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Too Many Cooks?
Committees in Monetary Policy*

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Abstract
How many people should decide about monetary policy? In this paper, we take an empirical perspective on this issue, analyzing the relationship between the number of monetary policy decision-makers and monetary policy outcomes. Using a new data set that characterizes central bank monetary policy committees (MPCs) in more than 30 countries from 1960 through 2006, we find a U-shaped relationship between MPC size and inflation; our results suggest that the lowest level of inflation is reached at MPCs with intermediate size of about five to nine members. Similar results are obtained for inflation variability. Other MPC characteristics also matter for monetary policy outcomes, though to a smaller degree. For instance, the membership composition of the MPC as well as the frequency of MPC membership turnover appear to affect economic variables.

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1. Introduction

The number of people who decide about monetary policy varies considerably across countries. At one extreme, decisions are made by a single person; examples where the governor alone is responsible for monetary policy include the Bank of Israel and the Reserve Bank of New Zealand. At the other extreme, central banks operate large monetary policy committees (MPCs) that comprise more than a dozen members.[1] A prominent example is the Governing Council of the European Central Bank which currently consists of 22 voting members. Similarly, in the U.S. Federal Open Market Committee, 19 members are participating in policy discussions, out of which 12 hold voting rights. Fry, Julius, Mahadeva, Roger, and Sterne (2000) report that 8 (of 82 surveyed) central banks have monetary policy boards with more than 10 members.

The number of monetary policy decision-makers, while generally persistent, also changes over time. In Brazil, for instance, the central bank reform of the late 1980s effectively reduced MPC size from a maximum of 26 members to 9 members. In the U.K., in contrast, the 1997 reform act took monetary policy decisions out of the hands of the governor and into the hands of a nine member MPC. In Germany, the Bundesbank MPC had initially 10 members, which changed to 18 members in the late 1950s and was cut back again, after German reunification, to 17 members in 1992.[2]

With MPCs varying across countries and time, a growing literature aims to quantify their optimal membership size as an important feature of central bank design. While there is a broad consensus that committees make better decisions than individuals, there is much less agreement on how large a committee should be.[3] It is frequently argued that the marginal benefits of MPC size become smaller, and the marginal costs of decision-making become larger, as MPC size increases. The magnitude of these offsetting forces, however, is likely to depend on a variety of factors, possibly including various national characteristics. As a result,

[1] We use the term MPC in the broadest possible sense, describing the board, council, or committee (etc.) making actual monetary policy decisions.
[2] The Bundesbank reform of 1992 prevented a significant increase in the number of voting governors in its Central Bank Council ('Zentralbankrat') due to German unification. Before the reform, each federal state had a representative in the Council, and without reform, membership would have exceeded 22 – a number that, according to the Bundesbank, "would have greatly complicated that body's decision-making processes" (Deutsche Bundesbank 1992, p. 50).
[3] For surveys of the literature, see, among others, Gerling, Grüner, Kiel, and Schulte (2005), Fujiki (2005), Sibert (2006), Vandenbussche (2006), Berger (2006), and Maier (2007).

Goodfriend (2005, p. 85) argues that the "efficient size of a policy committee might vary across countries".

In this paper, we take an empirical perspective on this issue. More specifically, we examine to what extent the economic outcomes of monetary policy are possibly associated with the number of monetary policy decision-makers. To that end, we have compiled a new data set of the de jure and de facto membership size of MPCs, creating an unbalanced panel that covers, on a yearly basis, more than 30 countries from 1960 through 2006. In addition, since our measure of de facto membership size is derived from the names, positions, and membership dates of individual MPC members, we were able to compute other measures of MPC membership such as the annual turnover rate of MPC membership. Finally, we gathered information on whether the MPC comprises industry representatives, regional delegates, or government representatives. In our empirical analysis, we use all these measures to examine the effects of MPC design on inflation (and other economic outcomes), after controlling for economic and institutional factors.

To preview our main results, we find a U-shaped relationship between MPC size and inflation. More precisely, inflation tends to fall as the number of MPC members increases from low levels, but this effect becomes smaller and eventually even changes sign at high levels of MPCs membership. Taken at face value, our estimates imply that inflation reaches a minimum at medium-sized MPCs with about five to nine members, holding constant all other factors. Similar results are obtained for inflation variability. In addition, there is evidence that other features of MPC design, such as membership turnover rates and the membership composition of MPCs, also shape economic outcomes. Finally, we find that MPC size affects the effectiveness of monetary targeting regimes, as defined by Fatas, Mihov, and Rose (2007).

The remainder of the paper is organized as follows. In Section 2, we provide a brief review of the relevant literature. Section 3 describes our empirical methodology and the data. The heart of our paper is Section 4 which presents the empirical results. Section 5 provides a short conclusion.

2. Related Literature

A sizable literature deals with the merits of smaller or larger MPCs from an applied theoretical and institutional perspective. Blinder (1998) and Gerlach-Kristen (2006), for example, argue that, when it comes to the efficiency of monetary policy making, 'bigger may be better' because a more numerous MPC will process information on the state of the economy more effectively than an individual; in a group, information is pooled, there may be even cooperation in information processing, and extreme decisions are likely to be avoided.[4] Blinder and Morgan (2005) and Lombardelli, Proudman, and Talbot (2005) provide supporting evidence based on experimental research.

The gains from larger MPCs, however, may not be linear, and, more importantly, they may come at a cost. For instance, the large literature on decision-making in groups surveyed in Sibert (2006) suggests that the advantages in information processing are likely to diminish as MPC size increases because members may have an incentive to 'free-ride' on the efforts of others; see also Mukhopadhaya (2003). Berger (2002, 2006) argues that in larger committees members will spend considerably more time 'sounding each other out' bilaterally before or during meetings so that decision-making costs are growing (possibly exponentially) in MPC membership.[5] In summary, however, the weight of these arguments will, at least to some degree, also depend on the traditions of decision-making prevailing in a particular MPC.[6]

Another set of papers takes a more empirical approach on the design of MPCs. Berger, Nitsch, and Lybek (2008) analyze differences in the size of MPCs in a cross-section sample of

[4] See also the discussion in Blinder (1998), Berk and Bierut (2004), and Riboni and Ruge-Murcia (2006). The argument that large decision-making groups can aggregate decentralized information more efficiently than small ones can be traced back to Condorcet's jury theorem.

[5] The governor of the Bank of England, Mervyn King (UK House of Commons, 2007, p. 29), has recently defended the membership size of nine members in the MPC of the Bank of England by arguing: "I do think that more than nine would run the risk of making the process much less effective because a conversation among the nine is a key part of it and to have many more people would run the risk, as I think happens in somewhat larger councils that set policy, that some people have more say than others; there may be inner deliberations that take place because a very large body is simply too big to have a sensible discussion."

