing to listen to the opinions of others. A consequence of not adhering to this recommendation is that reaching an agreement may not be achievable, as was demonstrated by Proposition 4 - when no member listens to the views of other members, consensus is not reached, unless one relaxes the assumption of initially diverse interest rate preferences. Yet the fact that what drives people to listen to one another is motivated by (i) career concerns and (ii) members’ subjective assessments of others information raises important questions. Is, for example, the consensus outcome the best for the economy, especially given that the propensity for members to reach agreement is emphatically not driven by a desire to adopt the ‘optimal’ policy, but selfish motives such as career advancement?

The model may potentially explain Alan Blinder’s (1998) contention that monetary policy committees reach decisions which are ‘inertial’ and ‘regress towards the mean’. For instance, consider how genuinely collegiate MPCs reach a ‘compromise’ interest rate characterised by an average of initial beliefs weighted by the unique stationary distribution of the influence matrix as \( \lim_{n \to \infty} P^n \). The model raises further questions about the benefits of delegating monetary policy to a committee. It is often assumed that such an institutional arrangement is beneficial because members are able to pool their information. However, this precludes the fact that (i) any given member’s assessment of others’ information may be purely subjective - and wide off the mark - and (ii) agents may be boundedly rational, using a simple heuristic to update beliefs, as opposed to more robust and computationally burdensome procedures. Very few models of monetary policy decision making consider these possibilities. In this sense there exists considerable scope for this chapter to be extended, especially if one relaxes the assumption of initially diverse interest rate preferences. This would entail that for example, some members may share identical beliefs prior to the deliberation process. The analysis in this section has not considered this more general case, and it therefore represents a possibility for further analysis. Secondly, one might compare the extent to which decision outcomes are different when members are fully as opposed to boundedly rational.
4. Appendix to Chapter 4

4.A.1 Proof of Proposition 1

To prove that a unanimous consensus will be reached by the committee if the influence matrix \( P \) is irreducible I draw heavily on Kemeny and Snell (1960) and Theil (1972). To establish the proof it is first necessary to draw on the following lemma:

Lemma 1

Let the \( m \times m \) transition matrix \( P \) contain strictly positive elements \( p_{i,j} \) such that \( p_{i,j} \in [0, 1] \) and \( \sum_{i=1}^{m} p_{i,j} = 1 \). Denote \( \epsilon \) as the smallest element of \( P \) by \( \mathbf{x} \), an \( m \times 1 \) column vector and \( P\mathbf{x} \) the vector arising from pre-multiplying \( \mathbf{x} \) by \( P \). Denote by \( m_0 \) and \( M_0 \) the smallest and largest elements of \( \mathbf{x} \) respectively, and let \( m_1 \) and \( M_1 \) denote the corresponding values for vector \( P\mathbf{x} \). Lemma 1 asserts that

\[
M_1 \leq M_0 \quad (4.33)
\]

\[
m_1 \geq m_0 \quad (4.34)
\]

and

\[
M_1 - m_1 \leq (1 - 2\epsilon)(M_0 - m_0) \quad (4.35)
\]

Proof of \( M_1 \leq M_0 \): To show (4.33) and (4.35), begin by denoting \( \mathbf{x}^* \) as an \( m \times 1 \) column vector obtained from \( \mathbf{x} \) through replacing all but one element \( m_0 \) with \( M_0 \). Where there is more than one \( m_0 \) element in \( \mathbf{x} \) assume that all but one of them are replaced by \( M_0 \). Now consider that we have that

\[
\mathbf{x} = \begin{bmatrix} m_0 \\ x_2 \\ \vdots \\ x_{n-1} \\ M_0 \end{bmatrix} \quad \text{and} \quad \mathbf{x}^* = \begin{bmatrix} m_0 \\ M_0 \\ \vdots \\ M_0 \end{bmatrix} \quad (4.36)
\]

where \( m_0 \leq x_1 \leq x_2 \ldots x_{n-1} \leq M_0 \). Let

\[
\mathbf{x} \leq \mathbf{x}^* \quad (4.37)
\]
by assuming that each element of \( x^* \) is greater than its corresponding element in \( x \) by a nonnegative amount. Using the relationships outlined above, and because \( \sum_{j=1}^{m} p_{i,j} = 1 \), the \( i^{th} \) element of vector \( P x^* \) is captured by

\[
p_{i,1} m_0 + \sum_{j=2}^{m} p_{i,j} M_0 = p_{i,1} m_0 + (1 - p_{i,1}) M_0 \]
\[= M_0 - p_{i,1} (M_0 - m_0) \tag{4.38} \]

Given that \( \varepsilon \) is the smallest element of the transition matrix \( P \), it follows that it must be less than or equal to any element \( p_{i,j} \), namely

\[
\varepsilon \leq p_{i,j} \tag{4.39} \]

Therefore we have that \( \varepsilon \leq p_{i,1} \). This implies that for vector \( P x^* \),

\[
M_0 - \varepsilon (M_0 - m_0) \geq M_0 - p_{i,1} (M_0 - m_0) \tag{4.40} \]

As it has already been defined that \( x \leq x^* \), it follows that

\[
M_0 - p_{i,1} (M_0 - m_0) \geq M_1 \tag{4.41} \]

Using (4.40) and (4.41) it is possible to write

\[
M_0 - \varepsilon (M_0 - m_0) \geq M_1 \tag{4.42} \]

Assuming \( M_0 \geq m_0 \) and \( \varepsilon \in [0, 1] \) in (4.42) establishes the first part of (4.33), namely \( M_1 \leq M_0 \).

**Proof of \( m_1 \geq m_0 \):** Proving (4.34) draws on the result shown in (4.33), namely (4.42). First consider the difference between the \( i^{th} \) element in the \( (m \times 1) \) column vectors \( P x^* \) and \( P x \), where \( x_j \) corresponds to the \( j^{th} \) element of \( x \) and \( x_j^* \) denotes the equivalent element of \( x^* \). Specifically, write that

\[
\sum_{j=1}^{m} p_{i,j} (x_j - x_j^*) \tag{4.43} \]

Given the assumption of \( x \leq x^* \) coupled with \( p_{i,j} \in [0, 1] \) it follows that (4.43) cannot be positive. Now supplant \( x \) with \(-x\) such that \( P x \) now becomes \( P (-x) = -Px \). This implies that the smallest and largest elements of \(-Px\) are \(-M_1\) and \(-m_1\)
respectively. Therefore re-write (4.42) as

\[-m_0 - \varepsilon(m_0 + M_0) \geq -m_1\]  

(4.44)

The inequality (4.44) establishes that \( m_1 \geq m_0 \). \( QED. \)

Proof of \( M_1 - m_1 \leq (1 - 2\varepsilon)(M_0 - m_0) \): To demonstrate that (4.35) holds hinges on the key results used to prove (4.33) and (4.34). Summing (4.42) and (4.44) yields

\[M_1 - m_1 \leq (1 - 2\varepsilon)(M_0 - m_0)\]  

(4.45)

which confirms (4.35). \( QED. \)

Convergence of a Regular Markov Chain to a Stationary Distribution

Using Lemma 1 it is now proved that consensus is reached by all MPC Members when the opinion matrix is regular. In keeping with the previous section the elements of the opinion matrix are assumed to have the values \( p_{ij} \in [0, 1] \) where \( \Sigma_{i=1}^{m} p_i = 1, \ i = (1, 2, \ldots m) \). Specifically, the proof requires demonstration that for any regular matrix \( P^t \), \( \lim_{t \to \infty} P^t = \lambda \pi' \), where is a \( m \times 1 \) vector of ones, and \( \pi' \) is a \( 1 \times m \) vector of probabilities. In other words, in the limit as \( t \to \infty \) \( P^t \) converges on an \( m \times m \) matrix with identical rows, entailing that elements in each column are identical. Write this as

\[\lim_{t \to \infty} P^t = \begin{bmatrix} \pi_1 & \pi_2 & \ldots & \pi_{m-1} & \pi_m \\ \pi_1 & \pi_2 & \ldots & \pi_{m-1} & \pi_m \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \pi_1 & \pi_2 & \ldots & \pi_{m-1} & \pi_m \\ \pi_1 & \pi_2 & \ldots & \pi_{m-1} & \pi_m \end{bmatrix} = \begin{bmatrix} \pi' \\ \pi' \\ \vdots \\ \pi' \\ \pi' \end{bmatrix} = \lambda \pi' \]  

(4.46)

where \( \Sigma_{i=1}^{m} \pi_i = 1, \ i = (1, 2, \ldots m) \). Now introduce the \( m \times 1 \) vector \( i_j \). All elements of are assumed to be zero apart from the \( j^{th} \) element, which equals 1. Further, consider the matrix \( A \) which has \( m \) columns. Post-multiplication of \( A \) by \( i_j \) yields an \( m \times 1 \) vector identical to the \( j^{th} \) column of \( A \).

Now envisage the chain of vectors \( i_j, P_i, P^2i_j, P^3i_j, \ldots, P^ti_j, \ldots \) denoting the largest corresponding elements \( M_0, M_1, M_2, M_3, \ldots, M_t, \ldots \) and the smallest ele-
ments \( m_0, m_1, m_2, m_3, \ldots, m_t, \ldots \). Applying Lemma 1, and using the relationship \( P^t i_j = P(P^{t-1} i_j) \) it is possible to conclude that

\[
M_0 \geq M_1 \geq M_2 \geq M_3 \ldots \geq M_t \tag{4.47}
\]

\[
m_0 \leq m_1 \leq m_2 \leq m_3 \leq \ldots \leq m_t \tag{4.48}
\]

and

\[
M_t - m_t \leq (1 - 2\varepsilon)(M_{t-1} - m_{t-1}) \tag{4.49}
\]

Substituting \( M_{t-1} - m_{t-1} \) with \( (1 - 2\varepsilon)(M_{t-2} - m_{t-2}) \) gives

\[
M_t - m_t \leq (1 - 2\varepsilon)^2(M_{t-2} - m_{t-2}) \tag{4.50}
\]

Systematically repeating this procedure for \( (M_{t-2} - m_{t-2}), (M_{t-3} - m_{t-3}) \) through to \( (M_{t-(t-1)} - m_{t-(t-1)}) \) - in other words using backwards substitution - gives

\[
d_t \leq (1 - 2\varepsilon)^t d_0 = (1 - 2\varepsilon)^t \tag{4.51}
\]

where \( d_t = M_t - m_t \) and \( d_0 = 1 \), the latter term being the value of the largest element of \( i_j, M_0 = 1 \), less the smallest element, \( m_0 = 0 \). As \( (1 - 2\varepsilon) \in [-1, 1] \), \( d_t \) necessarily converges to zero as \( t \to \infty \); essentially, as \( M_t \) and \( m_t \) are the largest and smallest elements in the \( j^{th} \) column of \( P \), all elements of the column converge to the same value, namely \( \pi_j \) in (4.46). \( QED \).

**Proof that \( \pi_j \) is positive:** It has previously been shown that \( m_1 \leq m_t \) [eqn. (4.48)]. As \( m_1 \) is identical to the smallest transition probability in row \( j \) of element of matrix \( P \), namely \( p_{1,j}, p_{2,j}, \ldots, p_{m-1,j}, p_{m,j} \), and each \( p_{i,j} \geq \varepsilon > 0 \), \( \pi_j \) must be positive. \( QED \).

**4.A.2 Proof of Proposition 2**

To prove Proposition 2 it is first necessary to draw on the theory of absorbing chains. For any \( m \times m \) transition matrix \( P \), a state \( s_t \) is defined as absorbing if and only if \( p_{j,j} = 1 \) \( \forall j = 1, 2, \ldots, m \). In the context of the model, an absorbing state is characterised by an MPC member listening only to himself, thereby placing no weight on the opinions of his colleagues. Should absorbing states arise, it is possible to permute and subsequently partition the rows and columns of the
corresponding influence matrix into the block form

\[
P = \begin{bmatrix}
I & 0 \\
B & C
\end{bmatrix}
\]  
(4.52)

where \(I\) is a \((m - s) \times (m - s)\) identity matrix, \(0\) is \((m - s) \times s\) array of zeros and \(B\) and \(C\) are \(s \times (m - s)\) and \(s \times s\) arrays of transient states respectively. This structure of (4.52) implies that members belonging to the initial \((m - s)\) rows weight only their own opinions, whereas individuals pertaining to the last \(s\) rows with are influenced by the opinions of members who weight only their opinions in the first \((m - s)\) rows. It follows from (4.52) that

\[
P^n = \begin{bmatrix}
I & 0 \\
\sum_{i=0}^{n-1} C^i B & C^n
\end{bmatrix}
\]  
(4.53)

where by Theorem 1.11.1 of Kemeny and Snell (1960), \(\lim_{n \to \infty} C^n = 0\). Using these theorems, proof of Proposition 2 now follows:

**Proof of Proposition 2:** For an \(m\) member committee if any member \(j\) is influenced only by himself, and influences all other members, either directly or indirectly a unanimous consensus will be reached by the committee. By (4.52) and Theorem 1.11.1 of Kemeny and Snell, members’ beliefs will necessarily converge to those of member \(j\). Treating \(I\) as a \((1 \times 1)\) matrix whose only element is \(p_{11} = 1\), it follows that in the limit all elements in the remaining \((m - 1)\) rows of the first column of the influence matrix will converge to a single column of ones, with all other elements converging to zero.

\[
\lim_{n \to \infty} P^n = \begin{bmatrix}
1 & 0 & \cdots & 0 \\
1 & 0 & \cdots & 0 \\
\vdots & \vdots & \ddots & \vdots \\
1 & 0 & \cdots & 0
\end{bmatrix}
\]  
(4.54)

QED.
4.A.3 Proof of Proposition 3

To prove Proposition 3 I draw on results from the proof of Proposition 1. For an \( m \) member committee, begin by introducing the block matrix

\[
P = \begin{bmatrix} \Upsilon & 0 \\ 0 & \Delta \end{bmatrix}
\]  

(4.55)

where \( \Upsilon \) and \( \Delta \) comprise two disjoint communicating classes. Specifically, let \( \Upsilon \) denote a \( (m - s) \times (m - s) \) bloc of opinion weights for insiders and \( \Delta \) denote a corresponding \( s \times s \) bloc for outsiders. In the limit it necessarily holds that

\[
\lim_{n \to \infty} P = \begin{bmatrix} \Upsilon^\infty & 0 \\ 0 & \Delta^\infty \end{bmatrix}
\]  

(4.56)

Given (4.56) it follows that each bloc can be treated as a matrix in its own right (as the elements of \( \Upsilon \) and \( \Delta \) do not influence each other). Because both matrices each comprise a \emph{single aperiodic recurrent class} (i.e. all members within each group are strongly connected) the results for Proposition 1 apply to the \( (m - s) \times (m - s) \) matrix \( \Upsilon \) and the \( s \times s \) matrix \( \Delta \). Thus the limiting distribution of \( P \) takes the form.

\[
\lim_{t \to \infty} P^t = \begin{bmatrix} \pi_1 & \ldots & \pi_{m-s} & 0 & \ldots & 0 \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ \pi_1 & \ldots & \pi_{m-s} & 0 & \ldots & 0 \\ 0 & \ldots & 0 & \pi_{m-s+1} & \ldots & \pi_m \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ 0 & \ldots & 0 & \pi_{m-1} & \ldots & \pi_m \end{bmatrix} = \begin{bmatrix} \pi_{\text{insiders}}' \\ \vdots \\ \pi_{\text{insiders}}' \\ \pi_{\text{outsiders}}' \\ \pi_{\text{outsiders}}' \end{bmatrix}
\]  

(4.57)

The first \( (m - s) \) rows will converge to a stationary distribution characterised by the first \( (m - s) \) columns containing strictly positive elements and the latter \( s \) columns comprising zeros. The last \( s \) rows will converge to a limit characterised by elements in the first \( (m - s) \) columns comprising zeros, and the remaining \( s \) columns containing strictly positive elements. Assuming \( (m - s) > s \) implies that insiders reach a \emph{majority consensus}. In the presence of a tie (i.e. when \( m \) is not odd), assume that the chairman has a casting vote. \textit{QED}.  

125
The special case of a unanimous consensus being reached in the presence of two aperiodic recurrent classes is characterised by both groups converging on the same interest rate. Again, assuming an $m$ member committee with initially diverse preferences, this occurs when

$$\sum_{j=1}^{m-s} \pi_j i_{j,0} = \sum_{j=m-s+1}^{m} \pi_j i_{j,0}$$

(4.58)

where $\pi_j$ denotes elements of matrix (4.18) in the $j$th column and the $i_{j,0}$s correspond to the elements of the period $t = 0$ belief vector $i^{[0]}$ as in (4.4). The first $m - s$ elements correspond to insiders' initial beliefs, and the latter $s$ elements correspond to the initial beliefs of outsiders. The transpose of the vector is given by

$$i^{[0]'} = \left[ i_{1,0}, \ldots, i_{m-s,0}, i_{m-s+1,0}, \ldots, i_{m,0} \right]$$

(4.59)

An equivalent representation of (4.4) is given by

$$\pi'_{\text{Insiders}} i^{[0]} = \pi'_{\text{Outsiders}} i^{[0]}$$

(4.60)

where $\pi'_{\text{Insiders}}$ is the vector capturing the unique stationary distribution for insiders, and $\pi'_{\text{Outsiders}}$ is the corresponding vector for outsiders.

### 4.A.4 Proof of Proposition 4

If members are neither directly nor indirectly influenced by their colleagues, they effectively place weight 1 on their own opinions. The influence matrix is thus an $m \times m$ identity matrix. This implies that

$$P = P^n, \quad \forall \ n, \ n = 1, 2, \ldots, \infty$$

(4.61)

If $P = P^n$, then

$$i^{[0]} = i^{[n]}, \quad \forall \ n, \ n = 1, 2, \ldots, \infty$$

(4.62)

as from (4.5) and (4.7) we have that $|i^{[n]} = P^n i^{[0]} = P^{[0]} = i^{[0]} \forall \ n$. Initial beliefs remain unchanged irrespective of the stage of the deliberation process, and no consensus is achieved. \textit{QED.}
4.A.5 Proof of Proposition 5

By Theorem XV.6.1 of Feller (1968), all states of an irreducible chain are of the same type. Thus for a periodic chain, if there are \( m \) recurrent states then \( P \) is cyclic of order \( m \). This implies that member \( j \) is only influenced by any another member \( k \) every \( t = m \) intervals. In all other \( t - 1 \) periods \( j \) is not influenced by \( k \).

Consider, for instance, a three member MPC sitting in a circle, where each member only weights the opinion of the person sitting to the right of him. Let the influence matrix \( P \) and subsequent powers to which it is raised be given by

\[
P = \begin{bmatrix}
0 & 1 & 0 \\
0 & 0 & 1 \\
1 & 0 & 0
\end{bmatrix}, P^2 = \begin{bmatrix}
0 & 0 & 1 \\
1 & 0 & 0 \\
0 & 1 & 0
\end{bmatrix}, P^3 = \begin{bmatrix}
1 & 0 & 0 \\
0 & 1 & 0 \\
0 & 0 & 1
\end{bmatrix}, P^4 = \begin{bmatrix}
0 & 1 & 0 \\
0 & 0 & 1 \\
1 & 0 & 0
\end{bmatrix}
\]

(4.63)

The matrix \( P \) is of period 3. Not only does \( P = P^4 \), but more generally \( P = P^{n+3+1} \), \( \forall n = 1, 2, \ldots, \infty \). Given that \( P \neq P^2 \neq P^3 \) and \( (P = P^{n+3+1}) \neq (P^2 = P^{((n+1)3)+1}) \neq (P^3 = P^{((n+2)3)+1}) \), \( \forall \), \( n = 1, 2, \ldots, \infty \), \( P^n \) can never converge. Extending this to the case of \( m \) members (and thus \( m \) cycles) it therefore follows that

\[
P \neq P^2 \neq \ldots \neq P^m
\]

(4.64)

and

\[
(P = P^{nm+1}) \neq (P^2 = P^{((n+1)3)+1}) \neq \ldots \neq (P^m = P^{((n+2)m)+1})
\]

(4.65)

Now apply (4.65) to the iteration process given by (4.7). The beliefs which emerge following subsequent revisions have the following properties:

\[
|^{[0]} = |^{[nm]} \]

(4.66)

\[
|^{[1]} = |^{[nm+1]} \\
\vdots \\
|^{[m-1]} = |^{[nm+(m-1)]}
\]

for all \( n = 1, 2, \ldots, \infty \). As \( P^n \) cannot converge, neither do initial beliefs. Rather, revised estimates at each stage of the deliberation process cycle in tandem with the period \( m \) of the listening matrix such that member \( j \) is only influenced by any
another member \( k \) every \( m^{th} \) interval.\(^\text{32}\) QED.

It is noted that the results for Proposition 5 do not extend to the case where the influence matrix \( P \) is characterised by \( m \) sets of cyclic recurrent classes. I stated earlier that it is possible for (i) unanimous consensus to be reached when there to exist some linear combination of opinion weights and initial beliefs such that \([1] = [2] = \ldots = [n]\) or (ii) a majority consensus arising when members beliefs converge on the same interest rate for \([n], n = 1, 2, \ldots \infty\), such that the composition of the majority switches regularly in sync with the period of the cycle. Illustrative examples of such behaviour are henceforth given.