[6] Decision-making traditions are often 'soft' in nature and, while an interesting subject of study, do not as readily lend themselves to measurement and quantitative analysis as does MPC size. While MPC statutes regularly detail voting rules, their interpretation and enforcement tends to vary across countries and time. For instance, members of the ECB's Governing Council often stress that monetary policy decisions are taken by consensus despite the fact that its statutes foresee decisions based on specific majority voting rules. Of course, such traditions or interpretations of decision making rules can also change over time. Another hard-to-measure and time variant characteristic of MPC decision making is the amount of leadership provided by the MPC chairperson. Some of these and related issues are discussed in greater detail in, among others, von Hagen and Brückner (2001), Gersbach and Pachl (2004), Gerlach-Kristen (2006), and Blinder and Morgan (2007). For a recent review of issues in MPC design, see Blinder (2007).

84 countries. Examining a large number of possible determinants of MPC size, they find that larger and more heterogeneous countries, countries with stronger democratic institutions, countries with floating exchange rate regimes, and independent central banks with more staff tend to have larger MPCs; see also Erhart and Vasquez-Paz (2007).[7] Erhart, Lehment, and Vasquez-Paz (2007) examine differences in the volatility of inflation for MPCs with more or less than five members. Based on cross-country evidence for 75 countries, they argue that inflation volatility is higher in (the small subset of) countries with MPC sizes below five.[8]

More broadly, our paper is also close in spirit to the large literature that has empirically examined the effects of institutional features of central banking on monetary policy and policy outcomes. Some of these papers focus on features of central bank design. Examples include Cukierman, Webb, and Neyapti (1992), Campillo and Miron (1997) and de Haan and Kooi (2000) on central bank independence, Fatas, Mihov, and Rose (2007) on monetary policy transparency, and Göhlmann and Vaubel (2007) on the personal background of central bankers. Other papers analyze the role of monetary policy strategies such as inflation targeting or exchange rate regime choice; see, for instance, Mishkin and Schmidt-Hebbel (2007) and Levy-Yeyati and Sturzenegger (2001, 2003).

Finally, there are close parallels to recent work in corporate finance on the effects of board size (and other board characteristics) on corporate performance. In an early empirical contribution, Yermack (1996) finds an inverse relationship between firm market value and the size of the board of directors for a sample of large U.S. industrial corporations; Eisenberg, Sundgren, and Wells (1998) provide complementary evidence for small Finnish firms. Most recently, de Andres and Vallelado (2008) have examined board characteristics and firm performance in the banking industry. They find an inverted U-shaped relationship between the number of board directors and the firm market-to-book value ratio. Hermalin and Weisbach (2003) provide an excellent survey of issues discussed in this literature.

[7] These findings are essentially positive in nature. To give them normative content, one must assume that observed MPC sizes are the outcome of optimal central bank design decisions and argue that larger and more heterogeneous currency areas should indeed have larger MPCs. Erhart and Vasquez-Paz (2007) provide an interesting attempt in that direction.

[8] In their sample, eight out of 75 countries have MPCs with less than five members. Most of these countries are small in size.

3. Methodology and Data

Our main goal is to explore the link between the membership size of a central bank's monetary policy decision-making body and monetary policy outcomes, in particular the level of inflation. Price stability or low inflation is often the most prominent target of central bank policy around the world; see Fry, Julius, Mahadeva, Roger, and Sterne (2000) for a survey. As a result, our empirical analysis has the potential to inform the debate on the optimal size of MPCs, thereby adding to insights derived from theoretical and experimental research.

Our empirical approach follows previous work that examines the effect of central bank characteristics on inflation; examples include Fatas, Mihov, and Rose (2007) and Acemoglu, Johnson, Querubin, and Robinson (2008). More specifically, we estimate equations of the form:

$$\Pi_{c,t+1} = \alpha + \beta_1 \text{MPCsize}_{c,t} + \beta_2 \text{MPCsize}^2_{c,t} + \Sigma_i \gamma_i X_{c,t} + \delta_c + \omega_t + \varepsilon_{c,t}, \quad (1)$$

where $\Pi_{c,t+1}$ denotes the inflation rate of country c at time t+1, MPCsize is the membership size of the central bank's monetary policy committee, X is a set of other features that may (potentially) affect inflation, and δ_c and ω_t stand for a full set of country and time fixed effects, respectively. To account for any serial correlation in the disturbance $\varepsilon_{c,t}$, standard errors are corrected for clustering at the country level.[9]

The use of the inflation rate as dependent variable raises a number of potential issues. Lower inflation is not always the preferred monetary policy outcome (e.g., in a deflationary environment). Also, inflation targets may differ both across countries and over time such that higher inflation does not necessarily indicate weaker central bank performance. However, these issues tend to be of minor relevance for our sample, and we perform a number of sensitivity checks to establish the robustness of our results.

The relevant data are obtained from various sources. At the heart of our data set is a new (unbalanced) panel that covers the identities of MPC members for 33 central banks from 1960 to 2006. The countries are listed in Appendix 1. The data set is constructed in a three-step

[9] Central bank institutions emerge as the outcome of a decision process and, thus, may be correlated with time-varying characteristics of countries that also influence inflation (e.g., the degree of inflation aversion of governments). Consequently, we are cautious in interpreting the results.

procedure. First, we identify the central bank's monetary policy decision-making body, the MPC. This information is typically available from the central bank law but, where necessary, we cross-checked the information with central bank officials. In most cases, the committee that runs a central bank's day-to-day operations also takes de jure responsibilities for monetary policy decision-making.[10] Second, we extract all relevant information describing the MPC from the central bank law. Features that are frequently defined in the law include the membership size and the composition of the decision-making body, the frequency of meetings, voting rules and majorities, and specific requirements on individual members (e.g., nationality, educational background). For instance, apart from de jure MPC size, we compile information on the number of voting and non-voting members and the presence of industry, regional, or government representatives in the committee. Finally, using a variety of sources such as annual reports and other forms of central bank communication, we identify individual MPC members and their positions. Since we have, based on this data, information on the entry and exit dates of individuals, we also construct measures of de facto MPC size and MPC membership turnover (as well as a more conventional measure of central bank governor turnover).

Other institutional and economic data used in the empirical analysis are obtained from standard sources. Our main dependent variable, inflation, is taken from the International Monetary Fund's International Financial Statistics. In the empirical implementation, we transform the raw inflation data (defined as the annual percentage change in the consumer price index) into normalized inflation, $\Pi_{c,t} = \text{Inflation}_{c,t} / (1 + \text{Inflation}_{c,t})$.[11] Other sources include the Penn World Table and the World Bank's World Development Indicators. For data on central bank design, we turn to Acemoglu, Johnson, Querubin, and Robinson (2008) for information on central bank independence and rely on Fatas, Mihov, and Rose (2007) for data on the presence of de jure monetary policy targets and whether a particular target was met in practice. A data appendix provides a detailed list of the variables used in the empirical analysis and a description of the sources.

[10] We ignore any informal or semi-official arrangements in the preparation of monetary policy decisions (e.g., when the governor or the board holds consultations before taking decisions) mostly because this type of arrangements may be easily changed on an ad hoc basis and is, in the end, very hard to document.

[11] This transformation helps to minimize the effects of outliers (i.e., countries that experienced extremely high rates of inflation); see Acemoglu, Johnson, Querubin and Robinson (2008) for a recent application. Temple (1998) highlights the role of extreme and influential observations in this literature.