**Case (i): Unanimous Consensus**

Consider a nine member committee characterised by the following belief matrix \( P \):

\[
P = \begin{bmatrix}
0 & 0 & 0 & \frac{1}{3} & \frac{1}{3} & \frac{1}{3} & 0 & 0 & 0 \\
0 & 0 & 0 & \frac{1}{3} & \frac{1}{3} & \frac{1}{3} & 0 & 0 & 0 \\
0 & 0 & 0 & \frac{1}{3} & \frac{1}{3} & \frac{1}{3} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & \frac{1}{3} & \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\
0 & 0 & 0 & 0 & 0 & \frac{1}{3} & \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\
\frac{1}{3} & \frac{1}{3} & \frac{1}{3} & 0 & 0 & 0 & 0 & 0 & 0 \\
\frac{1}{3} & \frac{1}{3} & \frac{1}{3} & 0 & 0 & 0 & 0 & 0 & 0 \\
\frac{1}{3} & \frac{1}{3} & \frac{1}{3} & 0 & 0 & 0 & 0 & 0 & 0 \\
\end{bmatrix}
\]

which is representable by the following bloc form, where each bloc is a \( 3 \times 3 \) sub-matrix:

\[
P = \begin{bmatrix}
0 & A & 0 \\
0 & 0 & B \\
C & 0 & 0 \\
\end{bmatrix}
\]  \( (4.67) \)

The dynamic behaviour of \( (4.68) \) is clearly analogous to that given by \( (4.65) \). Now introduce a belief vector \([0]\), the transpose of which is given by

\[
[0] = [4.5, 4.4, 4.3, 5.0, 4.6, 3.6, 4.9, 4.2]
\]  \( (4.69) \)

Given the influence structure in \( (4.65) \) and its corresponding cycling behaviour, it can be shown that revised estimates in every period converge to an interest rate

\(^{32}\)See Feller (1968) for an equivalent proof of the generalization to \( m \) states.
of 4.4%, namely

\[ l^{[n]} = [4.4, 4.4, 4.4, 4.4, 4.4, 4.4, 4.4, 4.4], \quad n = 1, 2, \ldots, \infty. \quad (4.70) \]

**Case (ii): Majority Consensus**

Under *majority consensus*, the *composition* of the majority switches regularly in sync with the period of the cycle. Again, consider the influence matrix given by (4.67) and its corresponding bloc form in (4.68). If a belief vector \( I^{[0]} \) is introduced such that

\[ I^{[0]} = [4.5, 4.4, 4.3, 5.0, 4.0, 3.6, 4.9, 4.2], \quad (4.71) \]

it follows that revised beliefs using the iterative procedure in (4.7) in successive rounds are given by

\[
\begin{align*}
I^{[1]} &= \begin{bmatrix} 4.2 \\ 4.2 \\ 4.2 \\ 4.2 \\ 4.2 \end{bmatrix}, \quad I^{[2]} = \begin{bmatrix} 4.4 \\ 4.4 \\ 4.4 \\ 4.4 \end{bmatrix}, \quad I^{[3]} = \begin{bmatrix} 4.2 \\ 4.2 \\ 4.2 \\ 4.2 \end{bmatrix}, \quad I^{[4]} = \begin{bmatrix} 4.4 \\ 4.4 \\ 4.4 \end{bmatrix} \\
I^{[n]} &= \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} 
\end{align*}
\]

Clearly, a majority consensus is reached at every iteration with six out of nine members preferring to settle for a rate of 4.4%. However, as stated above, the composition of the majority switches cyclically from period to period. More formally we have that \( I^{[n]} = I^{[n+\nu m]} \) where \( n \) denotes the deliberative round, \( m \) the period and \( \nu = 1, 2, \ldots, \infty \). This implies that all attempts by the chairman decide to continue deliberating in the hope of increasing the size of the majority will have no effect. Re-expressing \( I^{[0]} \) in the bloc form

\[ I^{[0]} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \quad (4.73) \]

where \( X, Y \) and \( Z \) denote \((3 \times 1)\) sub-matrices of the first, second and last three elements, a sufficient condition for *majority consensus* to be reached each period.
is thus given by

\[ BX = CX, \quad \text{(4.74)} \]
\[ AZ = BX, \]
\[ AX = CZ \]

and

\[ BZ = BX, \quad \text{(4.75)} \]
\[ CX = CZ, \]
\[ AZ = AX \]

Here, \( A, B \) and \( C \) denote the blocs in (4.68) and the elements in each sub-matrix in each multiplication are assumed to converge to the same value.
Part IV

The Formulation of Monetary Policy at the Bank of England
Chapter 5

Estimating MPC Members’ Reaction Functions

5.1 Introduction

“There shall be a committee of the Bank, to be known as the Monetary Policy Committee of the Bank of England, which shall have responsibility within the Bank for formulating monetary policy.” Bank of England Act 1998, Section 13(1).

June 1997 witnessed a landmark change in the conduct of UK monetary policy. In a move towards independence, the Bank of England was granted operational responsibility for setting interest rates to meet a Government inflation target of RPIX 2.5 percent. As part of the shift towards independence, operational decisions on monetary policy were delegated to a nine member Monetary Policy Committee. It is the interest-rate setting behaviour of this committee1 - more specifically, the policy preferences of individual members as revealed by the voting record - which forms the basis of this chapter.2 Since the inception of the MPC,

1Hereafter referred to as the BoEMPC.
2The decision to shift to operational independence can be interpreted as a means of ameliorating the well known problem of time-inconsistency: taking the decision on the short-term interest rate out of the control of “politicians... who might bend it for their electoral ends” (The Economist, September 1997, pp.36-37) should in theory be instrumental in increasing the credibility of, and by implication the success of UK monetary policy. However, using the criteria for measuring the degree of independence of a central bank developed by Grilli, Masciandaro and Tabellini (1991) - hereafter referred to as GMT - it is possible to see that the shift to operational independence has not drastically increased what they define as the level of ‘political’ independence afforded to the Bank - a measure associated “with how the members of the central bank board are appointed, its relationship with government and its responsibilities” (see TABLE 5.1 for clarification of this point). This is echoed in the words of Buiter (2002), for whom

“Even operational independence is qualified in the case of the Bank of England... Any form of pressure by the government on the MPC to change its behaviour, other than a public, and properly enacted, change in its mandate, would violate both the spirit and the letter of operational independence. There has not been a single instance of such pressure in the first three years of the MPC's existence.”
the voting behaviour of its members is a subject which has received considerable attention in the financial press and news media - attention largely attributable to the publication of voting records shortly after a decision on interest rates is taken. Near split decisions often constitute stories in themselves. The Financial Times on 25th January 2001 ran the headline ‘Bank committee voted 5-4 to hold interest rates’, reporting that only the use of the casting vote by the Governor of the Bank, Sir Edward George “prevented the MPC cutting [the] cost of borrowing by 0.25%”. The story also featured an index ranking MPC members according to their degree of ‘hawkishness’, with higher numbers corresponding to a more hawkish voting record.3 It is even a subject which has come to the attention of the House of Commons Treasury Select Committee, to which the MPC is partially accountable. The following exchange between George Palmer MP, Member of the House of Commons Treasury Select Committee, and Richard Lambert, external member of the MPC, reflects this assertion:

George Palmer: “It is known that there has been widespread speculation over the years that the Bank staff are more hawkish on interest rates than the independent members of the MPC. In May [2003], the five Bank staff all voted to maintain rates and the four independent members all voted to reduce rates. The probability of this happening by chance 0.019%. Do you think that there was in fact a coincidence?”

In other words, it is not implausible to suggest that the operational nature of the independence granted to the Bank is not in itself a guard against undue political influence. Indeed, commentators of more cynical leanings may, after close scrutiny of the Bank of England Act 1998, conclude that the monetary policy framework enjoyed by the Bank is potentially susceptible to political manipulation. This may be in spite of the relatively high degree of economic independence enjoyed by the bank, which to employ GMT’s terminology concerns the ability of a central bank to use the instruments of monetary policy without interference from governmental bodies or institutions. In the case of Bank of England, this corresponds to the ability to pursue the inflation target unimpeded. The interested reader is referred to the appendix for a comparison of the changing nature of political and economic independence enjoyed by the bank, both prior to and immediately after the switch to operational independence.

3It is also possible that changes in voting patterns may yield information about how interest rates will move in the future. This avenue of research is not pursued here. See Andersson et al (2001) and Gerlach-Kristen (2001) for applications to the Executive Board of the Swedish Riksbank and BoEMPC respectively.

4It is noteworthy to add that such interest in the voting record is not confined to the case of the Bank of England MPC. The composition and voting record of the United States Federal Open Markets Committee (FOMC) generates similar interest, where to quote Haubrich and Humpage (2001)...

“Newspapers and financial magazines can be counted on to count up the “hawks” and “doves” whenever a new member is appointed or the next batch of reserve bank presidents rotate on the committee.” p.3
Richard Lambert: "I am not sure I really properly understand the question. It seems to me, looking at the minutes, that there were nine people: four came to one conclusion and five came to another. I did not get a sense from the minutes that their internalness or externalness had a bearing on the outcome."\(^5\) (emphasis added)

In this study, evidence is presented demonstrating that 'internalness' and 'externalness' do in fact have a significant bearing on the policy preferences of MPC members, and therefore policy outcomes. Amongst other things, the hypothesis that Bank outsiders prefer relatively lower interest rates than insiders is tested.\(^6\)

To summarise the results, it is shown that on average, insiders prefer relatively higher interest rates than outsiders. In light of this finding, insiders can clearly be construed as behaving more 'conservatively' than their externally appointed peers. Further, insiders display a greater propensity for leaving interest rates unchanged than outsiders. In this sense, outsiders may be described as being more activist than their internally appointed colleagues. It is also reported that changes in interest rates are most likely to occur during months in which the Bank's quarterly Inflation Report is published. All of the findings are based on voting data contained in the Minutes of Monthly Meetings for a period covering the first five years of the MPC.\(^7\),\(^8\) This encompasses the entire spell for which the MPC was chaired by Sir Edward George\(^9\), namely June 10\(^{th}\) 1997 - 6\(^{th}\) June 2003. In all, this amounts to 74 meetings,\(^10\) a period over which MPC members cast 642 votes.

Having established significant differences in voting behaviour, reaction functions for both groups are estimated. To do this, limited dependent variable analysis is drawn upon. Using ordered logit analysis it is demonstrated that under a variety of different specifications, there exist differences in the policy preferences of insiders and outsiders.

\(^5\)Treasury Select Committee Minutes of Evidence (Q79), Monday 16\(^{th}\) June 2003.

\(^6\)This may be construed as a test to see if outsiders have a predilection for monetary policy which leads to comparatively lower inflation and higher unemployment than that preferred by Bank insiders.

\(^7\)Hereafter referred to as the Minutes. The Minutes are published 2 weeks after each MPC meeting.

\(^8\)During this period, Sir Edward George also presided as Governor of the Bank of England.

\(^9\)In July 2003 Sir Edward George was replaced by Mervyn King as both Governor of the Bank and Chairman of the MPC.

\(^10\)Also included are votes cast in the special MPC meeting held on September 18th 2001, which followed the terrorist attacks on the World Trade Centre.
5.2 Relationship to the Literature

As seen in Part II empirical studies of insider-outsider behaviour are relatively sparse. It was found that there exist no studies of BoEMPC behaviour which estimate the reaction functions of MPC members. What distinguishes this chapter from other BoEMPC studies is that in addition to providing a detailed examination of insider-outsider voting behaviour, reaction functions are estimated for insiders and outsiders under a variety of alternative econometric specifications.¹² That is, MPC votes are modelled as a function of the economic environment. This chapter therefore falls into what Meade and Sheets describe as the ‘reaction function camp’ [Tootell (1991a,b), Meade and Sheets (2002)], and not the ‘partisan theory of politics’ genus of studies. Unlike Tootell (1991b), who fails to find evidence to support the hypothesis that “FOMC policy votes of Federal Reserve Bank presidents are more ‘conservative’ than those of their Board Governor counterparts”, I find that the policy votes of insiders are more conservative than those of outsiders.

A second difference should be highlighted. Tootell (1991a) and Meade and Sheets (2002), investigate the hypothesis that District Bank presidents set policy according to regional, as opposed to national economic conditions. I do not pursue this hypothesis. This is because Bank Presidents can be viewed as providing regional representation on the FOMC. MPC members should not be seen as providing regional representation, unlike Bank presidents (Tootell 1991a,b) or members of the Governing Council of the ECB (Dornbusch et al, 1998). Thus whilst undoubtedly falling into the same genus as the FOMC, the MPC is a somewhat different animal to its US equivalent. Further, in this chapter, the emphasis is emphatically not on the dissent voting behaviour of MPC members, which is the focus of the following chapter.

5.3 The Monetary Policy Framework at the Bank of England

The framework determining the composition of the MPC and the means by which it reaches a decision is embodied in the Bank of England Act 1998 (hereafter re-

¹²The analysis only covers the period under which Sir Edward George presided as its Chairman, namely June 1997-June 2003. Mervyn King replaced Sir Edward George as Chairman of the MPC in July 2003. Restricting our sample to June 1997-June 2003 means that we do not have to control for the impact different chairmen on insider-outsider behaviour. This might be considered as an avenue for research in the more distant future.
ferred to as the Act). It is the piece of legislation accountable for (i) granting operational responsibility for monetary policy to the Bank of England and (ii) establishing the Bank’s nine member Monetary Policy Committee. The decision to shift to operational independence was taken by the British Labour Party, who announced their intentions in the period immediately following their general election victory on May 5th 1997. By June 1997 a committee had been established, although not containing a full complement of members. Nevertheless, the monetary policy framework at the Bank had undergone a seismic shift.\textsuperscript{12}

Acquaintance with the operational framework of UK monetary policy - particularly the structure of the BoEMPC - is useful in so far as it provides a background against which the interest-rate setting behaviour of the MPC can be rationalised. In light of this, analysis of the statutes of Bank of England with explicit reference to the Act is the focus of this section.\textsuperscript{13} In what follows, attention is drawn to those statutes pertaining to the objectives of monetary policy, the formulation of monetary policy and voting arrangements on the MPC, and transparency. Finally, the extent to which the granting of operational independence has influenced the degree of political and economic independence of the Bank, as defined by Grilli, Masciandaro and Tabellini (1991), is briefly examined.

### 5.3.1 Objectives of Monetary Policy

Part II, Section 11 (Objectives) of the Bank of England Act 1998 explicates the objectives of the Bank vis-à-vis monetary policy as

"(a) to maintain price stability, and
(b) subject to that, to support the economic policy of her Majesty’s Government, including its objectives for growth and employment." (Section 11)

In the context of the framework for UK monetary policy, price stability assumes the form of a government inflation target. Chosen by the Chancellor of the Exchequer, this stood as a 2.5% year on year increase in RPIX inflation for the period June 1997-December 2003. Thereafter, the Chancellor of the Exchequer, Gordon Brown

\textsuperscript{12}In the interim period between the Labour Party coming to power in May 1997 and the granting of Royal Assent for the Bank of England Act 1998 on June 1st 1998, the changes to the framework of UK monetary policy embodied in the Act operated \textit{de facto}.

\textsuperscript{13}Although no previous acquaintance with the Act is assumed, it is expedient here to only survey key clauses. More detailed accounts of the post-May 1997 framework for UK monetary policy are given in Budd (1998) and Rodgers (1997, 1998).
announced a new target of 2% year on year CPI inflation. It is important here to stress that Section 11(b) should be viewed as a secondary objective: it is subject to the fulfilment of Section 11(a). The meeting of the inflation target of RPIX 2.5% is the 'rate at which the MPC is required to achieve and for which it is accountable'.\footnote{Bank of England Act 1998, Part II.11 (Objectives)} It is worth noting here the symmetrical nature of the inflation target.\footnote{This is analogous to the loss function for the monetary authorities assuming the quadratic form $Z_t = \pi^2$. Assuming a zero inflation target, the squared term, $\pi^2$ indicates that a movement below or above the inflation target of like magnitude yields equal disutility.} If inflation deviates by more than 1% either side of its target the Governor of the Bank is required to write an open letter to the Chancellor explaining "why inflation was adrift, how long the divergence was expected to last, and the action taken to bring it back on course."\footnote{Rodgers (1997), p.3.} The inflation target should not be interpreted as a range of values, as is the case with the European Central Bank. Instead, "the inflation target is 2.5% at all times."\footnote{"Remit for the Monetary Policy Committee," letter from the Rt. Hon. Gordon Brown to Sir Edward George, 17th April 2002.}

5.3.2 The Monetary Policy Committee

Following the shift to operational independence, the responsibility for setting interest rates was not given to a single individual. The prerogative lay instead with the Monetary Policy Committee, or MPC, as it is more commonly known:

"There shall be a committee of the Bank, to be known as the Monetary Policy Committee of the Bank of England, which shall have responsibility within the Bank for formulating monetary policy." Bank of England Act 1998, Section 13(1)

Comprising nine members, the precise form of the committee is as follows:

"(a) the Governor and Deputy Governors of the Bank
(b) 2 members appointed by the Governor of the Bank after consultation
with the Chancellor of the Exchequer, and
(c) 4 members appointed by the Chancellor of the Exchequer."

Five members - namely those referred to in clauses (a) and (b) - are chosen internally, from within the ranks of Bank staff, hence the name insiders. The Act requires three of the internal members to be the Governor and two Deputy Governors responsible for Financial Stability and Monetary Policy respectively. These
members serve five year renewable terms. The remaining two internal appointees are chosen by the Governor following a discussion with the Chancellor, and serve three year terms. These members are usually directors of the Bank with executive responsibility for a given area of banking operations. Appointed directly by the Chancellor of the Exchequer, the remaining four members are chosen from outside the ranks of Bank staff, hence the name outsiders, or 'external' MPC members.\(^{18}\)

In this sense, outsiders cannot be viewed as Bank 'representatives', and are typically chosen from the private sector and academia. Outsiders serve renewable three year terms.\(^{19}\) Given this institutional arrangement the Chancellor arguably still has a potentially significant bearing on the direction of UK monetary policy.

In addition to powers to set and change the inflation target discussed earlier, the power of appointment represents an additional vehicle for influencing the direction of UK monetary policy.

5.3.3 Operational Independence

From the procedural standpoint, the Bank controls the short-term interest-rate as the key operating target of monetary policy. In this respect, and perhaps most significantly, Section 4(1) of the Bank of England Act 1946 has been amended to read:

> "The Treasury may from time to time give such directions to the Bank as, after consultation with the Governor of the Bank, they think necessary in the public interest, except in relation to monetary policy." [words in italics added by Section 10 of the Bank of England Act 1998]

This amendment is clearly aimed at ensuring that "decision-making on monetary policy is more effective, open, accountable and free from short-term political manipulation".\(^{20}\) In practice, Section 4(1) simply means that the Bank of England does not take instructions from the Chancellor with respect to the level of the short-term interest-rate. It is the embodiment of operational responsibility. The policy instrument used by the MPC is the rate on repurchase agreements, more

\(^{18}\)This does not preclude members who have previously worked at the Bank from becoming external appointees. Professor Charles Goodhart, for example, served on the MPC as an outsider, having previously been Chief Economist at the Bank.

\(^{19}\)Under Sir Edward George, no external member had their term renewed. However, following the departure of Edward George from the MPC in July 2003, some outsiders appointed during his time as Chairman had their positions renewed, namely Professor Stephen Nickell and Kate Barker.

commonly known as the repo-rate. This is the interest-rate at which the Bank of England lends to the money markets. The nature of the monetary transmission mechanism ensures that changes in the repo-rate propagate quickly to affect other short-term interest rates and ultimately long-term rates, which eventually feed through into inflation and GDP growth. It is estimated that changes in the repo-rate take two years to maximally impact inflation, and approximately one year for GDP (Bank of England, 1999).

5.3.4 Monetary Policy Formulation and Voting Arrangements at the Bank

Monetary policy is determined by simple majority rule, following a vote on the interest-rate tabled by the Governor of the Bank, who also chairs the MPC. In the event of a split decision, the Governor has a casting vote. This is in accordance with Schedule 3.11 clauses (2)-(6) which specify the form of MPC proceedings. Clauses (3)-(5) are of special relevance:

"(3) The chair shall be taken by the Governor of the Bank or, if he is not present, the Deputy Governor of the Bank with executive responsibility for monetary policy.
(4) Decisions shall be taken by a vote of all those members present at the meeting.
(5) In the event of a tie, the chairman shall have a second casting vote."

Under the current operational monetary policy framework, the bank is required to publish a quarterly Inflation Report, Minutes of MPC Meetings and the individual votes of MPC members. The composition of the MPC is stylised in Figure 5.1.

5.3.5 The GMT index

To provide the reader with an appreciation of the extent to which the shift to operational independence has increased the degree of independence enjoyed by the Bank I use the definitions provided by Grilli, Masicandaro and Tabellini (1991).\(^{21,22}\) Specifically, I compare the levels of independence before and after the Act. Gauging the degree of independence of a monetary institution is not an exact science,

\(^{21}\)Hereafter GMT.

\(^{22}\)I do not propose to provide a complete discussion of the GMT index. The interested reader is referred their original paper. Alternatively, for an updated GMT index the reader is referred to Hudson et al (2001).
and indices measuring the degree of central bank independence typically rely on what one author has termed ‘the statute reading methodology’. That is, one largely determines the independence of a central bank with explicit reference to its statutes. GMT delineate between two types of independence which a monetary institution may enjoy - political independence and economic independence. The political independence of a central bank is associated with how the members of the central bank board are appointed, its relationship with government and its responsibilities. So-called economic independence concerns the ability of a central bank to use the instruments of monetary policy without interference from governmental bodies or institutions. To see how the degree of independence has changed pre and post the shift to operational independence, refer to Table 5.1. Prima facie, the Bank has retained a low level of political independence, in spite of the shift to operational independence. For example, the maximum term length an MPC member may be appointed for is five years. Further, the Government is still responsible for appointing the Governor.

23See Forder (1995). Although highly critical of many methodologies used to construct central bank indices, Forder fails to offer an alternative method for measuring the degree of autonomy of monetary institutions.

24The introduction of the Act is notable in as far as it redefines the status of the Bank vis-à-vis goal and instrument independence. The Bank has instrument independence in that it sets short-term and key interest rates without interference from any other institutions; conversely, it does not have goal independence as the main objective of maintaining price stability set out in the Act can only be changed at the discretion of the Chancellor of the Exchequer. For an exegesis of the distinction between goal and instrument independence see Debelle and Fisher (1994). We however, use the criteria used by GMT.
Political Independence of the Bank of England

<table>
<thead>
<tr>
<th>Appointments</th>
<th>Government</th>
<th>Constitution</th>
<th>Index of political independence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-1998 Act</td>
<td>*</td>
<td>*</td>
<td>1</td>
</tr>
<tr>
<td>Post-1998 Act</td>
<td>*</td>
<td>*</td>
<td>3</td>
</tr>
</tbody>
</table>

Notes: (1) Governor not appointed by government; (2) Governor appointed for >5 years; (3) All the board not appointed by the government; (4) Board appointed for >5 years; (5) No mandatory participation of government representative in the board; (6) No government approval of monetary policy formulation is required; (7) Statutory requirements that central bank pursues monetary stability amongst its goals; (8) Legal provisions that strengthen the central bank’s position in conflicts with the government are present; (9) Overall index of political independence calculated by summing the number of stars in each row through (1) - (8).