4. Empirical Results

4.1 Descriptive Statistics

We begin by describing our data on MPC membership size in more detail. Figure 1 portrays the evolution of de facto MPC size over time. The figure graphs the average membership size for the full sample and, since the number of central banks with available MPC data varies across years, also for different groups of countries for which we have membership size data covering similar periods. The averages are based on the full membership size of committees (i.e., including non-voting MPC members) since, on a practical level, all MPC members are likely to contribute to MPC decisions. However, all of our empirical results are robust to using only voting members.

There are a number of notable observations. First, average MPC size is fairly persistent. While there are some short-term fluctuations due to temporary vacancies or minor adjustments in MPC design, there are very few radical changes in average committee size; the number of monetary policy decision-makers in central bank committees consistently averages between six and eight members since the late 1950s. A notable exception is Brazil where the size (and composition) of the monetary policy committee has fluctuated widely. In total, our sample includes 32 records of changes in central bank law that affected MPC size; the median absolute value of committee size adjustment is three members.[12]

Second, to the extent that there is variation over time, it appears that MPCs are converging in membership size. While the countries in Figure 1 are grouped according to data availability (and, thus, more or less randomly), it is interesting to note that the group of countries with initially small MPCs (labeled '5 countries') experienced on average an increase in membership size; this group of countries includes the Bank of England which has newly established an MPC in 1997. In contrast, groups with relatively large MPCs have tended to reduce membership size.

Third, the average MPC size of central banks in European countries that later joined the euro area (labeled as '9 countries' in Figure 1) appears to have been, on average,

[12] For some central banks, our data set covers more than one change in membership size (e.g., Brazil). In total, approximately one half of the central banksin our sample (15 out of 33) experienced a de jure change in MPC size.

disproportionately large. Especially in small open economies such as Austria, Belgium, Ireland and Portugal, the decision-making bodies were relatively large, often comprising more than 10 members.

These findings are, interestingly, in contrast to observations reported in Blinder (2004). Blinder (2004, p. 3) notes that "[i]n the real world, there has been a clear trend in the way central banks organize themselves to conduct monetary policy: One-man rule used to be the norm […], but today most central banks make decisions by committee". In our sample, however, one-person MPCs are the exception rather than the rule. Part of the explanation for this discrepancy in perceptions may be Blinder's focus on actual decision-making, where central banks have been dominated, at times, by autocratic governors, even though de jure committees have been in place; that is, influential chairpersons may have created the impression of a de facto 'one-man rule'. There is also a difference in samples. Blinder (2004) refers to a study of 34 (mainly industrial country) central banks by J.P. Morgan, while our sample covers a broader range of countries, both geographically and economically.[13] Still another possibility is that Blinder's observation refers to a different time period (e.g., before our sample begins).[14]

Figure 2 contains a scatter plot of the raw data we focus on. The figure presents some indicative evidence that MPC size and (normalized) inflation are related in a non-linear fashion. While hardly conclusive in the absence of additional controls, inflation seems to be higher at very low and very high MPC sizes, suggesting that moderate levels of inflation are most frequently found when the number of monetary policy decision-makers is not extreme. It is an open issue, however, whether this finding will stand up to a more rigorous statistical analysis.

4.2 Regression Analysis

To take full account of the panel nature of our data, we estimate variants of the augmented inflation model in equation (1). Instead of emphasizing the results from a particular model formulation, we explore a wide range of estimation methods and regression specifications. Benchmark estimation results are reported in Table 1.

[13] However, one-person MPCs are equally rare across all country groups in our sample.
[14] We thank one of our referees for making this point.

The impact of MPC size on inflation

The work most closely related to ours is that of Fatas, Mihov, and Rose (2007) who study the effects of another element of central bank design on inflation, quantitative goals for monetary policy.Since their basic framework also appears to be well suited for our purposes, we begin our empirical analysis by estimating a specification of equation (1) that is similar to their approach. Specifically, we estimate a model that takes account of factors that (potentially) shape the inflation experience in individual economies and include a comprehensive set of year fixed effects capturing any common components in the variation in inflation over time (such as oil price shocks). Following Fatas, Mihov, and Rose (2007), we include controls for economic variables that have often been found to affect inflation: trade openness, the fiscal balance, the state of the business cycle, per capita income and market size; see Campillo and Miron (1997) for earlier empirical evidence.In addition, we incorporate various measures of other central bank characteristics. Acemoglu, Johnson, Querubin, and Robinson (2008) have recently reexamined the relevance of central bank independence for inflation; we include their binary measure of central bank independence, which is expected to have a negative impact on inflation. We also add Fatas, Mihov, and Rose's (2007) controls for the presence of a de jure quantitative target and the central bank's success in meeting this target, again expecting a negative influence on inflation.[15] Our main focus, however, is on the effect of MPC size on inflation.

We start with an examination of the linkage between MPC membership size and inflation in simple linear fashion. The first column of Table 1 tabulates the results. The equation fits the data relatively well, with an R^2 of 0.40. Also, the (γ) coefficients for the auxiliary covariates of inflation are often statistically significant and take the anticipated sign. For instance, richer countries and economies more open to international trade tend to have lower inflation. Also, central bank independence and the presence of quantitative targets in monetary policy appear to reduce inflation. The estimated (β) coefficient on the de jure number of voting members in a central bank's MPC, in contrast, is indistinguishable from zero at conventional measures of statistical significance.

[15] Another central bank feature that may be relevant, but for which panel data is unfortunately unavailable, is transparency. As Blinder (2004) notes, there is a (quadratic) relationship between MPC size and transparency, while there exists a quite extensive empirical literature confirming a (linear) relationship between transparency and inflation; see van der Cruijsen and Eijffinger (2010) for a recent review.

To allow for possible nonlinearities, we next add a quadratic term of MPC size to our specification. As shown in column 2 of Table 1, this extension significantly improves the empirical fit of the regression. Most notably, the coefficients on the linear and quadratic measures of MPC size become highly statistically significant and take opposite signs, describing a U-shaped relationship between MPC size and inflation; that is, the positive effect of enlarging the number of monetary policy decision-makers on inflation dies off and eventually becomes negative as committee size increases. Taken at face value, the point estimates indicate that moving from an individual decision-maker to a decision-making body with seven to ten members is associated with a decline in inflation by about eight percentage points (at the sample mean inflation rate of 8 percent), an effect that is reversed when membership size approaches fifteen members. Indeed, committees that consist of seventeen or more members appear to be associated with higher inflation than for an individual central banker. The optimal committee size that minimizes inflation, holding other factors constant, is nine members. We also report the result of a formal test for the presence of a U shape, confirming our finding of a non-monotone relationship between MPC size and inflation; see Lind and Mehlum (2010) for details.