Economic Independence of the Bank of England

<table>
<thead>
<tr>
<th>Monetary financing of budget deficit</th>
<th>Monetary instruments</th>
<th>Index of economic independence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-1998 Act</td>
<td>*</td>
<td>5</td>
</tr>
<tr>
<td>Post-1998 Act</td>
<td>*</td>
<td>8</td>
</tr>
</tbody>
</table>

Notes: (1) Direct credit facility: not automatic; (2) Direct credit facility: market interest rate; (3) Direct credit facility: temporary; (4) Direct credit facility: limited amount; (5) Central bank does not participate in primary market for public debt; (6) Discount rate set by central bank; (7) Banking supervision not entrusted to the central bank (**); or not entrusted to the central bank alone (*); (8) Overall index of economic independence calculated by summing the number of stars in each row through (1) - (7).


TABLE 5.1.
GMT INDEX OF BANK OF ENGLAND POLITICAL AND ECONOMIC INDEPENDENCE

141
Recent institutional and regulatory changes with regard to UK banking supervision and debt management have increased the level of economic independence enjoyed by the Bank. The creation of the Financial Services Authority (FSA) - a body independent of the Bank of England responsible for UK banking supervision – coincided with the shift to operational independence in 1997. Essentially, banking supervision was no longer entrusted to the Bank of England. This move eliminates a possible conflict of interest emanating from when a central bank has the responsibility to set the discount rate and is also responsible for banking supervision. Hudson et al (2001) bring this point home:

"If banking failures could be triggered by an increase in the interest-rate, central bank might be unwilling to undertake monetary policy which is required at the macroeconomic level."\(^{25}\)

Furthermore,

"...if banking failures did occur, the central bank might be regarded as responsible, and this could undermine its reputation."\(^{26}\)

The establishment of the UK Debt Management Office (DMO) followed shortly after the creation of the FSA.

### 5.3.6 The Decision on the interest-rate in Practice

Decisions on the interest-rate are taken on the first Thursday of each month. Hosking (2000) describes how the decision on the interest-rate is made in practice:

"...the committee gathers before 9am and the Governor kicks off with a summary of what was discussed the day before. Members are free to chip in. Then comes the crux of the meeting. He invites every member to speak on where they should stand and what the policy decision should be. It is decision time...By 10.30am everyone has had their say. Unless the outcome is unanimous, the Governor will put a proposition and ask for a show of hands. Those voting in the minority are then given an opportunity to restate what they would do and why. The committee then decides to put out an accompanying statement. They tend to if they think their decision is likely to surprise the markets."\(^{27}\)

\(^{25}\)Hudson et al, p.5.
\(^{26}\)Ibid.
\(^{27}\)Hosking (2000), p.47.
5.4 MPC Performance Under Sir Edward George

Under the chairmanship of Sir Edward George, the MPC broadly met its objectives. Figure 5.2 shows that for the period covering June 1997-June 2003 the general trend was for interest rates to fall. RPIX inflation remained relatively stable and close to the target rate of 2.5%. A notable observation is that for a significant period (May 1999 - June 2002) inflation remained below target, which prompted some economists to speak of a deflationary bias inherent in monetary policy. On no occasion did the rate of inflation deviate from its target rate sufficiently to require the Governor writing a letter of explanation to the Chancellor. In terms of the precise nature of the policy decision, the repo-rate was raised on 9 occasions, lowered on 15 occasions but left unchanged 50 times. In this respect, Figure 5.2 also reveals the inertial nature of monetary policy under Sir Edward George. However, when policy did change, it is hallmarked by what might be referred as policy gradualism. Here, rates are gradually changed upwards or downwards in a series of small steps rather than fewer relatively larger steps.

5.5 The Timing of Decisions

Table 5.2 focuses on the likelihood of a change in monetary policy being taken vis-à-vis the release of the Bank of England’s quarterly Inflation Report. The Inflation Report, it has been argued, is central to decisions on the interest-rate. At the core of each report is the result of a forecasting exercise which leads to the construction of medium term forecasts for inflation and real GDP conditioned on a constant nominal interest-rate assumption. These are referred to as inflation and real GDP projections, and assume the form of ‘fan charts’. The charts are an

---

28Wallis (2002) sees this as stemming from a tendency for the Bank’s suite of forecasting models to overpredict the level of future inflation. One might reasonably suppose that it in practice this would lead to MPC members prescribing higher interest rates than would be the case given a lower forecast.

29We also find that the likelihood of a decision to tighten, loosen or leave rates unchanged being followed a qualitatively identical decision is 33.3%, 46.6% and 70% respectively.

30Related to this point is Blinder’s (1998) observation that a feature of monetary policy committees are policy decisions which “tend toward the mean and to be inertial”. (p.21)

31Another name for this phenomenon is interest rate smoothing.

32The forecasting horizon is 24 months.
innovative means of representing the probability of any given level of GDP growth or inflation pertaining at a particular point in time. Indeed, for any given point over the projection period, the intensity of shading on the fan chart characterizes the height of a probability density function for given inflationary outcomes. Such conditional forecasts are useful to the MPC insofar as they help the Bank "decide on the appropriate direction for future interest-rate moves."  

Release dates for the Inflation Report are February, May, August and November.  From a methodological perspective, the forecasting models developed by the Bank of England are devised with an inflation targeting regime in mind. Unlike policy frameworks such as monetary targeting which relies chiefly on the behaviour of money stock as a predictor of inflation, inflation targeting utilizes a broad array of information pertaining to the economy. This 'eclectic' approach to policy is embodied in the forecasting methodology employed in the inflation report, as acknowledged by Haldane (1997):

"...the Bank’s published inflation projection is not a mechanical extrapolation from a single macro model. Rather, it draws upon a much wider

34 Hutchison and Judd (1992) provide empirical support for openness in terms of releasing internal bank forecasts into the public domain for the case of the US. Their findings suggest that the disclosure of in-house monetary projections at the Federal Reserve would have appreciably lessened money surprises in the United States.
### Monetary Policy Decisions and the Inflation Report, June 1997-June 2003

#### Policy Decisions

<table>
<thead>
<tr>
<th></th>
<th>F(0)</th>
<th>F(1)</th>
<th>F(2)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change</td>
<td>13 (18)*</td>
<td>20 (27)</td>
<td>17 (23)</td>
<td>50 (68)</td>
</tr>
<tr>
<td>Change</td>
<td>11 (15)</td>
<td>6 (8)</td>
<td>7 (9)</td>
<td>24 (32)</td>
</tr>
</tbody>
</table>

#### Conditional Probabilities

- \( \text{Pr}(F(i) | \text{No change}) \): 0.26, 0.40, 0.34, 1
- \( \text{Pr}(F(i) | \text{Change}) \): 0.46, 0.25, 0.29, 1

#### Pooled Votes

<table>
<thead>
<tr>
<th></th>
<th>F(0)</th>
<th>F(1)</th>
<th>F(2)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change</td>
<td>100 (15)</td>
<td>145 (23)</td>
<td>128 (20)</td>
<td>373 (58)</td>
</tr>
<tr>
<td>Change</td>
<td>108 (17)</td>
<td>80 (12)</td>
<td>81 (13)</td>
<td>269 (42)</td>
</tr>
</tbody>
</table>

#### Conditional Probabilities

- \( \text{Pr}(F''(i) | \text{No change}) \): 0.27, 0.39, 0.34, 1
- \( \text{Pr}(F''(i) | \text{Change}) \): 0.40, 0.30, 0.30, 1

---

**Notes:**
- Policy Decisions gives the actual number of policy decisions taken by the MPC favouring a Change or No Change in the interest rate in Inflation Report months (F(0)) and subsequent non-Inflation Report Months (F(1) and F(2)). Pooled Votes gives the number of votes cast in favour of a Change or No Change in monetary policy in MPC meetings held during Inflation Report months (F(0)) and subsequent months in which an Inflation Report is not released (F(1) and F(2)).

- *Numbers in round brackets () denote the number of policy decisions (Policy Decisions) and votes cast (Pooled Votes) expressed as a percentage of all decisions taken/votes cast.

- *\( \text{Pr}(F(i)) \) denotes the probability of a decision being taken either in an Inflation Report month (i=0) or a non-Inflation Report month (i=1,2) conditional on there being a Change or No Change in the interest rate.

- \( \text{Pr}(F''(i)) \) denotes equivalent conditional probabilities for Pooled Votes.

**TABLE 5.2.**

**PUBLICATION OF THE INFLATION REPORT AND MPC DECISIONS**

145
and richer set of information variables - quantitative and qualitative, real and monetary"\textsuperscript{35}[emphasis added]

One question which I focus on is the following: what impact do the macro-projection exercises - initiated about one month before the \textit{Inflation Report} is released, and ultimately culminating in the production of the BoEMPC's quarterly inflation and output projections - have on the policy stance of the BoEMPC? Specifically, I ask whether changes in the interest-rate are more likely to occur in months in which the \textit{Inflation Report} is produced. To help develop priors, consider Budd (1998), who provides insight into the role of the months in which the \textit{Inflation Report} is not produced. During these months,

"...it is possible to evaluate new data with reference to the extent which they are consistent with the previously published forecast. In some cases the evidence may be fairly direct, e.g. new GDP data or revisions to previous data; in others it is indirect but may cast light on the starting point or on future developments...In some cases it is possible to revise the previous forecast in a fairly mechanical way in response to new data...But such revisions are not a substitute for the complete reassessment of all the evidence that is involved in a full forecasting round. In reaching its decision in these [non-\textit{Inflation Report}] months the MPC will assess how the new data, and any change in its underlying analysis of the inflationary process, affects its views of the prospects for inflation."\textsuperscript{36}(emphasis added)

This statement clearly provides a hint that months in which the forecasting round takes place are more ‘important’ than non-forecasting months. In Table 5.2, $F(0)$ denotes a month in which the \textit{Inflation Report} is released, with $F(1)$ and $F(2)$ denoting the two proceeding non-forecasting round months respectively. It shows that under the aegis of the MPC, the interest-rate changed relatively more in \textit{Inflation Report} months than other months. This is apparent in the top segment of the table which considers policy decisions taken between June 1997 and June 2003, 74 meetings in all. During months which the inflation report was released ($F(0)$), interest rates changed eleven times, compared to only six and seven times in subsequent non-forecasting months respectively. Another way of interpreting this finding is that interest rates are less likely to change during non-\textit{Inflation Report} months. The \textit{Conditional Probabilities} in the top part of the table reflect

\textsuperscript{35}Ibid, p.21.
\textsuperscript{36}Budd (1998), p.1790.
this fact. Over the sample period, the probability of changing the interest-rate - \( \text{Pr}(\text{Change}) \) - is 0.32, irrespective of the whether or not it is a month in which the Inflation Report is released. This reflects the inertial nature of UK monetary policy, as shown in Figure 5.2. Yet assuming that the MPC does decide to change the interest-rate, the (conditional) probability of it doing so in an Inflation Report month - \( \text{Pr}(\text{F}^D(0)|\text{Change}) \) - is 0.46.

As might be expected, these findings are reflected in the individual votes cast by MPC members. Of 642 votes cast by all MPC members over the sample period, 269 were for change. Given a member chooses to vote for a change in the interest-rate, the probability of their doing so in a month in which the inflation report is released is \( \text{Pr}(\text{F}^\text{vote}(0)|\text{Change}) = 0.4 \) as opposed to the months subsequent to the release of the Inflation Report. Again, the probability of an individual MPC member voting for no change is again greater in non-Inflation Report months. Although individual votes are more evenly spread across Inflation Report and non-Inflation Report months, the same qualitative conclusions hold as for the actual policy decisions taken by the MPC.

### 5.6 What Data is the MPC using?

In addition to the macroeconomic projections at the heart of the Inflation Report, MPC members are presented with a wide range of data upon which to base a policy decision. This is reflected in the Minutes, which contains sections on the ‘world economy’, ‘demand and output’, ‘money, credit and asset prices’ and ‘prices and costs’. Data on consumer confidence, changes in monetary aggregates (M0, M4), consensus forecasts of inflation and output, industrial production and exchange rates are invariably referred to in these sections. Of special importance is the role of the so-called ‘pre-MPC’ meeting which takes place on the Friday before a decision is taken. At such meetings, bank staff present various data and analyses which pertain to regional, national and international economic developments. It is notable that not all of the information presented at pre-MPC meetings is in the public domain. For example, the monthly report on regional developments presented at pre-MPC meetings by the Bank of England’s regional agencies is unavailable to the public at large.
5.7 Individual Policy Preferences

TABLE A shows (i) the individual members comprising the MPC for the sample period, (ii) their period of appointment and the corresponding number of votes cast and (iii) whether they are insiders or outsiders. This is complimented by PANELS 5.1 - 5.3, which display the interest-rate preferences of individual MPC members as revealed by their votes. Interest-rate preferences (%) are given on the vertical axes. The fact that MPC members' terms are overlapping in combination with varying term lengths associated with different types of member - as reflected in TABLE A - accounts for the different interest rate paths. Inspection of the charts reveals that although policy preferences across members do differ, members interest-rate paths are broadly similar. Members who served for the longest periods - namely the Governor, Mervyn King, Ian Plenderleith and David Clementi are all insiders. Omitted from the panels are Howard Davies and Richard Lambert - it was felt that each of their series was insufficiently long to warrant graphing. Davies, an insider, stands as the shortest serving MPC member, attending only the first two MPC meetings; Lambert's appointment coincided with the final meeting in the sample in June 2003, and so only voted once.

5.8 Group Policy Preferences

FIGURE 5.3 plots the average preferred interest rate for insiders and outsiders at each MPC meeting. This is obtained by taking the arithmetic mean of interest rates cast by each group respectively at each MPC meeting. It shows that for most of the first five years of the MPC, insiders preferred on average higher interest rates than outsiders. With the exception of a handful of MPC meetings between October 1997 and May 1998, the average interest-rate preferred by outsiders was less than that preferred by insiders. The extent of the differences is made clearer in the accompanying chart which plots the difference in mean interest rates preferred by insiders and outsiders.

\[37\] The policy preferences of Howard Davies and Richard Lambert are not presented. Howard Davies left the MPC after the second meeting; Richard Lambert's appointment coincided with the final meeting in our sample, and so only voted once.

<table>
<thead>
<tr>
<th>Insiders</th>
<th>Period of Appointment</th>
<th>Votes Cast*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eddie George*</td>
<td>Jun 1997 - Jun 2003</td>
<td>74</td>
</tr>
<tr>
<td>Howard Davies**</td>
<td>Jun 1997 - Jul 1997</td>
<td>2</td>
</tr>
<tr>
<td>Ian Plenderleith****</td>
<td>Jun 1997 - May 2002</td>
<td>61</td>
</tr>
<tr>
<td>Mervyn King***</td>
<td>Jun 1997 - Jun 2003</td>
<td>74</td>
</tr>
<tr>
<td>David Clementi**</td>
<td>Sept 1997 - Aug 2002</td>
<td>61</td>
</tr>
<tr>
<td>Charles Bean****</td>
<td>Oct 2000 - Jun 2003</td>
<td>34</td>
</tr>
<tr>
<td>Paul Tucker****</td>
<td>Jun 2002 - May 2005</td>
<td>13</td>
</tr>
<tr>
<td>Andrew Large**</td>
<td>Oct 2002 - Sept 2007</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outsiders</th>
<th>Period of Appointment</th>
<th>Votes Cast*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charles Goodhart</td>
<td>Jun 1997 - May 2000</td>
<td>36</td>
</tr>
<tr>
<td>Willem Buiter</td>
<td>Jun 1997 - May 2000</td>
<td>36</td>
</tr>
<tr>
<td>De Anne Julius</td>
<td>Sep 1997 - May 2001</td>
<td>45</td>
</tr>
<tr>
<td>Sir Alan Budd</td>
<td>Dec 1997 - May 1999</td>
<td>18</td>
</tr>
<tr>
<td>Sushil Wadhwani</td>
<td>Jun 1999 - May 2002</td>
<td>37</td>
</tr>
<tr>
<td>Stephen Nickell*</td>
<td>Jun 2000 - May 2006</td>
<td>38</td>
</tr>
<tr>
<td>Christopher Allsopp</td>
<td>Jun 2000 - May 2003</td>
<td>37</td>
</tr>
<tr>
<td>Kate Barker**</td>
<td>Jun 2001 - May 2007</td>
<td>26</td>
</tr>
<tr>
<td>Marion Bell</td>
<td>Jul 2002 - Jun 2005</td>
<td>12</td>
</tr>
<tr>
<td>Richard Lambert</td>
<td>Jun 2003 - May 2006</td>
<td>1</td>
</tr>
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</table>

* The number of votes cast by each member is identical to the total number of meetings attended by each member. The emergency MPC meeting following the terrorist attacks on the World Trade Centre on September 11th 2001 are also included - an extra meeting was held in this month.

* Governor of the Bank and Chairman of the MPC / ** Deputy Governor of the Bank for Financial Stability / *** Deputy Governor of the Bank for Monetary Policy / **** Executive Director of the Bank.


### TABLE A.
MPC Members and Periods of Appointment

149
Policy Preferences of MPC members, June 1997-June 2003

Panel 5.1.
Policy Preferences of MPC Members as Revealed by the Voting Record
Policy Preferences of MPC members, June 1997 - June 2003

Panel 5.2.
Policy Preferences of MPC Members as Revealed by the Voting Record
Policy Preferences of MPC members, June 1997 - June 2003

Panel 5.3.
Policy Preferences of MPC members as revealed by the voting record
5.8.1 Are the Differences Statistically Significant?

I initially test to see if the differences illustrated in FIGURE 5.3 are statistically significant using paired $t$-tests. The null hypothesis of no difference in the average preferred interest-rate in meeting $t$ for each group is tested against the alternative of the average preferred interest-rate in period $t$ being greater for insiders. More formally it is expressed as

$$H_0 : \bar{i}_{I,t} - \bar{i}_{O,t} = 0$$ \hspace{1cm} (5.1)

against

$$H_1 : \bar{i}_{I,t} - \bar{i}_{O,t} > 0$$ \hspace{1cm} (5.2)

where $\bar{i}_{I,t}$ and $\bar{i}_{O,t}$ denote meeting $t$ average preferred interest rates for insiders and outsiders respectively. A $t$-statistic of $t = 5.45$ with a corresponding $p$-value of 0.000 points to rejection of $H_0$ in favour of $H_1$: average preferred interest rates for outsiders are significantly higher for insiders than outsiders. This points to outsiders being more dovish than their internally appointed counterparts.

In the interests of completeness, further tests were conducted confirming that differences in insider-outsider voting behaviour are significantly different. Again, using paired $t$-tests$^{38}$ it was found that internalness and externalness have a statistically significant bearing on the voting behaviour of insiders and outsiders. The procedure was performed as follows. MPC members were categorised as falling into three groups - insiders, outsiders, and a third group consisting of all MPC members irrespective of type (All members). Then, for each meeting, the percentage of votes cast within each group for a change in the interest-rate (All changes), a tightening of the interest-rate (Tighter policy only) and an easing of the interest-rate (Looser policy only) was calculated.$^{39}$ Results are shown in TABLE 5.4. Section A.1 catalogues the differences in voting behaviour between insider and outsiders in each category. At an average MPC meeting - calculated by summing the percentages corresponding to the type of vote cast in each category across all meetings and dividing by the total number of meetings - insiders voted to change the interest-rate 36.15% of the time, compared to 50% for outsiders. This difference is significant at the 1% level. Correspondingly, the difference is not significant for decisions to tighten the rate, but highly significant when it come to voting to loosen policy. At an average MPC meeting, outsiders

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$^{38}$All calculations were performed using STATA 8.

$^{39}$In TABLES 5.4 and percentages are calculated through pooling members votes - there is no attempt to distinguish between meetings when performing calculations.
chose to vote for looser policy 33.45% of the time, compared with a rate of 19.19% for insiders. This difference is significant at the 1% level. Section B.1 compares each group's propensity to vote for a change in the interest-rate on the side of tightness or looseness. Across the 'All member' category, outsiders vote for looser policy significantly more than for tighter policy. This finding makes sense, as for the sample period interest rates on average fell. Although insiders are just as likely to vote for a change in tighter policy as a change in looser policy, for outsiders this difference is significant at the 1% level. In short, Figure 5.3 and Table 5.4 demonstrate that insiders are more hawkish and less activist than outsiders. These differences are statistically significant.
### Mean Percentage of votes for looser and tighter policy given the prevailing interest rate including Governor

#### Section A.1 - Insiders versus Outsiders

<table>
<thead>
<tr>
<th>All Changes</th>
<th>Insiders</th>
<th>Outsiders</th>
<th>Significance level of Difference*</th>
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<tbody>
<tr>
<td>All Changes</td>
<td>36.1</td>
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</tr>
<tr>
<td>Tighter Policy Only</td>
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<td>16.6</td>
<td>NS</td>
</tr>
<tr>
<td>Looser Policy Only</td>
<td>19.2</td>
<td>33.4</td>
<td>1%</td>
</tr>
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</table>

#### Section B.1 - Tighter versus Looser Policy

<table>
<thead>
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<th>Looser</th>
<th>Significance level of Difference*</th>
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</thead>
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</tr>
<tr>
<td>Insiders</td>
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<td>NS</td>
</tr>
<tr>
<td>Outsiders</td>
<td>16.6</td>
<td>33.4</td>
<td>1%</td>
</tr>
</tbody>
</table>

### Mean Percentage of votes for looser and tighter policy given the prevailing interest rate excluding Governor

#### Section A.2 - Insiders versus Outsiders

<table>
<thead>
<tr>
<th>All Changes</th>
<th>Insiders</th>
<th>Outsiders</th>
<th>Significance level of Difference*</th>
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</thead>
<tbody>
<tr>
<td>All Changes</td>
<td>37.2</td>
<td>50.0</td>
<td>1%</td>
</tr>
<tr>
<td>Tighter Policy Only</td>
<td>18.2</td>
<td>16.6</td>
<td>NS</td>
</tr>
<tr>
<td>Looser Policy Only</td>
<td>18.9</td>
<td>33.4</td>
<td>1%</td>
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</tbody>
</table>

#### Section B.2 - Tighter versus Looser Policy

<table>
<thead>
<tr>
<th>All Members</th>
<th>Tighter</th>
<th>Looser</th>
<th>Significance level of Difference*</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Members</td>
<td>17.6</td>
<td>26.2</td>
<td>NS</td>
</tr>
<tr>
<td>Insiders</td>
<td>18.2</td>
<td>18.9</td>
<td>1%</td>
</tr>
<tr>
<td>Outsiders</td>
<td>16.6</td>
<td>33.4</td>
<td>1%</td>
</tr>
</tbody>
</table>

Notes: *Significant differences are indicated for 1 percent, 5 percent and 10 percent levels.
NS indicates that the difference is not significant at the 10 percent level of significance.
All percentages rounded to 1 decimal place.