The main shortcoming of our estimation approach with a large set of control variables is that sample size is reduced substantially when these additional controls are included in the regression. In fact, a sizable fraction (about one-half) of our MPC size data remains unexplored, mainly due to the limited availability of other central bank data (especially along the time dimension). As an alternative, therefore, we reestimate our benchmark regressions using the most parsimonious specification of equation (1) in terms of data requirements. The model includes, in addition to our variable of interest, only a comprehensive set of binary dummy variables to control for any country-specific and year-specific effects on inflation (that is, all the γ's in (1) are set to be zero). Another advantage of the approach, similar in style to Acemoglu, Johnson, Querubin, and Robinson (2008), is robustness. By controlling for all time-invariant country characteristics that may affect a country's inflation rate in addition to any global trend in inflation, this estimator effectively limits any potential omitted variables bias. Its disadvantage is that the fixed effects prevent any cross-sectional or common time variation in MPC size to influence the inflation outcome in the estimation, thereby limiting the MPC size effect on inflation (as measured by β_1 and β_2) to time-variation at the country level. That is, the approach effectively focuses on the subset of central banks where membership size changed over time.

So how do the estimation results change when we apply panel fixed effects estimation? The last two columns (on the right) of Table 1 report the results. Encouragingly, the coefficient estimates strongly confirm our finding that the effect of MPC size on inflation is nonlinear and exhibits a U-shaped pattern. The coefficients in the quadratic specification again have the right sign and are both jointly and individually significant, as is the result of the formal U test. The focus on within-country estimates slightly lowers the MPC coefficients estimates, implying a somewhat smaller optimal number of monetary policy decision-makers as measured by their impact on inflation of five. Overall, however, the finding of a U-shaped relationship between central bank committee size and inflation outcome is remarkably consistent.

Figure 3 illustrates the relationship for the two quadratic regressions in Table 1 graphically. Since our estimates of optimal committee size are somewhat sensitive to the exact method of estimation, we do not aim to interpret our results too literally. Conceptually, the OLS model appears to be the more attractive benchmark for evaluating the inflation impact of MPC size: it allows the cross-sectional variation in MPC size to influence the inflation outcome and controls explicitly for various other inflation determinants. The fixed effects model, in contrast, may provide the more robust result, holding constant all observed and unobserved country specifics. In sum, we argue, based on our estimation results, that the optimal MPC is of medium size which excludes very small groups (with less than five members) and very large committees (with more than nine members). Interestingly, in practice, a majority of central bank MPCs appears to fall into this size range (Fry, Julius, Mahadeva, Roger, and Sterne 2000).

We have performed extensive checks to test the robustness of our findings. Table 2 investigates the sensitivity of our results to changes in the specification and the estimation technique. In a first exercise, we aim to control for persistence in inflation. Inflation is a highly serially correlated variable, which may have affected our estimates. Following Acemoglu, Johnson, Querubin, and Robinson (2008), we try to capture this persistence by including five lags of inflation as additional regressors. Columns 1 to 3 contain the results. As shown, for this specification, the estimated (short-run) coefficients generally keep their signs, but fall in magnitude. The nonlinear association between MPC size and inflation deteriorates to a marginal level of significance in the simple OLS framework (first column), but remains

intact in the fixed effects regression (second column). A possible reason is that the impact of smaller changes in MPC membership is dominated by short-run inflation dynamics. To further explore this idea, we also report OLS estimation results for a regression specification that focuses more explicitly on the time-series dimension. When we analyze a smaller subsample of countries whose central bank MPC has changed membership size, the effect of MPC size on inflation is again non-monotonic and significant (column 3).

Another potential problem is that our key variable of interest, MPC size, may be correlated with the error term. If this is the case, our estimators produce inconsistent results. A standard approach to deal with this endogeneity issue is the use of the Arellano-Bond generalized methods of moments (GMM) estimation method. This procedure transforms the variables into first differences (thereby eliminating the fixed effects) and then uses lagged variables to instrument for the differenced terms.[16] Columns 4 to 6 of Table 2 report GMM results analogous to the models estimated in the first three columns of the table, using the same samples and specifications. The results strongly confirm our benchmark findings: the estimated coefficients on the linear and quadratic term of MPC size take opposite signs and are always jointly and (with one exception) individually significant, with estimates of optimal board size being at the lower end of our size range of five to nine members. Also, the test statistics confirm the validity of our model. In sum, we conclude that there is consistent evidence of a nonlinear, U-shaped effect of MPC size on inflation.

The impact of MPC size on inflation variability

In another extension, we look at an alternative dependent variable. More specifically, we replace the (normalized) level of inflation with inflation variability. As Fry, Julius, Mahadeva, Roger, and Sterne (2000) report, stabilizing inflation around a given target is the focus of many inflation-targeting central banks; it is also close to the indicators of monetary policy success in standard micro-based models of monetary policy (e.g., Woodford 2003).

Table 3 presents the results. As shown, the impact of MPC size on the variability of inflation mirrors its impact on the level of inflation: the estimated coefficients on membership size indicate a strong U-shaped relationship between MPC size and inflation variability,

[16] For a recent application of GMM estimation in the board size literature, see, for instance, de Andres and Vallelado (2008).

irrespective of the exact regression specification. Overall, our key finding of a nonlinear association between MPC size and the monetary policy outcome seems reasonably robust.

The role of other MPC characteristics

In Table 4, we vary our key variable of interest. Our default measure of MPC size is the number of MPC members as specified (de jure) in the central bank law.[17] Now we substitute this indicator with measures of de facto MPC size. More specifically, we distinguish between the total number of MPC members (i.e., the number of MPC positions actually filled in a given year) and the number of voting members in the MPC. As before, we tabulate the results for the two benchmark specifications of interest; results for other estimation specifications are qualitatively identical.

Reviewing the coefficients, the point estimates appear to be somewhat smaller in magnitude and statistically slightly weaker than for de jure membership size. However, this finding is perhaps not too surprising, given that our size measure now also captures all minor fluctuations in MPC size (e.g., due to temporary vacancies) which are unlikely to have an immediate measurable effect on inflation. Generally, it is reassuring to note that our benchmark results are strongly confirmed. The number of monetary policy decision-makers has a strong and significant nonlinear effect on inflation. The optimal MPC size ranges between three and eight members, broadly in line with our earlier results.

Moving beyond membership size, we also analyze the effect of other measures that characterize a central bank's decision-making body on inflation. Many central bank laws specify not only the number of committee members but also the composition of the decision-making body. A frequent restriction, for example, is the presence of one or more government representatives in the MPC. Other central bank laws require the presence of regional or industry representatives (such as, for instance, a delegate from the national banking association). To examine the impact of these restrictions on inflation, we add a separate dummy variable for the de jure presence of each category of representatives. Columns 1 to 4 of Table 5 show the results of this specification for our default OLS framework; country fixed effects estimation appears to be inappropriate in this setting, given that there has been very little change in this feature over time. While we find no significant effect for the presence of

[17] When a range is given, we use the mid-point.

government or industry delegates in the committee, our empirical findings suggest that central banks with required regional representation in the MPC tend to achieve, on average, lower inflation. A plausible explanation is that regional representatives indeed bring relevant information to the MPC. The non-significance of the variable indicating the presence of government agents in the monetary policy committee is equally remarkable. The conventional wisdom often interprets membership of government representatives in the decision-making body of a central bank as an indicator of a government-dominated and therefore more inflation-prone monetary regime (see, for instance, Berger, de Haan, and Eijffinger 2001). Our estimation results provide no empirical support for this hypothesis.

We also explore measures that capture the extent of (de facto) membership turnover in the MPC. The number of central bank governor changes in a given period is frequently used as a proxy for (lack of) central bank independence and often found to be positively associated with inflation. Here, we also examine the effects of the frequency of changes in (non-governor) membership in the MPC on inflation.[18]

The four columns on the right of Table 5 contain the results. We begin by reporting estimates from the country fixed effects specification which is, in our view, a very strong test since the approach automatically controls for the average number of membership changes in a country over the sample period; the two columns on the extreme right tabulate the analogues from the OLS specification without fixed effects.[19] The estimated coefficients on the MPC membership turnover variable are consistently positive, which appears reasonable and is broadly in line with the literature on governor turnovers: greater turnover among central bank decision-makers is typically associated with higher rates of inflation. Not surprisingly, the coefficients increase in magnitude for the OLS specification, but only the estimate on membership turnover becomes statistically significant at any conventional level of confidence. Our finding of a nonlinear association between MPC size and inflation is unchallenged by this extension as is the estimated size range of the optimal number of monetary policy decision-makers.

[18] To the best of our knowledge, this is the first attempt to evaluate the relevance of MPC membership turnover for economic outcomes. The literature on central bank turnover after Cukierman (1992) has focused exclusively on governors; see, for instance, Sturm and de Haan (2001) and Dreher, de Haan, and Sturm (2007). In our sample, the correlation between governor turnover and membership turnover is positive, but not excessively strong; the correlation coefficient is 0.54.

[19] The OLS regressions include the full set of auxiliary control variables but, to save space, only the coefficients of interest are reported.

Finally, Table 6 examines the possible interaction between the size of a central bank committee and quantitative targets in monetary policy. Fatas, Mihov, and Rose (2007) argue that both having established and meeting a quantitative goal for monetary policy is robustly associated with lower inflation. We explore whether MPC size possibly affects the effectiveness of the link between policy targets and economic outcomes; that is, we examine whether the effects of having and hitting a quantitative target differ for MPCs of different membership sizes.

To investigate this question, we distinguish between large and small MPCs. More specifically, we define a dummy variable that takes the value of one if a given MPC has more than fifteen members and, thus, is clearly 'too large' by the standards of our previous results. This dummy variable is then interacted with the variables signaling the presence of a monetary target and whether the target is hit.

The first column of Table 6 shows the estimation results for the presence of a quantitative goal for monetary policy. The model set-up is similar to our benchmark OLS regression with control variables as reported in the last column of Table 1, except that we add a further control for disproportionately large MPCs and an interaction term. We find that having a quantitative target helps reducing inflation, thereby confirming our previous results. Our estimates also indicate, not surprisingly, that central banks with extremely large MPCs face higher rates of inflation, though the coefficient is not significantly different from zero.[20] Finally, turning to our variable of interest, the estimated coefficient on the interaction term is negative and, with a p-value of 0.15, just misses borderline significance. Therefore, a cautious interpretation would suggest that having a transparent target for monetary policy appears particularly beneficial when the MPC is too large; the effectiveness of having a quantitative goal in reducing inflation is greater for large committees, perhaps working as a device to combine different views.

Column 2 presents analogous estimates for hitting the declared target. Similar to our benchmark findings reported earlier in Table 1, the inflation impact of this feature is much less pronounced, though the coefficient on the interaction term again takes a negative sign. When we include both interaction terms jointly (column 3), our previous results remain

[20] Not surprisingly, the inclusion of this additional control weakens the impact of the (other) MPC size variables.

unaffected. In sum, there is clear evidence that the membership size of a central bank's MPC affects inflation both directly and indirectly.

5. Conclusion

There is a growing interest in central bank design and especially the optimal size of the central bank's monetary policy decision-making body. Empirically, the membership size of Monetary Policy Committees (MPCs) differs considerably across countries and, to a lower extent, also varies over time. However, while there is a broad consensus that groups make better decisions than individuals, there is little agreement on how large the MPC should be. Previous research suggests that the net benefits of MPC size are decreasing as more members are added, mainly because decision-making costs and externalities in information processing gain in importance. Since the precise magnitude of these forces, however, depends on a variety of factors, the efficient size of a MPC is likely to vary across countries.

This paper adds to the debate from an empirical perspective, exploring the association between MPC size and the economic outcomes of monetary policy. To analyze this issue, we compiled a new data set that characterizes MPCs in over thirty countries from 1960 through 2006. Our data set contains information on the de jure and de facto membership size, the turnover in membership and the membership composition of a central bank's MPC. We then use all these measures to examine the effects of MPC design on economic outcomes, after controlling for other economic and institutional factors.

In our empirical analysis, we find a U-shaped relationship between MPC size (both de jure and de facto) and inflation. Our estimates suggest that the optimal MPC is of medium size, between five and nine members, and that very small or very large groups lead to higher-than-necessary rates of inflation. Qualitatively similar results are obtained for inflation variability. Other MPC characteristics also matter for the monetary policy outcome, though to a smaller degree. For instance, inflation is lower in the presence of regional representatives in the MPC, there is some evidence that inflation increases in MPC membership turnover and that MPC size and the effectiveness of monetary policy targets in reducing inflation are interlinked. Overall, our results strongly confirm that the institutional setup and, in particular, the size of a MPC are important features of central bank design.

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Table 1: Baseline results

Dependent variable	Lead of normalized inflation			
De Jure Membership	0.0027 (0.0045)	-0.0298** (0.0077)	0.0151 (0.0101)	-0.0119** (0.0042)
De Jure Membership Squared		0.0017** (0.0004)		0.0013** (0.0002)
Openness (% GDP)	-0.0003# (0.0002)	-0.0004* (0.0002)		
Budget Balance (% GDP)	-0.0013 (0.0036)	0.0011 (0.0030)		
Business Cycle (Growth–Avg Growth)	-0.0019 (0.0020)	-0.0021 (0.0014)		
Log Real GDP per capita	-0.1039* (0.0433)	-0.1190** (0.0404)		
Log Real GDP	-0.0110 (0.0124)	-0.0260* (0.0096)		
Central Bank Independence	-0.0392* (0.0162)	-0.0474 (0.0310)		
De Jure Quant. Monetary Target	-0.0804# (0.0441)	-0.0940** (0.0281)		
Quant. Monetary Success	-0.0262 (0.0216)	0.0002 (0.0162)		
Country Fixed Effects?	No	No	Yes	Yes
p-value, membership and membership squared = 0		[0.003]		[0.000]
p-value, U test		[0.001]		[0.013]
Optimal Membership Size		9		5
Observations	671	671	1,276	1,276
Adj. R-squared	0.40	0.57	0.62	0.66

Notes: OLS estimation with year fixed effects. Robust standard errors, adjusted for clustering by country, are in parentheses. **, * and # denote significant at the 1, 5 and 10 percent level, respectively.