**Table 5.4.**

Testing for significant differences in the propensity for insiders and outsiders to change the repo-rate using paired t-tests
Estimating Members' Reaction Functions

In this section I identify the determinants of insider and outsider voting behaviour using ordered logit analysis. Reaction functions are independently estimated for insiders and outsiders using a variety of econometric specifications. As mentioned previously, voting data obtained from Bank of England Minutes of Monthly Meetings from between July 10th 1997 – 6th June 2003 is used. Three types of vote are identified:

1. No change: A vote for no change is defined as where an MPC member prefers to maintain the interest-rate set in the previous period.

2. Tightening: This is defined as where a member votes to raise the interest-rate set in the previous period.

3. Loosening: This is defined as where a member votes to lower the interest-rate set in the previous period.

A vote for Looser policy is coded -1, No change coded 0 and a vote for a Tightening of policy is assigned a value of 1. Specifications are geared towards competing ideas of how the monetary authorities set interest rates, reflecting views espoused in the recent literature on monetary policy making. Further, all explanatory variables are lagged by one month to take into account the data available to the MPC at the time of a decision. This reflects a methodological concern raised by Orphanides (1998) and Tchaidze (2001) originally proposed for the estimation of reaction functions in the monetary policy rules literature. From a methodological perspective, it is best practice to use what Orphanides (1998) defines as real time data - namely the actual data which the MPC was presented with and based its policy decision upon at each meeting. Clearly, it is a reasonable to assume that MPC reaction functions are best estimated using covariates in real time, and not estimates of macroeconomic variables which have been revised after a meeting has taken place. In this chapter, as real time data is not available, lagged data is used to proxy for what might be referred to as 'real time' data - contemporaneous covariates are not used. Tchaidze (2001) identifies three key problems which should be avoided when estimating a monetary policy reaction function, namely:

"... (i) the employment of contemporaneous rather than lagged variables as indicators of a state of the economy; (ii) the use of cleaned up, revised

Details of the procedures used in all estimations can be found in the Appendix to this chapter.
data; and finally (iii) a reliance on data which were not available at the moment of policy designing. The first ignores the so called “information lag”, while the last two add (or in fact, subtract) substantial noise to (from) the fundamentals... reliance on the information actually available to policy-makers in real time is essential for the analysis of monetary policy rules."\(^{41}\)

Similarly, Orphanides (1998) shows that using data which has undergone substantial revision distorts understanding of past monetary policy decisions. This rule naturally extends to the estimation of reaction functions using voting data. Accordingly, any analysis should be based on the data available to MPC members at each meeting. Given the recency of the period under scrutiny, it is plausible to suppose revised estimates will not differ too greatly from the originals. The econometric specifications are as follows:

### 5.9.1 The ‘Blinder’ Rule

The first specification is rooted in Alan Blinder’s (1998) observation that

> “Central banks are often tempted to ‘follow the markets,’ that is to deliver the interest path that the markets have embedded in asset prices.”\(^{42}\)

The reasons for such behavior are not difficult to comprehend:

> “Central bankers are only human; they want to earn high marks - from whomever is handing out the grades. While the only verdict that really matters is the verdict of history, it takes an amazingly strong constitution to wait that long. In stark contrast, the markets provide a kind of giant biofeedback machine that monitors and publicly evaluates the central bank’s performance in real time. So central bankers naturally turn to the markets - or rather, they have that evaluation constantly thrown back in their faces.”\(^{43}\)

The argument here is not, for instance, based on MPC members following the markets due to their faith in the efficient markets hypothesis.\(^{44}\) MPC members might not necessarily subscribe to the view that all information regarding future inflation and output will be fully embedded in asset and securities prices. Rather,

\(^{41}\)p.1.
\(^{42}\)Blinder (1998), p.60.
\(^{43}\)Ibid.
\(^{44}\)The seminal contribution is Fama (1965).
the implications of Blinder's argument is that when setting the interest-rate, the MPC follows the market knowing that a positive appraisal of policy from market participants greatly cements their reputation as a responsible and credible monetary authority. The view from the Bank is that market expectations do play an important role in shaping monetary policy, as asserted by Brook, Cooper and Scholtes (2000):

"The Bank's Monetary Policy Committee (MPC) is interested in financial market participants' expectations if future interest rates. Knowledge of such expectations helps the MPC to predict whether a particular policy decision is likely to surprise market participants, and what their short-term response is likely to be to a given decision. Expectations of future levels of official rates also play a key role in determining the current stance of monetary policy." (emphasis added)

In light of the previous assertions, a members' decision to loosen, tighten or leave rates unchanged is regressed on a variable which can be reasonably supposed to capture market expectations of the future level of interest rates, a specification which referred to as the Blinder Rule. The chosen instrument is a measure of implied inflation based on the difference between yield curve estimates of UK zero coupon nominal and index linked bonds at the 60 month horizon. The series is constructed by calculating monthly averages of daily estimates originally calculated by Anderson and Sleath (2002). A 60 month - as opposed to a shorter horizon is used as for reasons attested by Anderson and Sleath (2002):

"For maturities of less than two years, estimates of both the real and nominal yield curves have not been thought reliable, and as a result have not been used by the Bank's Monetary Policy Committee, nor published in the Inflation Report or Quarterly Bulletin."  

For completeness, Figure 5.4 plots the behaviour of 2 year nominal yields and implied inflation on a 60 month horizon. It can be readily observed that both series move very closely together. The series used in Blinder Rule estimations corresponds with the dotted black line.

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45 p. 392.
46 These calculations have a basis in the Fisher equation.
5.9.2 Taylor Rule

In this approach lagged forecasts of GDP and RPIX inflation are used to explain the voting behaviour of MPC members. These specifications are chosen as they, to quote Clarida et al (2000),

"...allow the central bank to consider a broad array of information (beyond lagged information and output) to form beliefs about the future condition of the economy, a feature which...[is] highly realistic."\[48\]

The choice of covariates thus comprise a forward-looking Taylor Rule information set. Forward looking variables for GDP growth and RPIX inflation are obtained from HM Treasury's Forecasts for the UK Economy. Published monthly, this is a compendium of forecasts produced by city and independent forecasters.\[49\] For the

\[48\]p.151.
sample period, forecasts from 47 city institutions and 19 independent forecasters are used. Each month city and independent organisations reported an average of 19 new forecasts and 6 new forecasts respectively. Two specifications are estimated. The first, labelled Taylor Rule$_C$, uses the following variables:

- Consensus forecasts of RPIX growth for the current calendar year as a percentage change on the previous calendar year (RPIX$_C$)
- Consensus forecasts of GDP growth for the current calendar year as a percentage change on the previous calendar year (GDP$_C$)

The second specification, denoted Taylor Rule$_F$ uses forecast data on a longer time horizon, namely

- Consensus forecasts of RPIX growth for the next calendar year as a percentage change on the current calendar year (RPIX$_F$)
- Consensus forecasts of GDP growth for the next calendar year as a percentage change on the current calendar year (GDP$_F$)

Consensus forecasts of GDP growth and RPIX inflation are referred to in the Minutes, in addition to being reported in the Bank’s Inflation Report. If members of the MPC use ‘simple’ rules to determine interest rates, then either specification may both explain and predict MPC voting behaviour. I note that Tootell (1991a, b) also uses forward looking variables in the form of Greenbook estimates of GDP growth and inflation as covariates - this is because

"...monetary policy affects the economy only with lags, the FOMC’s expectations of GNP growth and inflation can be used to determine its votes."

As noted previously, purportedly central to the decisions on interest rates are the Bank of England’s quarterly forecasts of inflation and GDP, which are published in the Inflation Report. However, the quarterly nature of these forecasts make it difficult to incorporate into the econometric framework as the MPC make a decision on interest rates on a monthly basis. Even if the quarterly GDP and RPIX forecasts contained in the inflation report are interpolated to form monthly variables, they have very low explanatory power in explaining MPC voting behaviour. These regressions are therefore not included.$^{50}$ A comparison of Bank versus

$^{50}$Even if the quarterly GDP and RPIX forecasts contained in the inflation report are interpolated to form monthly variables (through using a HP filter, $\lambda = 5$), they have very low explanatory power in explaining MPC voting behaviour.
Consensus forecasts for GDP and inflation are presented in Panel 5.5. Current consensus forecasts of GDP and RPIX clearly exhibit more volatility than forecasts on a longer term horizon. The same applies to the quarterly Bank forecasts. Also, visual inspection reveals that consensus forecasts for GDP sub F track the Bank’s quarterly forecasts on the 12 month horizon more closely than for the 24 month horizon. This applies to RPIX sub F forecasts too.

5.9.3 Broad Information Set

Prior to each MPC meeting, its members are presented with of a wide range of data upon which to base a policy decision. This is reflected in the Minutes, which contains sections on the ‘world economy’, ‘demand and output’, ‘money, credit and asset prices’ and ‘prices and costs’. Accordingly, it is conjectured that MPC votes may be explained better by using a broad data set. The final specification uses the variables from the Blinder Rule and the Taylor Rule sub F information set in addition to the following variables:

- 3 period moving average of the monthly annual change in the effective exchange rate (EER)
- Quarterly growth rate in industrial production (Industrial production)
- Monthly unemployment rate (Unemployment)
- Monthly annual change in retail sales (Retail sales)
- Monthly annual % change in narrow money growth (M0)
- Consumer confidence indicator, monthly levels (Consumer confidence)

The additional variables are chosen as they represent potential sources of inflationary pressure which the MPC may take into account when setting the interest rate. The behaviour of the variables used across all specifications is presented in Panel 5.4. When contrasting the rules in proceeding sections I find it useful to class the Blinder Rule, Taylor Rule sub C and Taylor Rule sub F specifications - as ‘simple’ rules for monetary policy. In contrast, the Broad Information Set is an example of an ‘eclectic’ rule, as it draws upon a wide and rich set of information variables.

51 Full details of the variables used are provided in the appendix.
52 This list is by no means exhaustive - for example, not included here are statistics related to the growth of input prices, M4, average earnings and house prices. Estimations were carried out using these variables, but many proved to be insignificant.
UK RPIX Inflationary Expectations, Jun 97 - Jun 03: Bank vs. Consensus

Expectations of UK GDP Growth, Jun 97 - Jun 03: Bank vs. Consensus

Panel 5.5: Expected RPIX inflation and GDP growth: Bank vs. Consensus
PANEL 5.4.
ADDITIONAL VARIABLES USED IN THE BROAD INFORMATION SET
<table>
<thead>
<tr>
<th>Ordered logit: Comparison of different econometric specifications</th>
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<tr>
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<td>8.76 12.53 3.62*</td>
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<td>0.03 0.02</td>
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*/*/*** Denotes significance at the 1%/5%/10% level.
5.10 Econometric Results

TABLE 5.5 reports the estimates and diagnostics for the four specifications outlined above, all of which are estimated separately for insiders and outsiders. At this juncture it is worth noting that a characteristic common to limited dependent variable analysis - particularly ordered logit estimation - is a difficulty in directly interpreting parameter estimates. This is because unlike estimation procedures such as OLS, coefficients cannot be directly interpreted as marginal effects. Ultimately, this is a consequence of imposing the constraint that the sum of probabilities across all categories are non-negative and sum to unity. The marginal effects associated with each category do not remain constant as the values of respective independent variables change, but vary instead. It is hence commonplace to provide estimates of marginal effects holding independent variables at their means.

Rather than adopt this approach - which produces rather unfriendly mean values - and to make the results between groups directly comparable (to correct for differences in sample means caused by the different sample sizes associated with both groups), marginal effects are calculated for all specifications through holding independent variables constant at the following (seemingly sensible) predetermined values: Implied inflation = 2.5%; M0 = 7%; RPIX\(_C\) = RPIX\(_F\) = 2.5%; GDP\(_C\) = GDP\(_F\) = 2.2%; Consumer confidence = 0; Unemployment = 3.5%; EER = 2%; Industrial production = -1%; Retail sales = 5%. In comparing two identical specifications for insiders and outsiders, the reported marginal effects
show the effect of a change in an independent variable at a given point. It provides a good general guide to the extent to which changes in explanatory variables drive members' propensity to change the interest rate for a given category. Full details of the estimation procedure are provided in the appendix to this chapter.

Starting with the Blinder Rule, the effect of implied inflation is highly significant for both insiders and outsiders. Marginal effects show that an increase in implied inflation reduces the probability that both insiders and outsiders will lower interest rates, but raises the likelihood of leaving rates unchanged or tightening policy. However, the reduction in probability associated with a loosening of policy is larger for outsiders than for insiders (marginal effects of 0.68 vs. 0.62). According to this specification, outsiders are more likely to lower interest rates than insiders for a given change in implied inflation. The marginal effects for tightening show the reverse - insiders are more likely to raise interest rates than outsiders for a corresponding change in implied inflation. This specification therefore points to asymmetries in policy preferences between the two groups. Insiders are comparatively more hawkish than their externally appointed counterparts, a finding which confirms the analyses of previous sections. All of the marginal effects are significant, although both the Cragg-Uhler and McFadden measures or $R^2$ (denoted $R^2$(C-U) and $R^2$(M) respectively) are only moderately high. However, under both goodness-of-fit criteria, the Blinder Rule specification still performs better than either of the Taylor Rule specifications, to which I now turn.

In Taylor Rule$_C$, consensus forecasts of RPIX growth for the current calendar year as a percentage change on the previous calendar year (RPIX$_C$) are insignificant across both groups, although forecasts of current GDP growth do seem to play a role. Marginal effects indicate that increases in RPIX$_C$ decrease the probability that both insiders and outsiders will lower interest rates (0.10 vs. 0.15), but raise the probability of leaving rates unchanged or tightening policy. The same applies to GDP$_F$. Nevertheless, although the marginal effects across all categories are

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53 From a practical perspective, a caveat of holding independent variables at their means, or indeed any other values is that (i) marginal effects are typically unique to those values and (ii) the calculated change in probability associated with voting to loosen, tighten or leave the interest rate unchanged is at best only accurate for very (ideally infinitesimally) small changes in an independent variable. Indeed, as the magnitude of a given change, $\delta$, in an independent variable becomes larger, so too does the inaccuracy of the estimated change in probability associated with a given category. One cannot therefore be confident, for example that a given change in an independent variable $\delta$ multiplied by the marginal effects associated with a particular category will provide good approximations to changes in probability.
qualitatively similar to those in the Blinder Rule, they are far less pronounced. Further, some of the marginal effects are not statistically different to zero. The final Taylor Rule specification, Taylor Rule\textsubscript{F}, which uses forecasts on a longer (12 month) horizon performs better than Taylor Rule\textsubscript{C}, with respect to both the significance and size of the marginal effects, and measures of pseudo $R^2$. This result may indicate that MPC members are quite forward looking when setting policy, and use longer as opposed to relatively shorter forecasting horizons.\textsuperscript{54} In both groups, the coefficients and marginal effects are generally highly significant, although for insiders, the marginal effects for no change are not significantly different from zero for RPIX\textsubscript{F} and GDP\textsubscript{F}. For outsiders, the marginal effects seem to be more pronounced than for insiders for changes in GDP\textsubscript{F}. This suggests that the behaviour of GDP plays more of an influential role in setting the interest rate for outsiders.

In the case of the Broad Information Set the diagnostics suggest that it performs best in explaining the voting behaviour of MPC members. Both measures of $R^2$ are moderate to high, and significantly higher than those under simple rules. However, although for both groups, EER and GDP\textsubscript{F} have the wrong signs. Unemployment, although statistically significant for insiders is not significant for outsiders. In both groups, the marginal effects are clearly dominated by the effect of Implied inflation, where clear asymmetries in policy can be seen as emerging. The nature of the asymmetry again points to outsiders being more dovish than insiders. The only variable other than Implied inflation which has statistically significant coefficients and marginal effects across both groups is M0, which also has the expected signs. Table 5.6 displays the results of likelihood ratio tests conducted to test the hypothesis that each specification should be estimated separately for insiders and outsiders. The hypothesis was accepted in every case.

All specifications evidence a very strong link between implied inflation and interest rates. However, it might be the case that decisions on the interest-rate are not driven by implied inflation, but vice versa. Market participants may just be extremely good at predicting future monetary policy decisions. Using data on the actual policy decisions taken by the MPC and rates of implied inflation, Granger causality tests suggest that the direction of causality runs from implied inflation to the repo-rate. Full results are shown in Table 5.8. Using up to seven lags, the-

\textsuperscript{54}This suggests that policymakers practice inflation forecast targeting as opposed to just inflation targeting.
null hypothesis that the repo-rate does not Granger-cause changes in inflation is accepted in every instance. Conversely, the null hypothesis that implied-inflation does not Granger-cause changes in the repo-rate cannot be rejected for every lag. This result strengthens the case for a Blinder Rule, namely that the MPC merely looks to the markets to set the interest rates.

5.11 Predicting the Votes of MPC Members

In this section the ability of each specification to predict the votes of insiders and outsiders is analysed. This procedure is implemented by calculating the fitted values in each category for each vote, and choosing the category associated with the highest value for each vote. As the fitted values are probabilities, this process merely involves choosing the category with the highest probability. Following Chevapatrakul et al (2001), directional predictions are formally stated as

$$z_i = m \text{ if } P_j = \max(P_0, P_1, P_2)$$

where no change in policy is predicted if $P_0 = \max(P_0, P_1, P_2)$, a tightening of policy is predicted if $P_1 = \max(P_0, P_1, P_2)$ and looser policy is predicted if $P_2 = \max(P_0, P_1, P_2)$. In other words, the prediction is given by choosing the probability with the highest value.

TABLE 5.7 looks at the predictive performance of each specification. Part A details the in-sample voting predictions for insiders and outsiders based on ordered logit estimations. Numbers in brackets (.) show the number of correct voting predictions within each category. Consider the Blinder Rule where insiders voted for looser policy 71 times (Actual Outcomes). The Blinder Rule specification predicted 40 votes for looser policy, of which 20 were correct. What immediately becomes apparent is the tendency inherent in all specifications to over-predict no change in policy. This comes at the expense of under-predicting decisions to loosen or tighten interest rates, an outcome which obtains for both insiders and outsiders. The Taylor Rule specification performs particularly poorly, and predicts that all votes for insiders will be to leave policy unchanged.

Parts B and C allow for the identification of the model which performs best in predicting the voting behaviour of insiders and outsiders. Part B shows the number of correct decisions expressed as a percentage of actual decisions. Con-
### A. Voting Predictions

#### Information Set

<table>
<thead>
<tr>
<th>Direction of Decision</th>
<th>Actual Outcomes</th>
<th>Blinder Rule</th>
<th>Taylor Rule$_C$</th>
<th>Taylor Rule$_P$</th>
<th>Broad Information Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insiders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loosen</td>
<td>71</td>
<td>40$^*$ (50)$^{**}$</td>
<td>0 (0)</td>
<td>30 (19)</td>
<td>45 (52)</td>
</tr>
<tr>
<td>No change</td>
<td>228</td>
<td>277 (190)</td>
<td>355 (228)</td>
<td>307 (213)</td>
<td>280 (210)</td>
</tr>
<tr>
<td>Tighten</td>
<td>57</td>
<td>39 (21)</td>
<td>0 (0)</td>
<td>19 (19)</td>
<td>31 (25)</td>
</tr>
<tr>
<td>Outsiders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loosen</td>
<td>99</td>
<td>96 (50)</td>
<td>44 (18)</td>
<td>56 (35)</td>
<td>100 (75)</td>
</tr>
<tr>
<td>No change</td>
<td>145</td>
<td>162 (92)</td>
<td>242 (119)</td>
<td>211 (114)</td>
<td>153 (112)</td>
</tr>
<tr>
<td>Tighten</td>
<td>42</td>
<td>28 (11)</td>
<td>0 (0)</td>
<td>19 (9)</td>
<td>33 (25)</td>
</tr>
</tbody>
</table>

#### Associated Percentages

<table>
<thead>
<tr>
<th>Direction of Decision</th>
<th>Actual Outcomes</th>
<th>Blinder Rule</th>
<th>Taylor Rule$_C$</th>
<th>Taylor Rule$_P$</th>
<th>Broad Information Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insiders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loosen</td>
<td>71</td>
<td>28.2$^*$ [50]$^{**}$</td>
<td>0 [0]</td>
<td>25.8 [63.3]</td>
<td>45.1 [71.1]</td>
</tr>
<tr>
<td>No change</td>
<td>228</td>
<td>83.3 [68.0]</td>
<td>100 [64.0]</td>
<td>93.4 [62.0]</td>
<td>92.1 [75.2]</td>
</tr>
<tr>
<td>Tighten</td>
<td>57</td>
<td>36.8 [83.8]</td>
<td>0 [0]</td>
<td>26.3 [78.9]</td>
<td>45.6 [83.9]</td>
</tr>
<tr>
<td>Outsiders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loosen</td>
<td>99</td>
<td>60.6 [62.5]</td>
<td>18.2 [40.9]</td>
<td>35.4 [62.5]</td>
<td>75.8 [75.2]</td>
</tr>
<tr>
<td>No change</td>
<td>145</td>
<td>63.4 [56.8]</td>
<td>82.1 [42.3]</td>
<td>78.6 [54.0]</td>
<td>77.2 [73.2]</td>
</tr>
<tr>
<td>Tighten</td>
<td>42</td>
<td>26.2 [39.3]</td>
<td>0 [0]</td>
<td>21.4 [47.4]</td>
<td>59.5 [75.8]</td>
</tr>
</tbody>
</table>

#### All Votes

<table>
<thead>
<tr>
<th>Direction of Decision</th>
<th>Actual Outcomes</th>
<th>Blinder Rule</th>
<th>Taylor Rule$_C$</th>
<th>Taylor Rule$_P$</th>
<th>Broad Information Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insiders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prediction</td>
<td>356</td>
<td>231</td>
<td>228</td>
<td>247</td>
<td>268</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>64.9</td>
<td>64.0</td>
<td>69.4</td>
<td>75.3</td>
<td></td>
</tr>
<tr>
<td>Ranking</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Outsiders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prediction</td>
<td>286</td>
<td>163</td>
<td>137</td>
<td>158</td>
<td>212</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>57.0</td>
<td>47.9</td>
<td>55.3</td>
<td>74.1</td>
<td></td>
</tr>
<tr>
<td>Ranking</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

* Note: Actual Outcomes refers to the total number of votes cast by Insiders and Outsiders to loosen, leave unchanged or tighten the repo-rate. As an example, the total number of votes cast by insiders to loosen the interest rate over the sample period is 71. In A. Voting Predictions, numbers in columns show the number of in-sample predictions under each rule. ** Figures in round brackets (.) show the number of in-sample voting predictions within each category (Loosen/No Change/Tighten). For instance, consider the Blinder Rule where insiders voted for looser policy 71 times (Actual Outcomes). The Blinder Rule specification predicts 40 votes for looser policy, of which 20 were correct.

* Part B shows the number of correct decisions expressed as a percentage of actual decisions. For example, consider the Blinder rule for insiders again, recalling that part A shows that of 40 predictions for looser policy, only 20 were correct. The Blinder rule thus has a ($40/71$) * 100 = 56.3% success rate in predicting a vote cast for looser policy. ** Figures in square brackets [.] show the conditional probability (expressed as a percentage) of a prediction made within a particular category being correct. This is calculated by dividing the number of correct predictions within each category by the total number of predictions for that category. For instance, to use the Blinder rule for insiders again, the likelihood of a prediction for looser policy being correct given that the prediction is for looser policy is calculated as Prob(Correct|Loosen)=100=40/71=55.9%.

* Part C pools all of the correct predictions together for each group (insiders and outsiders) irrespective of category (Loosen/No Change/Tighten) and divides this number by the total number of votes cast by each group. For instance, the Blinder Rule specification for insiders predicts 231 out of 356 votes correctly, which corresponds to a ($231/356$) * 100 = 65.3% success rate. These percentages are then used as a ranking criterion for each specification, where 1 denotes the best specification and 4 the worst.

**TABLE 5.7.**

**In-Sample Voting Predictions based on Ordered Logit Estimates**
sider the Blinder Rule for *insiders* again, and recall that part A shows that of 40 predictions for loosed policy, only 20 were correct. The Blinder Rule thus has a \( \frac{20}{40} \times 100 = 28.2\% \) success rate in predicting a vote cast for looser policy. Under this criteria, the Broad Information Set performs best. Further, it seems more able to predict votes for change for insiders than outsiders. The Blinder Rule is better at predicting votes cast for looser for outsiders than insiders, with the reverse being true for votes for tighter policy. However, some care should be taken when interpreting these results. Note that although the Taylor Rule enjoys a 64\% success rate in predicting votes for *no change* in policy for insiders, it does not predict *any* votes in favour of changing the interest rate, in either direction. *All* votes predict no change in policy.

Numbers in square brackets [.] show the conditional probability (expressed as a percentage) of a prediction made within a particular category being correct. This is calculated by dividing the number of correct predictions within each category by the total number of predictions for that category. Again, the Broad Information Set performs best - for example, the results show that a prediction by the model to tighten interest rates has an 83.9\% chance of being correct. Finally, part C pools all of the correct predictions together for each group *irrespective of category* and divides this number by the total number of votes cast by each group. The Broad Information Set out-performs the other categories. For insiders, 75.3\% of predicted votes were correct; for outsiders the figure was comparable at 74.1\%. The more parsimonious specifications are very bad at correctly predicting the votes of outsiders; for insiders this is not necessarily the case. This may be attributable to the finding in Chapter 4 that at any given MPC meeting, the interest rate preferences of outsiders are more widely dispersed than for insiders (see Figure 4.3). A conclusion that might be drawn from this is that outsiders are more ‘eclectic’ in their approach to setting monetary policy - the additional variables used in the Broad Information Set are relatively more important to outsiders than insiders. This may for example explain why the marginal effects for the extra variables are, with the exception of *Unemployment*, higher for outsiders across all categories.

### 5.12 Concluding Remarks

In this chapter I have demonstrated that *internalness* and *externalness* is a significant factor is explaining the voting behaviour of MPC members. Insiders are
shown to be more hawkish than their externally appointed counterparts, preferring *ceteris paribus* higher interest rates than outsiders. Further, insiders have a greater propensity for leaving interest rates unchanged. On a more general level, preliminary analysis of the timing of MPC decisions also demonstrates that if the interest rate is going to change, it is more likely to be changed in an *Inflation Report* month than at any other time.

The results of ordered logit analysis provide insight into the economic factors driving members’ voting decisions. A first conclusion is the seemingly crucial role of *forward looking* variables in setting interest rates for insiders and outsiders. Both the Blinder Rule and Taylor Rule*F* specification out-perform the Taylor Rule*C* specification by a significant margin. This is reflected in the associated measures of pseudo-$R^2$ and in-sample predictions presented in Table 5.7. Further, it is notable that whereas all parameters in the Blinder Rule and and Taylor Rule*F* are statistically significant, this is not the case for the Taylor Rule*C*. Marginal effects in the ‘simple’ rule specifications have the expected signs with respect to theoretical priors for both groups. Yet compared to the simple rules, the Broad Information Set specification is clearly superior, a finding which applies to both insiders and outsiders. Each group appears to use a broad array of variables when setting interest rates, which has implications for the view that the Bank merely follows the market or uses Taylor Rules. However, when one looks to the parameter estimates for implied inflation in the Broad Information Set, it is clearly seen to be the most influential variable. This suggests that although MPC members use an eclectic rule when setting monetary policy, market expectations of inflation play a dominant role.

Based on the results presented in this chapter, further research in this area is has the potential to be both fruitful and policy relevant. A key finding is that outsiders prefer systematically lower interest rates than insiders. This begs the question of whether the appointments procedure is open to political manipulation by the Chancellor of the Exchequer - does he, for example choose external MPC members on the basis of their being doves, or are such dovish tendencies attributable to chance? A further finding is the extent to which monetary policy would differ if outsiders formed the majority of members. Under such a regime, it is not implausible to suppose that monetary policy would be characterised by lower interest rates with a correspondingly higher rate of economic growth. It must be emphasised however that the approach adopted in this chapter approach lies
### Granger Causality Tests: Repo Rate vs. Implied Inflation

**H₀: The repo rate does not Granger Cause changes in implied inflation**

<table>
<thead>
<tr>
<th>Lags</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72</td>
<td>1.61</td>
<td>0.21</td>
</tr>
<tr>
<td>2</td>
<td>71</td>
<td>0.18</td>
<td>0.83</td>
</tr>
<tr>
<td>3</td>
<td>70</td>
<td>1.24</td>
<td>0.30</td>
</tr>
<tr>
<td>4</td>
<td>69</td>
<td>1.19</td>
<td>0.33</td>
</tr>
<tr>
<td>5</td>
<td>68</td>
<td>2.11</td>
<td>0.08</td>
</tr>
<tr>
<td>6</td>
<td>67</td>
<td>2.00</td>
<td>0.08</td>
</tr>
<tr>
<td>7</td>
<td>66</td>
<td>1.76</td>
<td>0.12</td>
</tr>
</tbody>
</table>

**H₀: Implied inflation does not Granger Cause changes in the repo rate**

<table>
<thead>
<tr>
<th>Lags</th>
<th>Obs</th>
<th>F-Statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72</td>
<td>44.33</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>71</td>
<td>11.65</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>70</td>
<td>6.06</td>
<td>0.00</td>
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<td>69</td>
<td>4.49</td>
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</tr>
<tr>
<td>5</td>
<td>68</td>
<td>3.44</td>
<td>0.01</td>
</tr>
<tr>
<td>6</td>
<td>67</td>
<td>5.21</td>
<td>0.00</td>
</tr>
<tr>
<td>7</td>
<td>66</td>
<td>5.21</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*5 year market expectations of implied inflation based on nominal zero coupon yields for UK government bonds. Source: Bank of England

### Table 5.8

**Granger Causality Tests: Repo Rate vs. Implied Inflation**

...well within the ‘reaction function’ genre. Put another way, the focus has been on determining how MPC members respond to changes in economic conditions. Other lines of investigation such as the propensity of MPC members to dissent and the effects of career backgrounds on such behaviour - lines of investigation associated with the ‘partisan theory of politics’ literature - form the focus of the next chapter.
5.A Appendix to Chapter 5

5.A.1 Ordered and Multinomial Logit Models

A common thread running through studies of monetary policy decision making is
the use of limited dependent variable models. From the mathematical perspective,
the logit model has the advantage being computationally less burdensome than
the probit model, which is based on the cumulative normal distribution. This section
provides a rudimentary treatment of ordered and multinomial logit models geared
specifically to the case of 3 outcomes, reflecting the choice faced by members of an
MPC to tighten, loosen or leave interest rates unchanged. For more complete ex-
positions of the ordered and multinomial logit models see Maddala (1983), Hosmer

5.A.2 The Ordered Logit Model

For the ordered logit model the choice between $M$ mutually exclusive alternatives
has an implicitly logical ordering. For members of an MPC faced with 3 choices,
the ordered logit model may be expressed as

$$
y_i^* = x_i'\beta + \epsilon_i
$$

$$
y_i = -1 \text{ if } y_i^* \leq \gamma_1
$$

$$
y_i = 0 \text{ if } \gamma_1 < y_i^* \leq \gamma_2
$$

$$
y_i = 1 \text{ if } y_i^* > \gamma_2
$$

55 This model is also referred to as the proportional odds model. It recently came to the
attention of the author that it is possible in STATA to estimate a generalized version of the
ordered logit model, which relaxes the proportional odds assumption. Created by Vincent Kang
Fu of the Department of Sociology, University of Utah, it is available as the gologit module and
can be installed from within STATA by typing “ssc install gologit”.

56 It is important to note here the difference between ordered logit model and the ordered
probit model. In the case of probit estimation, the cumulative density function, $\Phi$, is normal,
implying

$$
\Phi(\gamma_j - x_i'\beta) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{(\gamma_j - x_i'\beta)} e^{-s^2/2} ds
$$

where $s$ is a random variable such that $s = N(0,1)$. However, the cumulative logistic density,
$\Psi$, is given as

$$
\Psi(\gamma_j - x_i'\beta) = \frac{1}{1 + e^{-(\gamma_j - x_i'\beta)}}
$$
where $y_i^*$ is a stacked $m \times 1$ vector of $-1^s$, $0^s$ and $1^s$ corresponding to members’ votes to tighten, loosen or leave interest rates unchanged given the rate set in the previous period. $x_i$ is a $m \times h$ matrix containing $h$ independent variables capturing the information sets of MPC members at the time each vote was cast, and $\beta$ is a $1 \times h$ vector parameter estimates.\footnote{The ordered logit model is a more parsimonious specification than the multinomial logit model, given there are fewer parameters to be estimated.} The specification given above has likelihood and log likelihood functions given by

$$L(\beta) = \prod_{i=1}^{m} \prod_{j=0}^{2} [\Phi(\gamma_j - x_i^\prime \beta) - \Phi(\gamma_{j-1} - x_i^\prime \beta)]^{Z_{i,j}}$$

(5.8)

and

$$\ln L(\beta) = \sum_{i=1}^{m} \sum_{j=0}^{2} Z_{i,j} [\Phi(\gamma_j - x_i^\prime \beta) - \Phi(\gamma_{j-1} - x_i^\prime \beta)]$$

(5.9)

where $Z_{i,j} = 1$ if the $i^{th}$ vote falls in the $j^{th}$ category, and $Z_{i,j} = 0$ if not, across the $j = \{0, 1, 2\}$ outcomes. Letting $\Phi$ denote the cumulative standard logistic function it follows that

$$\Pr(Z_{i,j} = 1) = [\Phi(\gamma_j - x_i^\prime \beta) - \Phi(\gamma_{j-1} - x_i^\prime \beta)]$$

(5.10)

In the case of three ordered outcomes, the probability that $y_i^*$ assumes a particular value for the three categories is defined as:

**Looser policy:**

$$P(Z_i = -1) = \Phi(\gamma_1 - x_i^\prime \beta) = \frac{1}{1 + e^{x_i^\prime \beta - \gamma_1}}$$

(5.11)

**No change in policy:**

$$P(Z_i = 0) = \left[\Phi(\gamma_2 - x_i^\prime \beta) - \Phi(\gamma_1 - x_i^\prime \beta)\right]$$

$$= \frac{1}{1 + e^{x_i^\prime \beta - \gamma_2}} - \frac{1}{1 + e^{x_i^\prime \beta - \gamma_1}}$$

(5.12)

**Tighter policy:**

$$P(Z_i = 1) = 1 - \Phi(\gamma_2 - x_i^\prime \beta) = 1 - \frac{1}{1 + e^{x_i^\prime \beta - \gamma_2}}$$

(5.13)

where $\gamma_1$ and $\gamma_2$ are embody the lower and upper cut off points respectively.
5.A.3 Marginal Effects for the Ordered Logit Model

Marginal effects are computed by holding regressors at their mean values, and are given by:

**Looser policy:**

\[ \frac{\partial P(Z_i = -1|x)}{\partial x} = \frac{\partial \Phi(\gamma_1 - x_i' \beta)}{\partial x} = \Phi(\gamma_1 - x_i' \beta)[1 - (\gamma_1 - x_i' \beta)] \beta_i \]

\[ = \frac{1}{1 + e^{\beta' x_i - \gamma_1}} \left[ 1 - \frac{1}{1 + e^{\beta' x_i - \gamma_1}} \right] \beta_i \]

\[ = \frac{e^{\beta' x_i - \gamma_1}}{(1 + e^{\beta' x_i - \gamma_1})^2} \beta_i \]

(5.14)

**No change in policy:**

\[ \frac{\partial P(Z_i = 0|x)}{\partial x} = \frac{\partial [\Phi(\gamma_2 - x_i' \beta) - \Phi(\gamma_1 - x_i' \beta)]}{\partial x} \]

\[ = \frac{\Phi(\gamma_2 - x_i' \beta)[1 - (\gamma_2 - x_i' \beta)] \beta_i}{1 + e^{\beta' x_i - \gamma_2}} \]

\[ - \Phi(\gamma_1 - x_i' \beta)[1 - (\gamma_1 - x_i' \beta)] \beta_i \]

\[ = \left( \frac{1}{1 + e^{\beta' x_i - \gamma_2}} \left[ 1 - \frac{1}{1 + e^{\beta' x_i - \gamma_2}} \right] \right) \beta_i \]

\[ = \left( \frac{e^{\beta' x_i - \gamma_2}}{(1 + e^{\beta' x_i - \gamma_2})^2} - \frac{e^{\beta' x_i - \gamma_1}}{(1 + e^{\beta' x_i - \gamma_1})^2} \right) \beta_i \]

(5.15)

**Tighter policy:**

\[ \frac{\partial P(Z_i = 1|x)}{\partial x} = \frac{\partial (1 - \Phi(\gamma_2 - x_i' \beta))}{\partial x} \]

\[ = \frac{1}{1 + e^{-(\beta' x_i - \gamma_2)}} \left[ 1 - \frac{1}{1 + e^{-(\beta' x_i - \gamma_2)}} \right] \beta_i \]

\[ = \frac{e^{-(\beta' x_i - \gamma_2)}}{(1 + e^{-(\beta' x_i - \gamma_2)})^2} \beta_i \]

(5.16)

Unlike the linear probability model, marginal effects vary across probabilities, and must sum to zero across categories.\(^{38}\)

\(^{38}\)These results also apply to the multinomial logit model.
5.A.4 The Multinomial Logit Model

In the MNL model, choices between alternatives do not contain any implicit ordering.

\textit{No change in policy:} 
\[ P(Z_i = 0) = \frac{1}{1 + e^{\beta_1 x_i} + e^{\beta_2 x_i}} \tag{5.17} \]

\textit{Tighter policy:} 
\[ P(Z_i = 1) = \frac{e^{\beta_1 x_i}}{1 + e^{\beta_1 x_i} + e^{\beta_2 x_i}} \tag{5.18} \]

\textit{Looser policy:} 
\[ P(Z_i = 2) = \frac{e^{\beta_2 x_i}}{1 + e^{\beta_1 x_i} + e^{\beta_2 x_i}} \tag{5.19} \]

For \( M = \{1, 2, \ldots, m\} \) observations, the likelihood function for three choices is given by
\[ L(\beta_1, \beta_2) = \prod_{i=1}^{m} P_{i0}^d_{i1} P_{i1}^d_{i2} \tag{5.20} \]
with a corresponding log likelihood function expressed as
\[ \ln L(\beta_1, \beta_2) = \sum_{i=1}^{m} \sum_{j=0}^{2} d_{i,j} \ln \Pr(Z_i = j) \tag{5.21} \]

where \( d_{i,j} = 1 \) if the \( i^{th} \) vote falls in the \( j^{th} \) category, and \( d_{i,j} = 0 \) if not, across the \( j = \{0, 1, 2\} \) outcomes.\(^{59}\)

5.A.5 Marginal Effects for the Multinomial Logit Model

For the multinomial logit model, marginal effects are given by
\[ \varphi_j = \frac{\partial P_j(Z_i = j|x)}{\partial x} = P_j \left[ \beta_j - \sum_{k=0}^{J} P_k \beta_k \right] = P_j \left[ \beta_j - \overline{\beta} \right] \tag{5.22} \]
where \( \overline{\beta} = \sum_{k=0}^{J} P_k \beta_k \) is a weighted average of coefficients. For the case of three outcomes, and holding regressors at their means, the marginal effects of the \( q^{th} \)

\(^{59}\)Not considered here is the multinomial probit model, which relaxes the so-called IIA (Independence of Irrelevant Alternatives) assumption. Previously, this model has been computationally too burdensome to estimate. However, packages such as STATA 9 now offer this option. For an exegesis of the model see Maddala (1983) more recently Weeks (1997).
variable on respective probabilities for each category are given by:

No change in policy:

\[
\varphi_{0,q} = \frac{\partial \Pr(Z_i = 0|x)}{\partial x_q} = P_0 \left[ \beta_{0,q} - \sum_{k=0}^{2} P_k \beta_{k,q} \right] = P_0 \left[ \beta_{0,q} - \beta \right]
\]

\[
= P_0 \left[ \frac{\beta_{0,q}}{1 + e^{\beta_1 x_1 + \beta_2 x_2}} \frac{\beta_{1,q}}{1 + e^{\beta_1 x_1 + \beta_2 x_2}} \frac{\beta_{2,q}}{1 + e^{\beta_1 x_1 + \beta_2 x_2}} \right]
\]

(5.23)

Tighter policy:

\[
\varphi_{1,q} = \frac{\partial \Pr(Z_i = 1|x)}{\partial x_q} = P_1 \left[ \beta_{1,q} - \sum_{k=0}^{2} P_k \beta_{k,q} \right] = P_1 \left[ \beta_{1,q} - \beta \right]
\]

\[
= P_1 \left[ \frac{\beta_{1,q}}{1 + e^{\beta_1 x_1 + \beta_2 x_2}} \frac{\beta_{1,q}}{1 + e^{\beta_1 x_1 + \beta_2 x_2}} \frac{\beta_{2,q}}{1 + e^{\beta_1 x_1 + \beta_2 x_2}} \right]
\]

(5.24)

Looser policy:

\[
\varphi_{2,q} = \frac{\partial \Pr(Z_i = 2|x)}{\partial x_q} = P_2 \left[ \beta_{2,q} - \sum_{k=0}^{2} P_k \beta_{k,q} \right] = P_2 \left[ \beta_{2,q} - \beta \right]
\]

\[
= P_2 \left[ \frac{\beta_{2,q}}{1 + e^{\beta_1 x_1 + \beta_2 x_2}} \frac{\beta_{1,q}}{1 + e^{\beta_1 x_1 + \beta_2 x_2}} \frac{\beta_{2,q}}{1 + e^{\beta_1 x_1 + \beta_2 x_2}} \right]
\]

(5.25)

In practice, multinomial logit estimation in many instances delivers similar results to the ordered alternative. This becomes apparent when both ordered logit and multinomial logit estimates for the Blinder Rule are used to construct probability response profiles for insiders and outsiders. Multinomial estimates for the Blinder Rule are given in TABLE 5.9. The corresponding response curves for both estimation procedures are shown in PANELS 5.6 and 5.7. For completeness, I have also calculated and plotted the corresponding marginal effects - or the slope of the probability response profiles - using the formulas given above. Clearly, the results for both estimation procedures are virtually indistinguishable from each other. It should be stressed, however, that ordered logit estimation is certainly more appropriate when using MPC voting data, as it has an implicit ordering.
**Multinomial logit estimation of the Blinder Rule**

<table>
<thead>
<tr>
<th></th>
<th>Intercept</th>
<th>Implied inflation</th>
<th>( R^2 ) (C-LD)</th>
<th>( R^2 ) (C-M)</th>
<th>LR(6)</th>
<th>( \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blinder rule - Insiders</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightening</td>
<td>-12.65*</td>
<td>3.73*</td>
<td>0.45</td>
<td>0.26</td>
<td>167.80</td>
<td>0.000</td>
</tr>
<tr>
<td>Marginal effects</td>
<td></td>
<td>0.26*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loosening</td>
<td>7.33*</td>
<td>-3.43*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marginal effects</td>
<td></td>
<td>-0.37*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Blinder rule - Outsiders</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightening</td>
<td>-9.99*</td>
<td>2.88*</td>
<td>0.47</td>
<td>0.27*</td>
<td>149.86</td>
<td>0.000</td>
</tr>
<tr>
<td>Loosening</td>
<td>9.01*</td>
<td>-3.68*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Denotes significance at the 1% level

Omitted category = No change

**Should regressions for insiders and outsiders be estimated separately? Yes**

<table>
<thead>
<tr>
<th></th>
<th>Insiders only</th>
<th>Outsiders only</th>
<th>LR test statistic</th>
<th>5 % critical value</th>
<th>Reject ( H_0 )?</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both groups</td>
<td>-458.4</td>
<td>-236.6</td>
<td>25.282</td>
<td>5.99</td>
<td>yes</td>
<td>Estimate both groups separately</td>
</tr>
</tbody>
</table>

\( H_0 \): Both groups should not be estimated separately

\( H_1 \): Both groups should be estimated separately

LR test statistic calculated as \( \chi^2 = -2(L(R) - L(UR)) \) where \( L(R) \) is the log-likelihood value for the restricted model (both groups estimated together) and \( L(UR) \) is the sum of the log-likelihood values for both groups estimated separately.