Table 2: Specification sensitivity

Dependent variable	Lead of normalized inflation					
Estimation method	OLS with five lags of inflation			Arellano-Bond GMM		
	Full Sample	Full Sample	Countries with change in m'ship	Full Sample	Full Sample	Countries with change in m'ship
De Jure Membership	-0.0079 (0.0048)	-0.0063** (0.0022)	-0.0110** (0.0028)	-0.0041** (0.0015)	-0.0036** (0.0007)	-0.0028 (0.0017)
De Jure Membership Squared	0.0005 (0.0003)	0.0007** (0.0002)	0.0009** (0.0002)	0.0004** (0.0000)	0.0004** (0.0001)	0.0004** (0.0001)
Openness (% GDP)	-0.0001 (0.0001)		-0.0001# (0.0000)	0.0001 (0.0002)		-0.0002** (0.0001)
Budget Balance (% GDP)	-0.0006 (0.0015)		-0.0005 (0.0010)	-0.0008 (0.0006)		-0.0003 (0.0006)
Business Cycle (Growth–Avg Gwth)	0.0008 (0.0012)		0.0006 (0.0019)	0.0016* (0.0007)		0.0021* (0.0010)
Log Real GDP per capita	-0.0240 (0.0180)		-0.0557# (0.0259)	0.1082* (0.0466)		-0.0138 (0.0488)
Log Real GDP	-0.0091# (0.0046)		-0.0070* (0.0027)	-0.0733* (0.0372)		0.0237 (0.0428)
Central Bank Independence	-0.0091 (0.0088)		-0.0239 (0.0144)	0.0030 (0.0043)		0.0096 (0.0081)
De Jure Quant. Monetary Target	-0.0215 (0.0167)		-0.0188 (0.0143)	-0.0127 (0.0136)		0.0003 (0.0132)
Quant. Monetary Success	-0.0075 (0.0069)		-0.0011 (0.0139)	0.0012 (0.0071)		-0.0025 (0.0095)
Country Fixed Effects?	No	Yes	No	No	No	No
p-value, membership and membership squared = 0	[0.239]	[0.002]	[0.008]	[0.000]	[0.000]	[0.116]
p-value, U test	[0.071]	[0.012]	[0.003]	[0.010]	[0.000]	[0.239]
Optimal Membership Size	8	4	6	5	5	3
Observations	665	1,141	326	641	1,114	314
Adj. R-squared	0.82	0.82	0.86			
Sargan Test				[0.11]	[0.00]	[0.38]
Second-Order Serial Correlation				[0.27]	[0.02]	[0.57]

Notes: The estimation method is noted in the second line. Robust standard errors are in parentheses; standard errors are adjusted for clustering by country in the OLS fixed effects estimation. **, * and # denote significant at the 1, 5 and 10 percent level, respectively. The GMM (Arellano-Bond) estimation uses all available lags of inflation as instruments.

Table 3: Other dependent variable

Dependent variable	Inflation variability	
De Jure Membership	-28.9002* (10.4200)	-27.6114** (9.0660)
De Jure Membership Squared	1.7543* (0.6297)	2.0843** (0.4698)
Openness (% GDP)	-0.1611 (0.1266)	
Budget Balance (% GDP)	2.7702# (1.4855)	
Business Cycle (Growth–Avg Grth)	-0.5574 (1.0684)	
Log Real GDP per capita	-43.1282* (20.1217)	
Log Real GDP	-18.0420# (9.6164)	
Central Bank Independence	-9.6623 (21.5393)	
De Jure Quant. Monetary Target	-46.2451* (17.5139)	
Quant. Monetary Success	15.2392 (13.4742)	
Country Fixed Effects?	No	Yes
p-value, membership and membership squared = 0	[0.035]	[0.000]
p-value, U test	[0.006]	[0.004]
Optimal Membership Size	8	7
Observations	676	1,194
Adj. R-squared	0.58	0.79

Notes: OLS estimation with year fixed effects. Robust standard errors, adjusted for clustering by country, are in parentheses. **, * and # denote significant at the 1, 5 and 10 percent level, respectively.

Table 4: Other measures of MPC size

Dependent variable	**Lead of normalized inflation**			
De Facto Membership	-0.0243* (0.0103)	-0.0074 (0.0079)		
De Facto Membership Squared	0.0015* (0.0005)	0.0011** (0.0002)		
De Facto Voting Membership			-0.0194* (0.0080)	-0.0097* (0.0041)
De Facto Voting Membership Squared			0.0014** (0.0004)	0.0012** (0.0001)
Openness (% GDP)	-0.0005# (0.0003)		-0.0005 (0.0003)	
Budget Balance (% GDP)	-0.0001 (0.0027)		-0.0001 (0.0029)	
Business Cycle (Growth–Avg Grth)	-0.0034# (0.0020)		-0.0032 (0.0019)	
Log Real GDP per capita	-0.1322** (0.0365)		-0.1205** (0.0352)	
Log Real GDP	-0.0284* (0.0111)		-0.0194# (0.0111)	
Central Bank Independence	-0.0277 (0.0225)		-0.0481* (0.0215)	
De Jure Quant. Monetary Target	-0.1103** (0.0380)		-0.0964* (0.0411)	
Quant. Monetary Success	-0.0168 (0.0220)		-0.0325 (0.0231)	
Country Fixed Effects?	No	Yes	No	Yes
p-value, membership and membership squared = 0	[0.020]	[0.000]	[0.005]	[0.000]
p-value, U test	[0.015]	[0.248]	[0.015]	[0.038]
Optimal Membership Size	8	3	7	4
Observations	691	1,299	691	1,300
Adj. R-squared	0.50	0.65	0.51	0.65

Notes: OLS estimation with year fixed effects. Robust standard errors, adjusted for clustering by country, are in parentheses. **, * and # denote significant at the 1, 5 and 10 percent level, respectively.

Table 5: Other MPC characteristics

Dependent variable	**Lead of normalized inflation**							
De Jure Membership	-0.0277** (0.0062)	-0.0280** (0.0057)	-0.0278** (0.0065)	-0.0280** (0.0055)	-0.0302** (0.0067)	-0.0299** (0.0076)	-0.0122** (0.0042)	-0.0120** (0.0043)
De Jure Membership Squared	0.0016** (0.0003)	0.0017** (0.0003)	0.0016** (0.0004)	0.0018** (0.0003)	0.0016** (0.0004)	0.0017** (0.0004)	0.0012** (0.0002)	0.0013** (0.0002)
Government Representatives	0.0047 (0.0097)			0.0002 (0.0080)				
Regional Representatives		-0.0223* (0.0085)		-0.0252** (0.0080)				
Industry Representatives			0.0008 (0.0042)	-0.0027 (0.0030)				
Turnover Rate Membership					0.0127* (0.0046)		0.0046 (0.0036)	
Turnover Rate Governor						0.0342 (0.0232)		0.0105 (0.0118)
Other Controls?	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Country Fixed Effects?	No	No	No	No	No	No	Yes	Yes
p-value, membership and membership squared = 0	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]
p-value, U test	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.011]	[0.013]
Optimal Membership Size	8	8	9	8	9	9	5	5
Observations	634	634	634	634	669	669	1,251	1,251
Adj. R-squared	0.60	0.62	0.60	0.62	0.60	0.58	0.67	0.66

Notes: OLS estimation with year fixed effects. Robust standard errors, adjusted for clustering by country, are in parentheses. **, * and # denote significant at the 1, 5 and 10 percent level, respectively.