**Table 5.9. Multinomial logit estimation of the Blinder Rule for Insiders and Outsiders**
Ordered logit probability response profiles for Insiders and Outsiders based on changes in inflationary expectations

Ordered logit marginal effects for Insiders and Outsiders based on changes in inflationary expectations

Panel 5.6.
Ordered logit probability response profiles and marginal effects for the Blinder Rule
Multinomial logit probability response profiles for Insiders and Outsiders based on changes in inflationary expectations

Multinomial logit marginal effects profiles for Insiders and Outsiders based on changes in inflationary expectations

Panel 5.7.
Multinomial logit probability response profiles and marginal effects for the Blinder Rule
5.A.6 Measuring the Goodness of Fit

Following Maddala (1983), define

\[ R^2 = 1 - \left( \frac{L(\gamma_1, \gamma_2)}{L(\beta_1, \beta_2)} \right)^\frac{1}{n} \]  

(5.26)

where \( L(\beta_1, \beta_2) \) is the likelihood function maximized with respect to all of the parameters in the model, \( \beta_1, \beta_2 \), including the constant terms, \( \gamma_1 \) and \( \gamma_2 \), and \( L(\gamma_1, \gamma_2) \) denoting the maximum of the likelihood function maximized with respect to the constant terms only. The term \( m \) denotes the total number of observations. However, this measure of fit suffers from severely underestimating the measure of fit of the regression: even if the model has perfect fit, \( R^2 \) may be well below 1. For this reason, it is apposite to employ McFadden’s (1974) measure of goodness-of-fit, pseudo-\( R^2 \), denoted \( \rho_M \). This is defined as

\[ \rho_M = 1 - \frac{\ln L(\gamma_1, \gamma_2)}{\ln L(\beta_1, \beta_2)} \]  

(5.27)

An alternative measure of goodness of fit, also referred to as pseudo-\( R^2 \) is provided by Cragg-Uhler (1970), and given as

\[ \rho_{CU} = \frac{\left[ L(\beta_1, \beta_2) \right]^\frac{1}{n} - \left[ L(\gamma_1, \gamma_2) \right]^\frac{1}{n}}{1 - \left[ L(\gamma_1, \gamma_2) \right]^\frac{2}{n}} \]  

(5.28)

where the same notational definitions used for McFadden’s (1974) measure of \( R^2 \), \( \rho_M \) are employed.

An alternative approach is to conduct a likelihood ratio test. To test for the joint significance of all explanatory variables in each model, calculate

\[ \chi^2_{q, \delta} = -2 \left( \frac{\ln L(\gamma_1, \gamma_2)}{\ln L(\beta_1, \beta_2)} \right) \]  

(5.29)

which is distributed as a Chi-squared variate with \( q \) degrees of freedom and \( \delta \) restrictions. This formula lends itself to a more general setting, with the maximized log likelihood values for unrestricted and restricted versions of the model

---

\( ^{60} \)In the case of the ordered logit model the constant terms can be interpreted as cutoff points.  
\( ^{61} \)This implies restricting the values of all explanatory variables to zero. In the ordered logit model this is equivalent to just estimating cutoff points.  
\( ^{62} \)This measure is also referred to as McFadden’s likelihood ratio index.
corresponding to the denominator and the numerator respectively. As one might expect, the null of no joint significance against the alternative hypothesis that at least one explanatory variable is significant is tested.
### Table 5.A.
**Description of Variables Used in Econometric Estimation**

<table>
<thead>
<tr>
<th>Constructed Variables</th>
<th>Description</th>
<th>Constructed from</th>
<th>Source</th>
<th>Mnemonic</th>
</tr>
</thead>
<tbody>
<tr>
<td>EER</td>
<td>3 period moving average of the monthly annual change in the effective exchange rate.</td>
<td>UK sterling (Δ) effective exchange rate index, not seasonally adjusted.</td>
<td>Datastream</td>
<td>UKXTH.WHF</td>
</tr>
<tr>
<td>Industrial production</td>
<td>Quarterly growth rate in industrial production.</td>
<td>UK Industrial production volume index, seasonally adjusted.</td>
<td>Datastream</td>
<td>UKIPTOT.G</td>
</tr>
<tr>
<td>Unemployment</td>
<td>Lagged monthly unemployment rate.</td>
<td>UK unemployment rate, seasonally adjusted.</td>
<td>Datastream</td>
<td>UKUN%TOTQ</td>
</tr>
<tr>
<td>Retail sales</td>
<td>Monthly annual change in retail sales.</td>
<td>UK retail sales volume index, seasonally adjusted.</td>
<td>Datastream</td>
<td>UKODDO15G</td>
</tr>
<tr>
<td>M0</td>
<td>Monthly annual % change in narrow money growth.</td>
<td>UK M0 money supply monthly calendar levels, current prices, seasonally adjusted.</td>
<td>Datastream</td>
<td>UKM0...B</td>
</tr>
<tr>
<td>Consumer confidence</td>
<td>Consumer confidence indicator, monthly levels.</td>
<td>UK consumer confidence indicator, seasonally adjusted.</td>
<td>Datastream</td>
<td>UKCNFCONQ</td>
</tr>
<tr>
<td>RPIX&lt;sub&gt;c&lt;/sub&gt;</td>
<td>Consensus forecasts of RPIX growth for the current calendar year as a percentage change on the previous calendar year.</td>
<td>Average of new monthly forecasts for RPIX growth provided by City and Independent forecasters.</td>
<td>HMT</td>
<td>No mnemonic. Forecasters' projections of movements is series ABMG, found in National Accounts Table C2.</td>
</tr>
<tr>
<td>GDP&lt;sub&gt;c&lt;/sub&gt;</td>
<td>Consensus forecasts of GDP growth for the current calendar year as a percentage change on the previous calendar year.</td>
<td>Average of new monthly estimates of current GDP growth provided by City and Independent forecasters.</td>
<td>HMT</td>
<td>No mnemonic. Forecasters' projections of movements is series CDKQ, found in ONS Consumer Prices release, Table 1.</td>
</tr>
<tr>
<td>RPIX&lt;sub&gt;f&lt;/sub&gt;</td>
<td>Consensus forecasts of RPIX growth for the next calendar year as a percentage change on the current calendar year.</td>
<td>Average of new monthly estimates of future RPIX growth provided by City and Independent forecasters.</td>
<td>HMT</td>
<td>No mnemonic. Forecasters' projections of movements is series ABMG, found in National Accounts Table C2.</td>
</tr>
<tr>
<td>GDP&lt;sub&gt;f&lt;/sub&gt;</td>
<td>Consensus forecasts of GDP growth for the next calendar year as a percentage change on the current calendar year.</td>
<td>Average of new monthly estimates of future GDP growth provided by City and Independent forecasters.</td>
<td>HMT</td>
<td>No mnemonic. Forecasters' projections of movements is series CDKQ, found in ONS Consumer Prices release, Table 1.</td>
</tr>
</tbody>
</table>
Chapter 6

The Dissent Voting Behaviour of MPC Members

6.1 Introduction

Like all monetary policy committees, the BoEMPC is obliged to reach decisions on the short-term interest-rate, even in the presence of substantial disagreement. When a committee member does not hold the view of the majority, a way of registering such difference in opinion is to vote against it, that is, to cast a dissenting vote. Consider the vote reported by the Financial Times on 25th, referred to at the beginning of Chapter 5. It was characterised by all outsiders dissenting for lower interest rates. Effectively, all Bank insiders found themselves on the winning side of the decision, and all outsiders on the losing side. In this chapter I compare the type and frequency of dissenting votes cast by insiders and outsiders. I not only evidence differences between the two groups, but explain why such differences might arise, and in particular, why BoEMPC members might be incentivised to dissent.

To survey the results, it is determined that firstly, outsiders are much more likely to cast dissenting votes than insiders. Interpreted differently, insiders have a significantly higher chance of being on the winning side of monetary policy decisions. Secondly, whereas insiders dissent for tighter policy more often than looser policy, outsiders dissent overwhelmingly on the side of monetary ease. Also measured is the impact of career backgrounds on dissent voting, an approach used in studies of FOMC dissent voting. Specifically, binary logit analysis is used to estimate the effect of career backgrounds on members’ propensity to dissent on side of ease or tightness. The dataset used is highly truncated in that it uses only dissenting votes, and the analysis to some extent draws on Havrilesky and Schweitzer
When controlling for a member's type, years spent working in the private sector, the civil service and non-governmental organisations all contribute to a member's propensity to dissent on the side of ease or tightness, although the effects are not highly pronounced.

The chapter progresses as follows. I begin by relating the chapter to previous studies on dissent voting, a literature which falls into the 'partisan theory of politics' genre [Meade and Sheets (2002)]. I then develop some priors. In particular, I look to reasons why the frequency and type of dissent voting associated with insiders and outsiders might be expected to differ. Amongst other things, I suggest that differences in dissent voting behaviour is partially attributable to the presence of members' career concerns - simply put, disagreeing with fellow members may damage one's career path, especially if one is an insider. However, other factors may come into play, and for any individual member, dissent voting behaviour may not necessarily be driven by any single factor in isolation, but by a combination thereof. Following this, I formally define is meant by dissent, and proceed to evidence the dissent voting behaviour of BoEMPC members for the first five years of the MPC.2 As in Chapter 5, monthly voting data from July 10th 1997 – 6th June 2003 is used. The career backgrounds of MPC members and associated econometric evidence relating this to dissent voting is then presented. The chapter concludes by addressing the implications of the findings for the future conduct of UK monetary policy.

6.2 Relationship to the Literature

Previous studies of dissent voting in MPCs (i) fall into the 'partisan theory of politics' genre and (ii) typically consider the case of the FOMC. The approach used in this chapter draws mainly on Belden (1989) and Havrilesky and Schweitzer (1990). Belden analyses the record of dissenting votes from FOMC meetings with a view to identifying differences in the dissent voting behaviour of Bank presidents and Board members. Bank presidents dissent more frequently than Board members, with the latter group preferring to dissent on the side of ease, and the former on the side of monetary tightness. The reason for the observed differences, according to Belden, lay in the different appointments procedures for each type of member.

1Meade and Stasavage (2004) draw on the literature on the career concerns of experts in explaining the dissenting votes of outsiders.
2During this period, Sir Edward George also presided as Governor of the Bank of England.
Board Governors are appointed by the US President, thereby lacking the independence of Bank Presidents. Because Belden assumes that governments have an in-built bias towards activist policy, the finding that Board Governors have a greater propensity to dissent on the side of monetary ease than Bank Presidents is not unexpected. Further, Bank Presidents are less influential in setting monetary policy than Board members - they feature on the losing side of decisions more often than Board members. Like Belden (1989), Havrilesky and Schweitzer (1990) is premised on the notion that all governments have a time-consistent inflationary bias. FOMC members whose career backgrounds are more 'proximate' to central government are more liable to conform to such bias, and the more one conforms to it, the greater the propensity to dissent on the side of ease. Conversely, members whose experiences are relatively further from of central government are more likely to dissent on the side of tightness. Havrilesky and Schweitzer make assumptions about the kinds of career characteristics which lead to a members having more of a propensity to dissent on the side of ease or tightness. As discussed later, their assumptions might not hold in the context of UK monetary policy.

The latter point is worth elaborating on. Care should be taken when comparing the results of FOMC studies with BoEMPC studies. On the one hand, the distinction between insiders and outsiders has some parallels with that made between Bank presidents and Board members in many studies of FOMC voting behaviour. In this sense, I adopt an approach which belongs to the long tradition of studies examining the voting behaviour of US Federal Open Market Committee members. However, this similarity should not be stretched too far. As one might

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3The idea that governments have an inbuild inflationary bias does not convince everyone. Charles Goodhart (1997), a member of the MPC with an academic background, is a key example of someone who questions the wisdom embodied in writings on time-consistent monetary policy:

"Whilst I have consistently supported central bank autonomy in setting interest rates, to achieve an inflation set by the political authorities, I have at the same time had doubts about the virtues of the main theoretical analysis paraded in support of that step, i.e. the time-inconsistency argument. There is little compelling evidence that governments have sought consciously to use expectational inertia to trick people into working harder, in pursuit of a short-run electoral feel good factor, and, indeed little evidence, given to the long lags in monetary policy and the wide range of uncertainty surrounding the effects of such policies over time on nominal incomes and prices. Yet in most time-inconsistency models, the monetary authorities can control prices instantly and perfectly! Absolute nonsense. Yet this model not only survives, but is highly influential. This is partly because it combines technical mathematical virtuosity with a fashionable cynicism about the motives and agendas of politicians."
expect, FOMC studies are geared towards the institutional nuances of the US Federal Reserve and US political system. I suggest that the notion of 'partisanship', despite its applicability to US studies is more difficult to apply to the case of the MPC. Firstly, the government plays a role in all appointments to the MPC, for both external and internal appointments. Even insiders appointed from within the Bank by the Governor must have the approval of the Chancellor of the Exchequer. Contrast this with the nature of the appointments procedure to the FOMC. All Federal Reserve Board Governors are appointed by the President. Contrastingly, Bank Presidents are chosen without political interference, and the President has all but no say in the matter. Secondly, many approaches used to test for 'partisanship' in FOMC studies cannot be applied here due to data limitations. The entire sample period falls within the incumbency of the British Labour Party. Appealing to the partisan theory is thus rendered less attractive when compared to, say, US studies where the monetary policy preferences of individual FOMC members are modelled as a function of the political affiliation of the individuals who appointed them. These studies typically cover periods which include different political administrations, Republican and Democrat. For example, Chappell et al (1993) conclude that

"...the power to make appointments provides an important channel of systematic partisan influence...Democratic appointees favour easier monetary policies than traditional Republicans do, and supply-side Republicans prefer even easier policies than Democrats do." (p.209)

Nevertheless, in spite of such differences, this does not preclude the author from undertaking a thorough and systematic analysis of dissent voting for the British case. Further, the analysis of dissent voting in this chapter extends Gerlach-Kristen (2002), who provides a descriptive breakdown of MPC voting behaviour.

6.3 Rationalising Dissent Amongst Insiders and Outsiders - Some Priors

The analysis in this section endeavours to rationalise, a priori, why rates of dissent amongst insiders might differ from those associated with outsiders. It predicts

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that the rate of dissent will be lower for insiders than outsiders. Previous chapters have evidenced large discrepancies in insider-outsider voting behaviour. Chapter 4 presented evidence suggesting that whereas insiders vote as a bloc, outsiders are less prone to do so. Chapter 5 went onto demonstrate that on average, insiders prefer systematically higher interest rates than outsiders for any given MPC meeting, a difference which was shown to be statistically significant. In justifying the prediction that insiders should dissent less frequently than outsiders, I appeal to the career incentives facing MPC members, the career backgrounds and experiences of MPC members, the appointments procedure, term lengths of MPC members and the information sets used by members to arrive at a decision. This list of reasons given here is by no means exhaustive, but I feel sufficient to capture the main determinants of dissent voting behaviour of BoEMPC members. Further, I suggest that for any individual member, voting behaviour may not necessarily be driven by any single factor in isolation, but by a combination thereof. To some degree, this builds on the more generalised framework of diverse interest rate preferences corresponding to (4.15) in Chapter 4.

6.3.1 Career Incentives

Whereas the career paths of internal appointees are linked to the bank, the same cannot be said for outsiders, whose future career paths may all be linked to a plethora of different organisations. Accordingly, insiders have an incentive to ‘get on’ with each other as they may have to work with each other long after they have finished serving on the MPC. For this reason, I propose that insiders face more pressure to vote as a group on the MPC than outsiders. This may explain the results shown in the appendix on measures of agreement in Chapter 4. Evidence that the career concerns of members of monetary policy committees can affect voting behaviour is well documented in Havrilesky and Schweitzer (1990). Cited therein are the comments of Lawrence Roos, President of the St. Louis Federal Reserve Bank and member of the FOMC, who maintains that:

“If one is a young, career oriented president who’s got a family to feed
he tends to be more moderate in his opposition to Governors.”

Havrilesky and Schweitzer (1990), p.3. Also cited is the opinion of Henry Wallich, a member of the Board of Governors:

“It is not a pleasant thing to have to keep dissenting... One dissents less often than you would think. After all you are a member of a group and you want to get along with the other members.”
Clearly, the suggestion here is that Governors exert a very real influence on the future career paths of Bank Presidents - Bank Presidents with aspirations of advancing their career further within the Federal Reserve System may feel under pressure not to vote against those individuals serving on the FOMC who may have a bearing on their future career. For this reason, Havrilesky and Schweitzer propose that there is a degree of disutility associated with dissenting.

Secondly, career progression within a central bank may be a function of behaving like a 'central banker'. Arguably insiders act in a way consistent with their perception of what being a central banker requires. As central bankers are associated with conservatism, this leads to them acting conservatively when setting monetary policy. In practice, this could lead to insiders preferring ceteris paribus

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6There is also the possibility that sequential voting - which is the practice enjoyed by the MPC - may lead to different outcomes than simultaneous voting. For example, the government itself aired views to the effect that it would all other the things being considered prefer MPC members to vote simultaneously and not sequentially.

"We remain to be convinced that the process of voting in the MPC is sufficiently robust. We recommend that the Governor and the MPC itself, gives further attention to the voting procedure and in particular to a system of simultaneous voting." (emphasis added by author) Response of the Government to the Report of the House of Lords Select Committee on the Monetary Policy Committee of the Bank of England (HL Paper 34, Session 2000-01)

This is not a moot point. In the presence of career concerns sequential voting may indeed have consequences for voting outcomes, as noted by Scharfstein and Stein (1990):

"...consider the case of a capital budgeting committee meeting, where the managers are supposed to vote in turn on an investment project. Ideally the point of having several managers vote is to gather a wide range of information. However, if career concerns are present, this may not work very well. Once the first manager has voted, the others may simply echo his choice, regardless of their private beliefs. Thus a false consensus is achieved, and the information of the other managers is wasted." Scharfstein and Stein (1990), pp. 477-478.

Although not fully explored here, the herding literature may offer a plausible explanation for the discrepancies in insider-outsider behaviour. Bank Insiders may simply 'follow the leader', so to speak.

7This is a view espoused in much of the theoretical literature on time-consistent monetary policy. Consider Rogoff (1986) who concludes that optimal monetary policy is delivered when central bankers are conservative, but not too conservative.

8The notion that people modify their behaviour in accordance with the roles or labels they are given is well established in the psychology literature. Consider Philip G. Zimbardo's well known prison experiments conducted at Stanford University in 1971. Here, participants quickly assumed the roles of 'guards' and 'prisoners'. Although the experiment was planned to last for two weeks, it was stopped after a mere six days. The 'guards' directed increasingly cruel behaviour towards the prisoners, who began to exhibit depressive tendencies and behaviour associated with extreme stress. We note here that university students were the subjects of the experiment.
higher interest rates than outsiders, support for which is found in Chapter 5. It may also imply that when insiders dissent, they would prefer to do so on the side of tightness: it basically signals their credentials as 'conservative' central bankers.

6.3.2 Career Backgrounds

The premise that career backgrounds and experiences have a role in explaining the voting behaviour of members of monetary policy committees is a theme which has been well explored in the FOMC literature. Yet in appealing to the career backgrounds of MPC members to explain their voting behaviour, one must be careful not to apply the same priors as those used to explain those of the FOMC. Consider the effect of working in government as a civil servant. In studies focusing on FOMC voting behaviour, it is assumed that experience in government will be positively related to a member's propensity to vote on the side of ease, as opposed to tightness, as in Havrilesky and Schweitzer (1990) and Gildea (1990). The more time spent working in government, the more one conforms to the government's in-build bias towards activist policy. Chappell et al (1993, 1995) find that where partisan behaviour does arise, it is to some extent attributable to the career backgrounds of FOMC members, concluding that

"...experience in government, particularly at the Federal Reserve Board, is associated with significantly stronger preferences for monetary ease..." 9

However, in the UK, civil servants have a long tradition of neutrality, so the effect of experience working in government on voting behaviour may be hard to call. Thus, unlike the literature on FOMC voting, it is hard to form priors regarding how members will vote. Indeed, reported estimates from the regression of career backgrounds, presented later, suggests that experience in government promotes dissent on the side of tightness, contrary to Chappell et al (1993, 1995).

As a further example, FOMC studies assume that a background in or training as an academic economist leads members to behave less hawkishly. This is supposed to reflect the fact that many economists serving on the FOMC received their training in the heyday of Keynesianism, where policy was characterised by demand-management, with less emphasis on supply-side measures. Academic economists are thus assumed to be sympathetic to output, and are ceteris paribus more likely

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to act to stimulate demand via reducing interest rates. It is certainly also true that the impact of Keynesianism was more pervasive in the UK than the US. One might therefore predict that economists with an academic background serving on the MPC are more likely to dissent on the side of monetary ease than tightness. Yet this rationale fails to reflect the enormous influence of the literature on time-consistent monetary policy on the economic community, in addition to for example, the impact of the Chicago school. It is worth recalling that Professor Alan Walters, who served as Chief Economic Adviser to Margaret Thatcher 1980-1984 and 1989, was an vocal proponent of supply side policies. More recently, Professor Patrick Minford, a well known UK British supply side economist was one of the so-called "six wise men" serving on HM Treasury's Panel of Forecasters. According to Seldon (1987), Minford was

"...formally deeply steeped in Keynesian macro-thinking, but has propounded a micro-founded Rational Expectations theory based on the idea that...economic expectations are based on the efficient use of available information." (p.12)

If anything, this demonstrates that even if one does receive a Keynesian style training, one's views may shift seismically over time.

In light of the preceding discussion on career incentives, however, I suggest that previous experience at the bank is most likely to promote dissent on the side of monetary ease. Other career backgrounds such as working in the private sector and experience in independent trans-national organisations may be ambiguous. In the case of private sector experience - if private sector experience is dominated by manufacturing it may promote dissent on the side of ease, whereas the banking sector may promote dissent on the side of tightness.

6.3.3 Appointments Procedure

The Chancellor has a potentially significant bearing on the direction of UK monetary policy. In addition to powers to set and change the inflation target at will, the power of appointment represents a further vehicle for influencing the direction of UK monetary policy. This is relevant in two respects. In the first case, this amounts to the last word on the appointment of and, if considered necessary, reappointment of the Governorship of the Bank of England. This is particularly significant if one considers that the Governor of the Bank also sits as Chairman of the Monetary Policy Committee and has the casting vote in split MPC decisions.
The second issue pertains to the appointment and selection procedures for MPC members on a more general level, and is a consideration which is not restricted to the Bank of England MPC. For instance, in the case of the ECB, Dornbusch et al (1998) is notable for highlighting the way in which the selection procedure, regional or political affiliations of members of the ECB Governing Council may influence monetary policy decisions at the ECB.

"[Firstly] the selection process that puts them in place may be systematically biased, so that they are 'hawks' or 'doves' chosen to be just that. Secondly, regional economic conditions may diverge significantly from the average of the monetary zone, and this may lead a particular board member to respond in a differential way."\(^{10}\)


"Members of the Board of Governors are appointed by the President and congress and the Senate. Bank presidents, on the other hand, are appointed by the directors of each Federal Reserve district bank and accepted by the Chairman. No elected representatives participate directly in the choice of the Bank presidents."

She later adds

"If the lack of Senate confirmation does not result in bank presidents who have policy preferences that are different from Board members, the issue [of how FOMC members are appointed] is moot...But a difference in policy preferences is evident from the record of dissenting votes."

Whilst BoEMPC members cannot be construed as providing regional representation,\(^{11}\) the shift to operational independence has not left the MPC immune to


\(^{11}\)See for example Buiter and Sibert (2002):

"The only criteria supposed by which potential MPC members in the UK are to be judged is professional competence and independence. They are not viewed as regional, industrial or sectoral delegates or representatives. Only the nationwide inflation objective and the nationwide subsidiary objectives are to be taken into account by the Chancellor in their appointment and by the MPC members themselves in their voting behaviour." (p.10)
political manipulation vis-à-vis the appointments procedure. As the power of appointment rests with the Chancellor, he may appoint ‘doves’ or ‘hawks’ to be just that.\textsuperscript{12} Indeed, the government plays an influential role in choosing all MPC members. The precise extent of its influence arguably varies in relation to the type of member being appointed. Whereas all outsiders are chosen \textit{directly} by the Chancellor, two of the internal appointees serving on the MPC are chosen by the Governor of the Bank of England \textit{after consultation with the Chancellor}. Cobham (2000) argues that the appointments procedure for MPC members is “opaque” and “incapable of securing public trust or market credibility”.\textsuperscript{13} He further attests that the decision in June 2000 to appoint Christopher Allsopp rather than renew the contract of Charles Goodhart

“...may have been designed to steer the MPC into keeping interest rates as low as possible for the next election.”\textsuperscript{14}

Evidence presented in the next section provides support for this conjecture - in practice, whereas Goodhart dissented only on the side of tightness (on 3 occasions), Allsopp dissented only on the side of ease (11 occasions), a case of a ‘hawk’ being replaced by a ‘dove’. The \textit{Evening Standard} spoke of Charles Goodhart being ‘forced to step down against his will’, duly noting that the Treasury was ‘standing by its appointment’,\textsuperscript{15} in spite of Allsopp’s rejection by the Commons Treasury Select Committee on the grounds of being ill-suited for the position. At the time, the debacle was reported as a dispute which

“...raises questions about Allsopp’s credibility...City economists were already speculating that he would initially be under pressure to vote with Bank chief Eddie George at the monthly meetings...Despite a close five-four vote against endorsing his nomination...all were of the view that he was unsuitable.”\textsuperscript{16}

The opaque nature of the appointments procedure is further captured in the following exchange between Andrew Tyrie MP, member of the Treasury select committee and Richard Lambert, who joined the MPC in May 2003:

\textsuperscript{12}It is also a consideration which has a bearing on the credibility of the delegation. The interested reader is referred to Sibert (2001) for a formal treatment of this issue.
\textsuperscript{13}Financial Times, 10th August 2000.
\textsuperscript{14}Ibid.
\textsuperscript{15}Evening Standard 24\textsuperscript{th} May 2000.
\textsuperscript{16}Ibid.
Andrew Tyrie: "...one thing has surprised me, which is that there was no formal interview process at all, as far as I can tell. If you were creating a system in order to appoint people to something like the MPC, do you think that it might be sensible to have some kind of formal interview where you sit in front of someone at least for 20 minutes or so, or a couple of people, and have an exchange of views?"

Richard Lambert: "I have not really thought through that. I do not really know the answer to that. My conversations, which were necessarily on the telephone, were lengthy."

Andrew Tyrie: "Did it not cross your mind to wonder whether a couple of calls to Japan was all there was to becoming a member of the MPC?"

The exchange continues:

Andrew Tyrie: "Do you know of any other very important and challenging job which is appointed over the phone on a long distance call?"

Richard Lambert: "I do not know enough about how government ministers are appointed or civil servants are appointed to be able to answer that question."

Andrew Tyrie: "You and I both know that permanent secretaries are interviewed before they take their post, that cabinet secretaries are given extensive interviews by the Prime Minister. You know that already."

Richard Lambert: "Yes"

Andrew Tyrie: "So that was a flippant reply from you."

Richard Lambert: "Forgive me; I apologise."\(^{17}\)

Given the opaqueness of the appointments procedure I therefore tentatively suggest that the appointment of outsiders is a potential vehicle for packing out a

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substantial portion of MPC with doves. It is arguably more difficult to appoint an opportunistic or dovish Governor given the intense public scrutiny surrounding associated with such a decision - the credibility of the Bank would suffer

6.3.4 Term Lengths

Both the Governor and the two Deputy Governors serving on the MPC are appointed for terms of five years. This is longer than the three year terms given to all other MPC members, and increases reduces a members independence from the Chancellor. This is a point which has been seized upon by economists and politicians alike. Michael Howard (2002), leader of the Conservative Party comments that

“One practical problem which has emerged is that the relatively short, three-year term for MPC members is often considered too short, while reappointment leads to relatively lengthy terms of office and also diminishes members’ independence from the Chancellor.” (emphasis added)

Under this interpretation, MPC members which have shorter tenures to serve should vote in more partisan fashion. Those members with a relatively longer term of office should exhibit more independence, and are less prone to lower interest rates before an election. In other words, it might be expected that members with shorter term lengths are more prone to exhibiting dovish tendencies. The fact that the two internal members are appointed with three year terms is tempered by the fact that they are chosen by the Governor of the Bank in consultation with the Chancellor. For this reason, it is plausible to suggest that outsiders, all of who serve three year terms, will exhibit more dovish tendencies than insiders - precisely what is seen in practice. Outsiders are the least independent of all MPC members.

6.3.5 Information Sets

Different BoEMPC members will invariably be both exposed to and receptive to different sources of information during their time on the MPC. Sushil Wadhwani (2002) is an example of an MPC member to openly express doubts about the efficacy of the suite of Bank of England models used in the forecast of inflation and GDP. These forecasts, which form the basis of the Bank’s Inflation Report, are purportedly integral to decisions on the interest-rate, and are supposed to
represent the collective judgement of the MPC. I suggest that Bank insiders may de facto have more faith than outsiders in the suite of in-house models used in the generation of the forecasts of inflation and GDP. Speaking in May 2002, Wadhwani, an outsider who served on the MPC between June 1999-May 2002 attested: “... the MPC has, in the past been criticised on account of its forecasting performance. I note that the actual outturn for inflation has always been lower than the MPC’s two-year ahead forecast, with an average error of up to around 0.5% ... to the extent that policy was held too tight because of a biased forecast, a challenge for the future is to ensure that any relevant lessons from the past ...”

Furthermore, and in light of the budget of April 17th 2002 given by Chancellor Brown, the Inflation Report itself comes in for criticism: “In my opinion, the central projection embodied in the May 2002 inflation report probably assumes a higher pass-through into prices than is likely, and too large a ‘balanced budget stimulus’ to demand growth next year.”

With respect to the MPC’s position on GDP growth, he later adds: “Over the past few years, the MPC has, had too gloomy a view about the level of potential output in the economy. Although some adjustments about this view have been made, I would regard the current view about the level of potential output as still being too pessimistic.”

If insiders - who have an in-built majority over outsiders - place their faith in a suite of in-house econometric models at the Bank of England which have a tendency to over-predict the level of future inflation [Wallis (2002)] this may predict a higher rate of dissent on the side of ease associated with outsiders. It may be the case that outsiders have more of a tendency to follow private sector, independent and consensus forecasts, such as the kind seen in [Panel 5.5 in Chapter 6]. For example, the twelve month consensus forecasts predict a level of future inflation which is systematically lower than the Bank’s 24 month horizon RPIX forecasts across the entire sample.

In the generation of the forecasts of inflation and GDP, speaking in May 2002, Wadhwani, an outsider who served on the MPC between June 1999-May 2002 may de facto have more faith than outsiders in the suite of in-house models used.
6.4 Dissenting Votes

6.4.1 Defining Dissent

The information provided in the *Minutes* identifies who the dissenting voters are at each meeting, and whether they dissented on the side of ease or tightness. This level of detail enables a meaningful analysis of dissent voting behaviour. Three types of dissent are identified: *dissent*, *dissent for tighter policy* and *dissent for looser policy*. There are important caveats to these classifications, which will become clear in the following definitions.

- **Dissent**: On this definition, a dissenting vote is defined as a vote against the interest-rate chosen by the majority of MPC members at each meeting. However, this 'broad' definition of dissent makes no distinction between dissenting for tighter or looser policy. The remaining two definitions, which fall into the broader category of *dissent* are thus defined accordingly:

- **Dissent for tighter policy**: This is defined as where a member reveals a preference for a higher short-term interest-rate relative to the actual decision on the short-term interest-rate taken by the MPC. On this definition a member may vote for no change or a decrease in the current interest-rate but still be classed as dissenting for tighter policy if the actual rate chosen by the MPC is greater than their preferred rate.

- **Dissent for looser policy**: Defined as where a member reveals a preference for a lower short-term interest-rate relative to the actual short-term interest-rate taken by them:

  "...the introduction of outside experts into a Committee process of forecasting is inevitably likely to generate some tension and disagreements." Goodhart (2001), p.62.

He raises the distinct possibility that:

"...the actual modal forecast at the heart of the Inflation Report was believed in - as the most likely outcome - by no one on the MPC; it was itself an average over Members...Take for example the assumption about the exchange rate, a key element in the forecast...some on the MPC thought the use of uncovered interest parity (UIP) provided the best analytical basis for considering the future of the exchange rate; others assumed that it was dominated in practical forecasting by assuming a random walk (i.e. a constant future exchange rate). With the two groups being roughly evenly balanced the compromise was to assume half-way between the two, which nobody believed! Truly a camel is a horse designed by a Committee." Ibid, p.63.
chosen by the MPC. On this definition a member may vote for no change or an increase in the current interest-rate but still be classed as dissenting for looser policy if the actual rate chosen by the MPC is less than their desired rate.

### 6.4.2 The MPC’s Dissent Voting Record

Tables 6.1-6.3 document the dissent voting behaviour of the MPC. Table 6.1 chronicles the voting record of insiders and outsiders on an individual and collective basis. The first column shows the total number of votes cast by MPC members. As one would expect, the figures for individual members vary according to the different length of appointments and the overlapping nature of members’ terms. Numbers in the last three columns pertain to the number of dissenting votes cast, and correspond to the three types of dissent defined above. Figures in round brackets (.) express the number of dissenting votes cast as a proportion of the total number of votes cast.

The pattern of dissenting votes is very different for insiders and outsiders. Outsiders dissented approximately 27% of the time, compared with around 8% for insiders. This disparity is reflected in the votes of individual members in both groups. Sir Edward George recorded no dissents - he was never on the losing side of a monetary policy decision during his time as Chairman of the MPC. Moreover, the largest proportion of dissenting votes cast by an insider is 18%, by John Vickers. This level of dissent is relatively low by outsiders’ standards. Just under one half of all of Buiter’s, and one third of the votes of De Anne Julius and Sushil Wadhwani were dissenting.

A further finding is that whereas the overwhelming majority of dissenting votes cast by insiders are on the side of tightness, for outsiders the overwhelming majority are on the side of monetary ease. Collectively, insiders voted to dissent on the side of ease just 1% of the time - the corresponding figure for outsiders is in the region of 20%. Mervyn King who dissented 16% of the time typifies the kind of dissent voting behaviour associated with insiders - all of his dissents were on

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22 Calculate this by dividing the number of votes cast in each dissenting category by the total number of votes cast in each row.

23 It is certainly possible for the Chairman to lose a vote, and there is no reason to suspect that this might not happen in the future.
### Table 6.1

**Dissenting Votes Cast by MPC Members by Frequency and Type**

<table>
<thead>
<tr>
<th></th>
<th>Insiders</th>
<th>Outsiders</th>
<th>All Members</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Votes Cast</td>
<td>Dissent</td>
<td>Dissent for Tighter Policy</td>
</tr>
<tr>
<td>Eddie George</td>
<td>74</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Howard Davies</td>
<td>2</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Charles Bean</td>
<td>34</td>
<td>1 (3%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>David Clementi</td>
<td>61</td>
<td>4 (7%)</td>
<td>3 (5%)</td>
</tr>
<tr>
<td>Paul Tucker</td>
<td>13</td>
<td>1 (8%)</td>
<td>1 (8%)</td>
</tr>
<tr>
<td>Ian Penderleith</td>
<td>61</td>
<td>5 (8%)</td>
<td>3 (5%)</td>
</tr>
<tr>
<td>Andrew Large</td>
<td>9</td>
<td>1 (11%)</td>
<td>1 (11%)</td>
</tr>
<tr>
<td>Mervyn King</td>
<td>74</td>
<td>12 (16%)</td>
<td>12 (16%)</td>
</tr>
<tr>
<td>John Vickers</td>
<td>28</td>
<td>5 (18%)</td>
<td>5 (18%)</td>
</tr>
<tr>
<td><strong>All Insiders</strong></td>
<td><strong>356</strong></td>
<td><strong>29 (8%)</strong></td>
<td><strong>25 (7%)</strong></td>
</tr>
<tr>
<td><strong>Excluding Governor</strong></td>
<td><strong>282</strong></td>
<td><strong>29 (10%)</strong></td>
<td><strong>25 (9%)</strong></td>
</tr>
<tr>
<td>Charles Goodhart</td>
<td>36</td>
<td>3 (8%)</td>
<td>3 (8%)</td>
</tr>
<tr>
<td>Kate Barker</td>
<td>26</td>
<td>3 (12%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Sir Alan Budd</td>
<td>18</td>
<td>4 (22%)</td>
<td>4 (22%)</td>
</tr>
<tr>
<td>Stephen Nickell</td>
<td>38</td>
<td>9 (24%)</td>
<td>3 (8%)</td>
</tr>
<tr>
<td>Marian Bell</td>
<td>12</td>
<td>3 (25%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Christopher Allsopp</td>
<td>37</td>
<td>11 (30%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>De Anne Julius</td>
<td>45</td>
<td>14 (31%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Sushil Wadhwani</td>
<td>37</td>
<td>13 (35%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Willem Buiter</td>
<td>36</td>
<td>17 (47%)</td>
<td>9 (25%)</td>
</tr>
<tr>
<td>Richard Lambert</td>
<td>1</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>All Outsiders</strong></td>
<td><strong>286</strong></td>
<td><strong>77 (27%)</strong></td>
<td><strong>19 (7%)</strong></td>
</tr>
</tbody>
</table>

*The number of votes cast by each member is identical to the total number of meetings attended by each member.*

*Dissent is equivalent to the sum of dissents for tighter policy plus dissents for looser policy. Numbers in round brackets () show the corresponding percentage of dissenting votes cast by each member/group. For example, in the case of Willem Buiter, the percentage of dissents is calculated by dividing the number of dissents by the total number of votes cast and multiplying by 100 (i.e. \((17/36)\times100 \approx 47\%)\). All percentages are rounded to the nearest integer.
the side of tightness.\textsuperscript{24} Contrastingly, outsiders like Christopher Allsopp, DeAnne Julius and Sushil Wadhwani cast all of their dissenting votes on the side of ease.

At this point, it is perhaps useful to compare BoEMPC and FOMC levels of dissent. Meade and Sheets (2002) report that over the period 1978-2000, only 198 out of 2403 votes cast by FOMC members were of the dissenting variety. This amounts to about 8\% of all votes cast. Contrast this with the voting behaviour of Bank of England Monetary Policy Committee members. For the first five years of the MPC, 106 out of 642 votes cast were dissenting in nature - over 16\% of votes cast. Crudely put, it would appear that MPC members are twice as likely to dissent than FOMC members.\textsuperscript{25}

TABLE 6.2 shows the percentage of dissenting votes for tighter (looser) policy as percentage of dissenting votes only. The percentages shown here differ from those given in round brackets in TABLE 6.1 in so far as values in the latter table are calculated as a percentage of all votes cast, irrespective of whether they are dissenting or not. The figures thus have a basis in conditional probabilities. For example, since the category 'Dissents for tighter (looser) policy as \% of all dissents' corresponds to the probability of dissenting on the side of tightness (looseness) \textit{given} a dissenting vote is cast.\textsuperscript{25} Some of the results must be treated with caution. Three insiders - two with a 100\% record for casting dissenting votes on the side of tightness (Paul Tucker and Andrew Large) and one with a 100\% record on the side

\textsuperscript{24}For this reason, Mervyn King earned himself a reputation as a 'hawk' in the first five years of the MPC. An interesting question is were all twelve of Mervyn King’s dissents on the side of ease, would he still have become the Governor of the Bank?

\textsuperscript{25}Comparison with other committees is also of interest. Nobuyuki Nakahara (2002), member of the Policy Board of the Bank of Japan, attributes differences in the dissent voting behaviour of members of the monetary policy committees of the Bank of England and Bank of Japan to individual accountability, attesting:

"I heard that Dr. DeAnne Julius, a former member of the Monetary Policy Committee of the Bank of England, said that when members are not individually accountable, they lose the incentive to make public their position at the voting stage even if they had voiced opposing views during the debate, and that it will become easier for the majority, which would include the most influential individual, to carry the vote. To avoid this situation, the parliament holds individual hearings. Although the connection is not clear, since April 1998, deputy governors, though they are chosen from the staff of the Bank of England, are known to have cast eleven minority votes on eight occasions. As for the Bank of Japan, it was revealed at a recent parliamentary session that there had never been a division of views of the governor and two deputy governors." (emphasis added)

\textsuperscript{25}In this sense, the percentages obtained for tighter and looser categories are formally expressed as \((\Pr(\text{Tighten}|\text{Dissent}) \times 100)\) and \((\Pr(\text{Loosen}|\text{Dissent}) \times 100)\) respectively.
of ease (Charles Bean) each only cast one dissenting vote. Nevertheless, even when bearing this in mind, results show that five out of the six insiders who cast dissenting votes all voted on the side of tightness the majority of the time, the exception being Charles Bean. Contrastingly, of the nine outsiders shown to have cast dissenting votes, six voted on the side of ease on the majority of occasions. Of these six members, five voted on the side of ease 100% of the time. Whereas the vast majority of dissenting votes cast by insiders are on the side of tightness (86%), the opposite is true for outsiders, for whom the overwhelming majority of dissenting votes are cast on the side of ease (75%).

Table 6.3 displays the results of paired t-tests confirming that the proportion of dissenting votes cast by insiders and outsiders on a meeting by meeting basis are significantly different. Tests were applied across both groups for each category of dissent voting. Section A.1 shows that although insiders dissent and dissent for looser policy significantly less often than outsiders, there is no significant difference in dissents for tighter policy between the two groups. Section B.1 compares each group's propensity to vote on the side of tightness or looseness. Clear-cut statistically significant differences arise between insiders and outsiders. Dissent for tighter policy is significantly higher for insiders than for outsiders. Further, dissent for looser policy is significantly higher for outsiders than for insiders. The lower part of the table omits the Governor from the sample. This is because the Governor frames the question on which a policy decision is based. The same qualitative conclusions hold as for when the Governor is included, although they are slightly less pronounced - the Governor has never dissented.

27 No outsiders fall into this category.
28 Namely David Clementi, Paul Tucker, Ian Plenderleith, Andrew Large, Mervyn King and John Vickers.
29 The six members are Kate Barker, Stephen Nickell, Marian Bell, Christopher Allsopp, De Anne Julius and Sushil Wadhwani. The remaining three individuals are Charles Goodhart, Sir Alan Budd and Willem Buiter.
30 In this respect, only Stephen Nickell does not have a 100% record on the side of looseness for the sample period under consideration.
31 All calculations were performed using STATA 8.
32 In Tables 6.1 and 6.2, estimates are calculated through pooling members votes - no attempt is made to distinguish between meetings when performing our calculations.
33 The rate of dissent for insiders is higher than for outsiders.
### Breakdown of Dissenting Votes

<table>
<thead>
<tr>
<th>Type of Dissenting Vote</th>
<th>Dissents for Tighter Policy as a Percentage (%) of Dissenting Votes</th>
<th>Dissents for Looser Policy as a Percentage (%) of Dissenting Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insiders</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eddie George</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Howard Davies</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Charles Bean</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>David Clementi</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Paul Tucker</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Ian Plenderleith</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Andrew Large</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Mervyn King</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>John Vickers</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>All Insiders*</td>
<td>86</td>
<td>14</td>
</tr>
<tr>
<td><strong>Outsiders</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charles Goodhart</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Kate Barker</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Sir Alan Budd</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Stephen Nickell</td>
<td>33</td>
<td>67</td>
</tr>
<tr>
<td>Marian Bell</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Christopher Allsopp</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>De Anne Julius</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Sushil Wadhwani</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Willem Buiter</td>
<td>53</td>
<td>47</td>
</tr>
<tr>
<td>Richard Lambert</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All Outsiders</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td><strong>All MPC Members</strong></td>
<td>42</td>
<td>58</td>
</tr>
</tbody>
</table>

*Unlike Table 6.1 it makes no sense to include a category which excludes the Governor from the sample, as he has never cast a dissenting vote. All percentages are rounded to the nearest integer. A zero appearing in both columns for any given member indicates no dissenting votes were cast. This only applies to Eddie George, Howard Davies and Richard Lambert. All other members dissented.