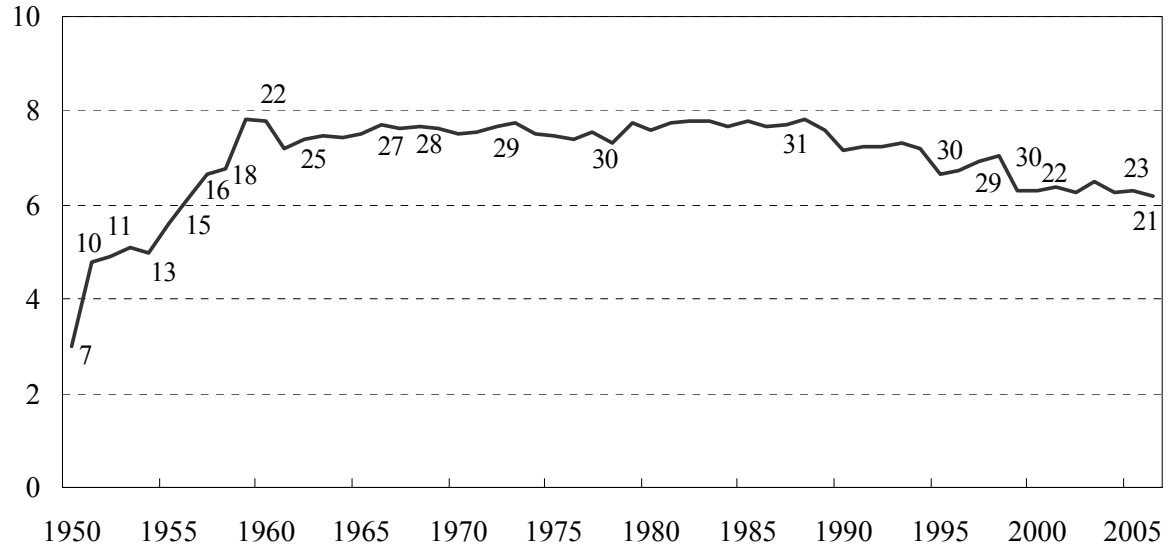
Table 6: MPC membership size and quantitative targets

Dependent variable	Lead of normalized inflation		
De Jure Membership	-0.0181* (0.0082)	-0.0244** (0.0071)	-0.0177* (0.0080)
De Jure Membership Squared	0.0008 (0.0005)	0.0012* (0.0004)	0.0008 (0.0005)
Dummy for Large Committees (>15 Members)	0.3079 (0.2132)	0.1683 (0.1475)	0.3268 (0.2089)
De Jure Quant. Monetary Target	-0.0605* (0.0256)	-0.0998** (0.0285)	-0.0659* (0.0272)
De Jure Quant. Monetary Target × Large Committee	-0.2766 (0.1870)		-0.2458 (0.1733)
Quant. Monetary Success	-0.0121 (0.0126)	0.0138 (0.0179)	-0.0059 (0.0116)
Quant. Monetary Success × Large Committee		-0.1612 (0.1170)	-0.0633 (0.0408)
Openness (% GDP)	-0.0003* (0.0001)	-0.0003* (0.0001)	-0.0003* (0.0001)
Budget Balance (% GDP)	-0.0010 (0.0022)	0.0001 (0.0027)	-0.0012 (0.0023)
Business Cycle (Growth –Avg Growth)	-0.0014 (0.0012)	-0.0021 (0.0014)	-0.0015 (0.0012)
Log Real GDP per capita	-0.1055* (0.0391)	-0.1200** (0.0372)	-0.1063* (0.0389)
Log Real GDP	-0.0248* (0.0099)	-0.0317* (0.0119)	-0.0269* (0.0113)
Central Bank Independence	-0.0296 (0.0292)	-0.0356 (0.0318)	-0.0270 (0.0299)
Country Fixed Effects?	No	No	No
p-value, membership and membership squared = 0	[0.049]	[0.007]	[0.051]
p-value, large committee, policy measure and interaction = 0	[0.041]	[0.554]	[0.049]
Observations	671	671	671
Adj. R-squared	0.62	0.59	0.63

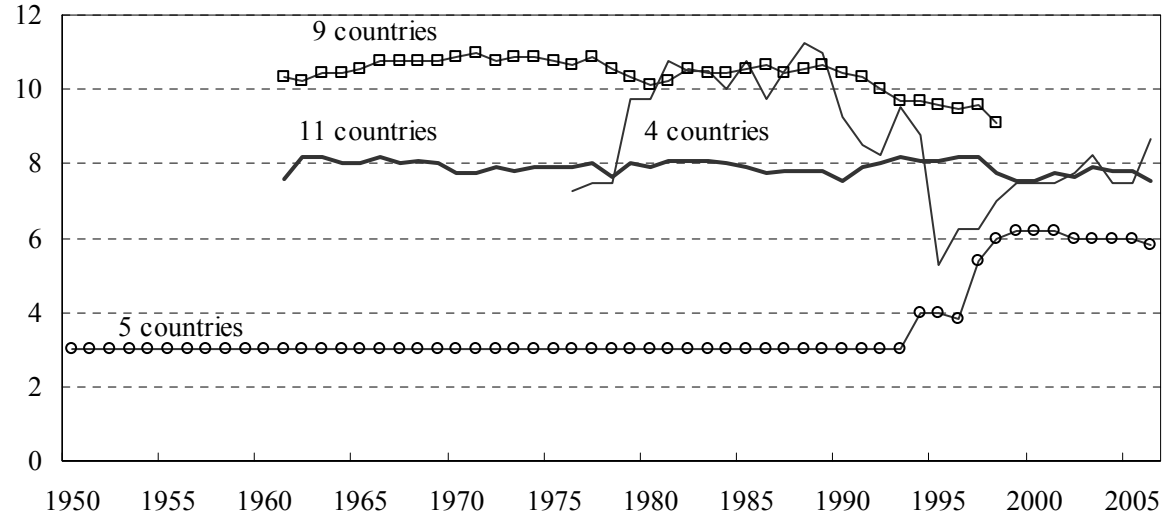
Notes: OLS estimation with year fixed effects. Robust standard errors, adjusted for clustering by country, are in parentheses. **, * and # denote significant at the 1, 5 and 10 percent level, respectively.

Figure 1: MPC Membership Size

(a) Sample average



(b) Average for various groups of countries



Notes: Panel (a) plots the average membership size of monetary policy decision-making bodies; the numbers denote sample size. Panel (b) depicts the average MPC size for various groups of countries. Countries were grouped according to data availability. The groups are as follows. *5 countries*: Canada, Denmark, Japan, and Switzerland, and U.K.; *11 countries:* Australia, Iceland, Israel, Korea, Malaysia, New Zealand, Norway, Sweden, Trinidad & Tobago, Turkey, U.S.; *4 countries*: Botswana, Brazil, Mauritius, and Singapore; *9 countries (euro area):* Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal.