**Table 6.2.**

Dissents for Tighter and Looser Policy Expressed as a Percentage of Dissenting Votes
## Mean Percentage of Dissenting Votes including Governor

### Section A.1 - Insiders versus Outsiders

<table>
<thead>
<tr>
<th></th>
<th>Insiders</th>
<th>Outsiders</th>
<th>Significance level of Difference*</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Dissents</td>
<td>8.0</td>
<td>26.0</td>
<td>1%</td>
</tr>
<tr>
<td>Dissents for Tighter Policy</td>
<td>7.0</td>
<td>6.4</td>
<td>NS</td>
</tr>
<tr>
<td>Dissents for Looser Policy</td>
<td>1.1</td>
<td>19.6</td>
<td>1%</td>
</tr>
</tbody>
</table>

### Section B.1 - Tighter versus Looser Policy

<table>
<thead>
<tr>
<th></th>
<th>Tighter</th>
<th>Looser</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>All members</td>
<td>6.9</td>
<td>9.3</td>
<td></td>
</tr>
<tr>
<td>Insiders</td>
<td>7.0</td>
<td>1.1</td>
<td>1%</td>
</tr>
<tr>
<td>Outsiders</td>
<td>6.4</td>
<td>19.6</td>
<td>1%</td>
</tr>
</tbody>
</table>

## Mean Percentage of Dissenting Votes excluding Governor

### Section A.2 - Insiders versus Outsiders

<table>
<thead>
<tr>
<th></th>
<th>Insiders</th>
<th>Outsiders</th>
<th>Significance level of Difference*</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Dissents</td>
<td>10.1</td>
<td>26.0</td>
<td>1%</td>
</tr>
<tr>
<td>Dissents for Tighter Policy</td>
<td>8.8</td>
<td>6.4</td>
<td>NS</td>
</tr>
<tr>
<td>Dissents for Looser Policy</td>
<td>1.4</td>
<td>19.6</td>
<td>1%</td>
</tr>
</tbody>
</table>

### Section B.2 - Tighter versus Looser Policy

<table>
<thead>
<tr>
<th></th>
<th>Tighter</th>
<th>Looser</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>All members</td>
<td>7.8</td>
<td>10.5</td>
<td></td>
</tr>
<tr>
<td>Insiders</td>
<td>8.8</td>
<td>1.4</td>
<td>1%</td>
</tr>
<tr>
<td>Outsiders</td>
<td>6.4</td>
<td>19.6</td>
<td>1%</td>
</tr>
</tbody>
</table>

Notes: *Significant differences are indicated for 1 percent, 5 percent and 10 percent levels. NS indicates that the difference is not significant at the 10 percent level of significance. All percentages rounded to 1 decimal place.

**Table 6.3.**

Testing for significant differences in insider and outsider dissent voting behaviour using paired t-tests
6.5 Career Characteristics of MPC Members

I now turn to determining whether a members' career backgrounds have a bearing on dissent voting behaviour. Although some judgement calls have been made in the construction of career variables, I distinguish between the varied career experiences and backgrounds of MPC members34 using a broad range of categories. My system of classification covers only full time positions and secondments held by MPC members up to but not including time working on the MPC. The time spent on the MPC is embodied in a binary variable for a member's type, which is employed in the estimation procedure. Excluded from the criteria are all part-time positions, special advisory roles and academic consulting. Consequently, all time served on the MPC – which technically constitutes a full-time position working for the Bank of England – is purposely neglected. Career backgrounds are categorised according to years spent working in the following broadly defined areas:

- **Private Sector** - refers to positions held in banking or the service industries and also covers manufacturing industries.

- **NGO** - refers to non-governmental organizations. Specifically, this covers both national and international independent research organizations such as the National Institute of Social and Economic Research (NIESR) and the Organisation for Economic Cooperation and Development (OECD), and transnational institutions such as the International Monetary Fund (IMF), World Trade Organization (WTO) and Bank for International Settlements (BIS).

- **Government** - denotes years spent working in the civil service.

- **Academia** - refers to years working at a university in an academic capacity.

- **Bank** - denotes the number of years employed at the Bank of England.

Individual member experience is displayed in Table 6.4. Other than Howard Davies and DeAnne Julius, all MPC member have spent over half of their working lives within a single career category. No single member has experience in more than three career categories. Sir Edward George, Ian Plenderleith, and Charles

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34 Also see Goodhart and Meade (2002) for a breakdown of the career characteristics of MPC members. Note that the system of classification used in this chapter differs slightly. Further, Goodhart and Meade (2002) base their results on data available on the Bank of England website. This data was felt to be somewhat limited in nature, and where necessary, career data was obtained from other sources.
### MPC Member Career Histories Prior to Joining the MPC

<table>
<thead>
<tr>
<th>Insiders</th>
<th>Years at the Bank</th>
<th>Years in Academia</th>
<th>Years in the Private Sector</th>
<th>Years in Government</th>
<th>Years working in NGOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eddie George</td>
<td>29</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Howard Davies</td>
<td>3</td>
<td>0</td>
<td>8</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Mervyn King</td>
<td>7</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ian Plenderleith</td>
<td>32</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>David Clementi</td>
<td>0</td>
<td>0</td>
<td>22</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>John Vickers</td>
<td>0</td>
<td>17</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Charles Bean</td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Paul Tucker</td>
<td>12</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Andrew Large</td>
<td>0</td>
<td>0</td>
<td>28</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outsiders</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Willem Buiter</td>
<td>0</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Charles Goodhart</td>
<td>17</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>De Anne Julius</td>
<td>0</td>
<td>4</td>
<td>9</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Sir Alan Budd</td>
<td>0</td>
<td>22</td>
<td>4</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Sushil Wadhwani</td>
<td>0</td>
<td>8</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Stephen Nickell</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Christopher Allsopp</td>
<td>4</td>
<td>31</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Kate Barker</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Marian Bell</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Richard Lambert</td>
<td>0</td>
<td>0</td>
<td>26</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: MPC member CVs, various sources

*Note:* The table covers full-time positions only. Consultancy or advisory roles taken on a part-time basis are neglected.

**TABLE 6.4.**

CAREER BACKGROUNDS OF MPC MEMBERS
Goodhart have spent most of their lives at the Bank; contrastingly, Mervyn King, Charles Bean, John Vickers and Willem Buiter have spent most of their careers in academia. Table 6.5 builds on this analysis, and measures the percentage of insiders and outsiders to have worked in each category. A much greater percentage of insiders than outsiders have worked at the Bank of England (55.6% vs. 20%). The same applies to experience in Government as civil servants (44.4% vs. 40%), although the difference is less pronounced. Outsiders dominate in all other areas - by substantial margins in the case of Academia and NGOs, and by a less pronounced difference in the case of the Private sector.

Related to career backgrounds of MPC members is the suggestion that the level of expertise of MPC members has through successive appointments been 'diluted'. In June 2003, The Times aired precisely these concerns.

"...there is concern that the level of academic expertise on the MPC has been diluted by recent appointments. When the MPC was established, its members included academic heavyweights such as Sir Alan Budd, former Chief Economic Adviser to the Treasury, and Charles Goodhart of the London School of Economics. However, in recent years, the bias appears to have shifted to economists with a less academic focus. These include Kate Barker, former chief economist of the CBI, and Sir Andrew Large, former deputy chairman of Barclays and now a Bank of England Deputy Governor."\(^3\)

A typical governmental response to this type of criticism is found in the second report of the Lords Select Committee on the MPC (2001), which asserts that

"...it is economic expertise that would drive our choice of MPC member, it is the capabilities of the individual. The fact that we have someone who is an academic and whose principal subject has been the labour market [Stephen Nickell] must also be balanced by the fact that we also have someone who came straight from working with one of the biggest companies in our country and had a great deal of industrial policy expertise in that sector [De Anne Julius]. We choose the best people we can find with economic expertise\(^3\) (emphasis added)

\(^3\)The Times, June 16th 2003.
Unfortunately, the notion of economic expertise says nothing about the relative hawkishness or dovishness of an MPC member. It cannot generally be construed as a characteristic causing one to dissent more on the side of monetary ease than tightness. All one can say it that an MPC member with relatively less expertise than other members is prima face liable to make bigger mistakes than other members. However, to address whether the level of academic expertise has diminished, it is possible to turn to Panels 6.1 and 6.2 shown in the appendix to this chapter. These reflect how the career backgrounds of MPC members have changed over time, using the criteria established in previous sections. It shows the level of experience for the average MPC member at each meeting. It is readily seen that the average level of academic experience - which might be used to proxy academic expertise - has not dropped substantially over the first five years of the MPC. However, experience at the Bank of England - has dropped markedly, whilst Private Sector experience has risen. This is true for insiders and outsiders alike.

### 6.6 Estimation

To determine the effect of members’ career backgrounds on a propensity to dissent on the side of ease or tightness I estimate a regression of the form

\[ Z_j = \beta_0 + \beta_1 \text{Type} + \beta_2 \text{Private sector} + \beta_3 \text{Government} + \beta_4 \text{NGO} + \beta_5 \text{Academia} + \beta_6 \text{Bank} + u_j \]  

(6.1)
where $Z_i = 1$ denotes a dissenting vote on the side of tightness and $Z_i = 0$ is a dissenting vote on the side of ease. In particular, denote

$$Z = 0 \text{ if } i_{h,t} < i_{maj,t}^*$$

and

$$Z = 1 \text{ if } i_{h,t} > i_{maj,t}^*$$

where $i_{h,t}$ is member $h$'s ideal interest-rate as reflected in their vote in meeting $t$ and $i_{maj,t}^*$ is the interest-rate chosen by the winning majority of MPC members at a given meeting. Type is a binary variable where a 1 is assigned if a member is an insider and a zero if an outsider. Estimations are performed in EViews 4.1 and results are shown in Table 6.6. $p$ values are given in round (.) brackets. Results suggest that experience at the Bank of England and Academia have no impact on dissent voting behaviour - this is clear from the high $p$-values associated with their coefficients. All other variables have a statistically significant effect on voting behaviour. Exerting by far the largest impact is the binary variable Type. A positive value indicates that insiders are more likely to dissent on the side of tightness. This result is in line with the findings reported in Tables 6.1-6.3. Experience in the Private Sector and NGOs promote dissent on the side of monetary ease, whilst the coefficient on government indicates that time spent in the civil service promotes dissents on the side of tightness. All of these

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38 This excludes all votes in cast agreement with the winning majority of MPC members for any given meeting. This occurs in instances where $i_{h,t} = i_{maj,t}^*$. Given the limited number of observations, the econometric specification has been kept simple. In doing so, my purpose is to gain a broad feel for nature of the relationship between career backgrounds, a member’s type and their decision to vote on the side of tightness or ease. It is noteworthy that whilst I have controlled for a member’s type using an intercept dummy, interaction dummies have not been applied. This was imposed for two reasons. The first relates to the small sample size. It was felt that adding interaction terms this would use up significant degrees of freedom, resulting in a less than parsimonious specification. Secondly, I have assumed that the marginal effects of a given career background on a member’s propensity to vote on the side of tightness or ease should a priori be the same. Marginal effects are not reported due to the negligible size of the parameters on career variables when compared to the coefficient for the type dummy.

It has also been brought to my attention that the data sample may suffer from clustering. This arises when observations are no longer independent, and implies that the sample joint distribution function is no longer the product of the distribution functions for each observation. Consequently, this results in a log-likelihood which is not true for the sample. In the context of my data-set, clustering might be thought to occur if some members dissent significantly more often than others. For example, consider the frequency of dissent voting behaviour associated with Willem Buiter, as compared to Charles Goodhart. The former dissented far more frequently than the latter. Due to the limited sample size, I do not adjust for cluster effects. For an informative discussion of the issue, the interested reader is referred to Wooldridge (2003).
variables are significant at the 5% level. Coefficients for these variables are all similar in magnitude, although the effect of a members type exerts by far the largest influence on the decision to dissent on the side of ease or tightness. The rise in private sector experience in PANELS 6.1 and 6.2 coincides with a gradual decrease in interest rates, and is also seen lead to promote dissenting on the side of ease in the career characteristics regression. The increase in average Private Sector experience seems to be at the expense of experience at the Bank.

6.7 Conclusions

At the outset of this chapter, I set out to explain the type and frequency of dissenting votes cast by insiders and outsiders. To rationalise a priori why any discrepancies between the two groups might arise, I appealed to career incentives, career backgrounds, the appointments procedure, term lengths and the information sets of MPC members. I predicted that (i) outsider would dissent significantly more often than insiders and (ii) whereas insiders would dissent overwhelmingly on the side of monetary tightness, outsiders would dissent on the side of monetary ease. In all cases, arguments were backed up by a rich array of evidence ranging from the past experiences of FOMC members to spoken evidence given by BoEMPC members at Treasury select committee hearings.

I proposed that insiders have more of an incentive to agree with each other because as members of the same organisation, they are more likely to have to work with each other in the future - disagreeing too much with one's peers may be detrimental to future career advancement. Insiders may also have more of an incentive to act like 'conservative' central bankers. This implies that if insiders choose to dissent, it will most likely be on the side on monetary tightness. In
terms of appointments and term lengths, outsiders have least independence from the Chancellor: they are both (i) directly appointed by the Chancellor and (ii) serve the shortest term lengths. If one is seeking reappointment, then voting for lower, as opposed to higher interest rates may secure a second term. It is important to note that even though the Governor of the Bank is appointed by the Government, his independence is somewhat reinforced through serving a longer term length. Further, given the opaque nature of the appointments procedure, it is also possible that an outsider may be appointed precisely because he or she is a dove. It is arguably more difficult to appoint an opportunistic or dovish Governor given the intense public scrutiny and attention surrounding the decision in the news media and financial markets. Turning to information sets, outsiders are more likely to dissent on the side of monetary ease in as far as they pay less attention than insiders to the Bank's suite of in-house forecasting models which (i) tend to over-predict inflation and (i) have too pessimistic a view about the level of potential output. This may also promote dissents on the side of monetary tightness by insiders.

The predictions listed above were fully supported by the evidence. In practice, outsiders dissented significantly more often than insiders. Secondly, whereas insiders dissent overwhelmingly on the side of monetary tightness, the reverse was found to be true for outsiders. These differences were found to be statistically significantly. I also presented evidence suggesting that the level of 'expertise' on the MPC was not diluted over time, using the mean number of years working in a university in an academic capacity as a measure. In short, the academic focus on the MPC remains high.

In the final section I tested for the impact of career backgrounds on members propensity to dissent on the side of ease or tightness using binary logit analysis. This is an approach which is commonly applied in studies of FOMC member voting. It was found that for the case of the BoEMPC, evidence to support the notion that career backgrounds impact on the propensity to dissent is weak. A problem I encountered was predicting a priori the effects specific career backgrounds exert on dissent voting - particularly with respect to experience in government and academia. It is not immediately obvious why experience in the Private Sector and NGOs promotes dissent on the side of monetary ease, whilst time spent in the civil service promotes dissents on the side of tightness. Nevertheless, the effects of these variables are clearly marginal compared to the effects for the dummy variable
capturing a member's type. It may be the case that the sample size is too small - it is somewhat truncated in that it uses only dissenting votes, and votes cast in agreement with the majority are ignored.

The results of the analyses presented here have ramifications for the future conduct of UK monetary policy. I have evidenced clear asymmetries in both the levels and type of dissent associated with insiders and outsiders. Monetary policy is delegated to committees for a number of reasons. Many of the arguments are founded on the benefits of heterogeneity - MPCs are assumed to reach better decisions because members pool information and exchange different views. If career concerns are present, such informational pooling and exchange of views might not take place. Some members may effectively be scared of speaking out. In the context of the BoEMPC, one solution to this problem would be to reduce the number of insiders sitting on the committee. Whilst this may increase the level of dissent, it is possible that it may increase the quality of the decision.
6.A Appendix to Chapter 6

6.A.1 Average Career Experiences of All MPC Members, Insiders and Outsiders per Meeting

The following two panels plot the average career experiences of MPC Members over time. PANEL 6.1 focuses on the MPC as a whole, and is based on all MPC members, insiders and outsiders inclusive. The upper and lower graphs in PANEL 6.2 (overleaf) show average career experiences for insiders and outsiders separately.

![Average career experiences of MPC members per meeting, Jun 97 - Jun 03](image)

**PANEL 6.1.**
AVERAGE MPC MEMBER CAREER EXPERIENCES PER MEETING

212
6.A.1. Average Career Experiences of All MPC Members, Insiders and Outsiders per Meeting (continued)

Average career experiences of insiders per MPC meeting, Jun 97 - Jun 03

Average career experiences of outsiders per MPC meeting, Jun 97 - Jun 03

Panel 6.2.
Average MPC member career experiences per meeting by type
Part V

Concluding Remarks and Bibliography
Chapter 7

Concluding Remarks

This thesis has endeavoured to examine aspects of the formulation of monetary policy by committee, and has adopted various approaches in pursuit of this objective. Techniques from game theory and boundedly-rational models of agency have been applied, in addition to the use of empirical and econometric analyses of MPC member voting behaviour.

The literature review revealed several important facets of modern monetary policy making. It was determined that monetary policy seldom falls under the aegis of a single central banker, and recent studies of monetary policy frameworks reveal that MPCs enjoy near ubiquity as vehicles for setting the short-term interest rate. Yet despite their relative abundance, it was also found that MPCs across the world vary considerably with respect to their size, member composition, method of reaching a decision and voting rights. Even then, it is crucial to appreciate that MPCs invariably make policy within a wider context of fulfilling particular policy objectives, which may differ from country to country. For example, consider policy formulation by the United States FOMC - Section 2.A of the Federal Reserve Act stipulates the objectives of monetary policy to be the achievement of economic growth in line with the economy's potential to expand, a high level of employment, stable prices and moderate long-term interest rates. No single objective is assumed to take precedence over any other. This is in contrast to the remit for the Bank of England MPC, which stipulates the pursuit of price stability in the form of an inflation target as a primary objective of UK monetary policy. All other considerations are secondary.

By way of a first conclusion, I suggest that the behaviour of members of a monetary policy committee may differ as the result of the different incentives facing
them. In Chapter 3, it was argued that free-riding is a feature of monetary policy committees. The model demonstrated that when information acquisition is costly, some MPC members are incentivised to free-ride on the signals of other members. It was found that in terms of policy outcomes, smaller, not larger MPCs are more likely to make the correct policy decisions. In terms of policy recommendations, it was suggested that MPCs such as the ECB Governing Council should undergo a significant reduction in size. Further, measures should be taken to lessen the propensity of MPC members to free-ride, such as making members individually accountable to an external body.

The role of incentives was found to be a key determinant of behaviour in Chapter 4, where a model was developed to account for how members of a monetary policy committee are able to reach a consensus, even when members share initially diverse policy preferences. It was assumed for instance, that when career concerns are present, some members are prone to heavily weight the opinions of individuals who are perceived to have a bearing on their future career path. Evidence was presented which showed that in the case of the US FOMC, some Bank Presidents faced considerable pressure to vote with Board members. There were clear incentives to listen to some members, but not others. It was also suggested that the internal culture of an MPC was important - for instance, the more an MPC places a value on reaching a consensus, the more likely its members are to listen to the views of other members or any individual member, such as the Chairman. This, it was argued, could account for the differences in dissent voting on the FOMC and the Bank of England Monetary Policy Committee, where it was found that BoEMPC members are twice as likely to dissent as their counterparts on the FOMC.

As a second main conclusion, I suggest that the precise composition of a committee - in terms of who the members are, who appointed them and their career backgrounds - have a bearing on voting behaviour and ultimately policy outcomes. Evidence of this is found in Chapters 4, 5 and 6, where it is shown

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1This is one of a number of factors examined in Part III, where the focus is on the voting behaviour of the Bank of England Monetary Policy Committee.

2In particular, the section of the literature review entitled Evidence Based Literature examined a corpus of studies of FOMC member voting behaviour which shed light on the relationship between the dissent voting behaviour of FOMC members and their type. It may be that the incentives facing Federal Reserve Bank Presidents members when they vote may differ from those affecting Board members, duly noting that whereas the President of the United States directly appoints all Board members, the said individual has no influence in the appointment of
that on the Bank of England Monetary Policy Committee, outsiders act very differently to insiders. Compared to outsiders, insiders prefer systematically higher interest rates, are more likely vote as a cohesive homogeneous group, and dissent significantly less frequently. The fact that both groups behave very differently in itself warrants further research. Further, as was concluded in Chapter 4, MPCs should be populated by individuals who are likely to listen to the views of others. This would ensures that the deliberation process is not marked by considerable disagreements and that compromise can be reached.

At this point, it is perhaps worth reflecting on the comments of Lawrence Meyer (2001) who suggests the behaviour of members on the many monetary policy committees around the world may indeed differ as the result of, amongst other things, the different incentives facing them:

"Assume that the ECB Governing Council or the Bank of England’s Monetary Policy Committee replaced the Federal Open Market Committee and made monetary policy in the United States – or vice versa. How would policy outcomes and, in turn, macroeconomic policy be affected? To what extent does the process followed in making monetary policy shape the details and effectiveness of the outcomes? Does the nature of the governance and decision process matter? For example, does it matter whether there are outsiders as well as insiders on the [monetary policy] committee; whether there is individual or collective responsibility for the decisions of the committee; and whether the committee is made up only of centralized members or also includes regional representatives?"

The findings of this thesis go some way in addressing these issues, with many of the answers to these questions being in the affirmative. Policy outcomes are seemingly affected by the structure, composition, and decision making process of an MPC. The decision making framework certainly has a bearing on policy outcomes. It seems to matter whether there are outsiders as well as insiders on the committee. With reference to the UK experience, it is arguable that were the MPC comprised of more outsiders, interest rates would have been systematically lower, and the overall rate of dissent would be higher. In addition to this, the extent to which individual and collective responsibility is a feature of an MPC has a bearing on policy outcomes, especially if one considers that MPCs can be either autocratically-collegial, genuinely-collegial or individualistic. One ultimately Federal Reserve Bank Presidents.
concludes therefore that in spite of the ubiquitous nature of MPCs, their structure, and the corresponding behaviour of their members may vary substantially from one country to the next. This necessarily has ramifications for the conduct of monetary policy, a fact which is borne out by both the theory and evidence presented in this thesis.

Future directions for research include more empirical studies of monetary policy frameworks, with particular emphasis on understanding how internal MPC culture differs from one central bank to the next. There is also significant scope for more econometric analysis - the Bank of England Monetary Policy Committee and the United States FOMC are not alone in publishing the votes of its members. For example, the Policy Board of the Bank of Japan has been doing so since its inception in 1998. Undertaking cross-country comparisons of MPC voting behaviour would therefore potentially represent a fruitful avenue of research. In terms of theory development, there is great scope for advancement. An interesting line of investigation would be to consider what the optimal composition of an MPC should be. Should it, for example, consist solely of insiders, or outsiders too? Further, what are the benefits of publishing the voting record? This is already considered by Sibert (2003), but is also linked to the issue of transparency. Recently there has been a trend for central banks to be more transparent. This makes it possible that in the future more voting records will be published, analysis of which can only enhance our understanding of monetary policy formulation by committee.
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