Figure 2: Scatterplot of MPC Size and Inflation

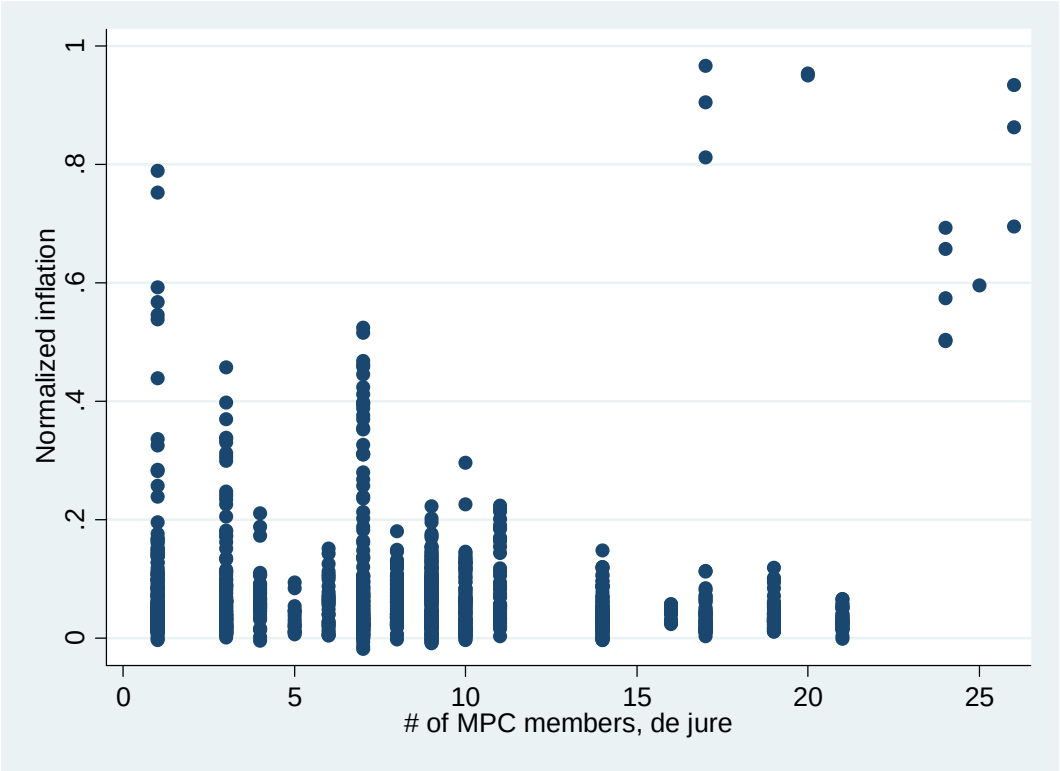
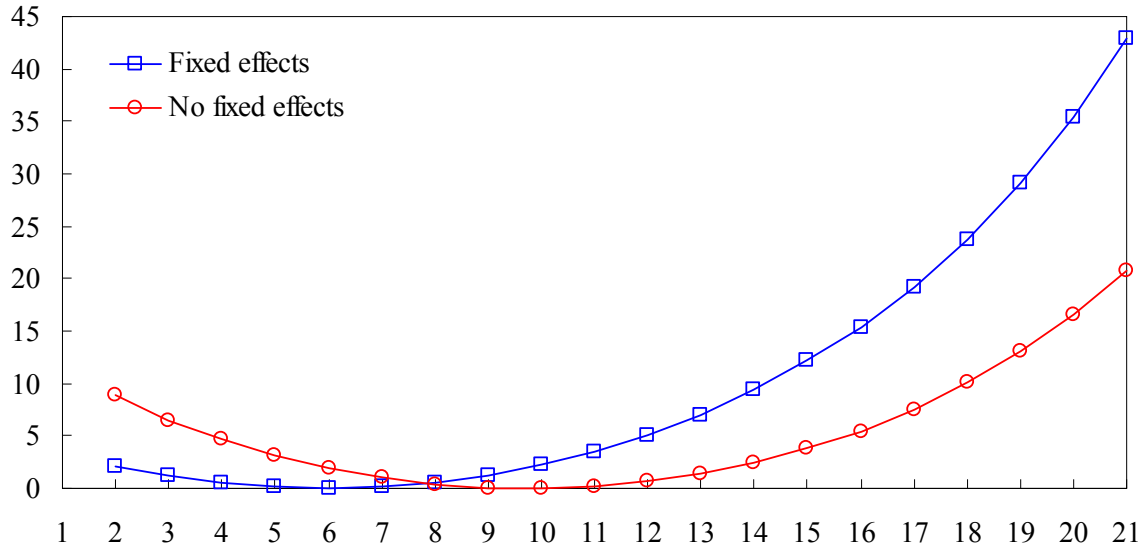


Figure 3: Simulated Effect of MPC Size on Inflation



Notes: Inflation in percent. The simulation is based on the estimation results reported in column 2 (no fixed effects, other covariates) and column 4 (fixed effects, no other covariates) of Table 1, keeping all other variables constant. The minimum inflation rate has been calibrated to zero.

Appendix 1: Countries in sample

Argentina
Australia
Austria
Belgium
Botswana
Brazil
Canada
Denmark
Finland
France
Germany
Iceland
Ireland
Israel
Italy
Japan
Korea
Malaysia
Mauritius
Netherlands
New Zealand
Norway
Pakistan
Portugal
Singapore
Spain
Sweden
Switzerland
Thailand
Trinidad & Tobago
Turkey
U.K.
U.S.A.

Appendix 2: Data sources and variable list

Variable:	Description:	Source:
Inflation	CPI inflation, %	IMF IFS
Inflation Variability	Standard deviation of inflation over (non-overlapping) five-year intervals	Own compilation
De Facto Membership	Number of actual members in the MPC	Own compilation
De Jure Membership	Number of members in the MPC as defined in the central bank law	Own compilation
Membership Turnover Rate	Fraction of membership changes in total membership of MPC	Own compilation
Governor Turnover Dummy	Dummy variable if central bank governor changed	Own compilation
Government Representatives	Dummy variable if MPC comprises government representative(s)	Own compilation
Regional Representatives	Dummy variable if MPC comprises regional representative(s)	Own compilation
Industry Representatives	Dummy variable if MPC comprises industry representative(s)	Own compilation
Central Bank Independence	Dummy variable if central bank is independent	Acemoglu, Johnson, Querubin & Robinson
De Jure Quant. Monetary Target	Dummy variable if the country had a quantitative monetary policy target	Fatas, Mihov & Rose
Quant. Monetary Success	Dummy variable if the country hit its de jure quantitative target	Fatas, Mihov & Rose
Openness (% GDP)	Trade, % GDP, from PWT	PWT 6.2
Budget Balance (% GDP)	Government budget balance, % GDP, from IFS & WDI	IMF IFS
Business Cycle (Growth –Avg Growth)	Difference between real GDP growth and average (country-specific) GDP growth, percentage points	Own compilation
Log Real GDP per capita	Log of real GDP per capita (chain method)	PWT 6.2
Log Real GDP	Log of real GDP, computed from per capita GDP and population	PWT 6.2