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Optimal monetary policy committee size: theory and cross country evidence

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Working Paper No. 439

**Optimal Monetary Policy Committee Size:
Theory and Cross Country Evidence**

by

Szilárd Erhart and Jose Luis Vasquez-Paz

March 2007

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**OPTIMAL MONETARY POLICY COMMITTEE SIZE:
THEORY AND CROSS COUNTRY EVIDENCE**

*Szilárd Erhart**
*Jose Luis Vasquez-Paz**:*

Abstract

Theoretical and empirical studies of different sciences suggest that an optimal committee consists of roughly 5-9 members, although it can swell mildly under specific circumstances. This paper develops a conceptual model in order to analyze the issue in case of monetary policy formulation. The optimal monetary policy committee (MPC) size varies according to the uncertainty of MPC members' information influenced by the size of the monetary zone and overall economic stability. Our conceptual model is backed up with econometric evidence using a survey of 85 countries. The MPC size of large monetary zones (EMU, USA, Japan) is close to the estimated optimal level, but there exist several smaller countries with too many or too few MPC members.

JEL Classification: E50, E58

* Szilárd Erhart: Magyar Nemzeti Bank

**Jose Luis Vasquez Paz: Banco Central de Reserva del Peru

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1. Introduction¹

What is the optimal size of a monetary policy committee (MPC)? And which, if any features of the monetary authority or the monetary zone, may influence the optimal size? While there is a broad literature on theoretical aspects of optimal committee size, only few works focus on empirical analysis, and even fewer attempt to link theory and practice. In order to bridge this gap, we provide a simple conceptual model that is consistent with the findings of the previous theoretical literature and also suitable for empirical analysis.

In our literature review we found evidence showing that an optimal committee consists of around 5-9 members. In addition, the optimal size varies according to specific factors such as problem to be solved, information availability, decision-making procedures, etc.. Committees pool the information of their members and are able to arrive at superior decisions, often even faster, than individual members. However, there is a clear trade-off between the benefits of information pooling and the costs of larger committees. Because the decision-making process exponentially slows down as the committee becomes larger, the optimal MPC size has to be relatively small.

We have surveyed 85 central banks in order to test our conceptual model. So far empirical research of MPC size focused on “de jure” size of committees (number of members by law), while our survey also covers “de facto” size (number of members in reality appointed) and the “quorum” (minimum number of members needed to be present at a meeting before decisions can be taken). In principle, “de facto” size is always smaller than “de jure” size due to practical difficulties associated with appointment procedures. Also, it seems that central banks try to avoid individual decision-making because the quorum is almost always larger than one.

According to our survey, the average central bank’s monetary policy committee consists of 7 members, that is the MPC size is relatively small in line with the theoretical considerations. Not surprisingly, committees consisting of odd number of members are more frequent than committees with even number of members. The bias towards committees with odd number of members is understandable taking into account that the

¹ We are very grateful to our supervisor who helped us with ideas, José Berrospide, Csaba Csávás, Tibor Erhart, Harmen Lehment, Tonny Lybek, Bálint Menyhért, Sidney Nakahodo, Mewael Tesfaselassie and Gerardo Tirado for data and valuable comments and several anonymous colleagues in central banks who have helped our work with their remarks and provided us with the survey information. All remaining errors are the responsibility of authors.

probability of indecisiveness is considerably higher if the committee has even number of members.

The econometric analysis performed in this paper show significant differences in the optimal committee size among central banks. The estimation results support most of the conclusions drawn from our conceptual model. The optimal committee size estimation result is in line with the optimal range of 5-9 members derived from scientific literature. However, the heterogeneity of the monetary zone has an increasing impact on the optimal committee size and larger zones usually have larger MPCs. Economic stability also constitutes an important driving factor. Turbulences make information pooling more difficult, and countries with higher uncertainty need more MPC members. Although our results are sensitive to the applied estimation methodology, they suggests that different exchange rate regimes, decision making procedures and features of central banks (number of workers) are consistent with different MPC size.

The model based estimates are also used to draw conclusions whether the MPC size of sample central banks significantly differs from the optimal level. We show that the size of the monetary policy committee among the largest central banks (FED, ECB, BOJ) is close to the estimated optimal size, while there are several smaller central banks which have too many or too few members in their MPCs.

The paper addresses its objectives in six parts. Section 2 reviews the theoretical literature. In particular, it summarizes the important findings of studies not only in economics but also in other sciences. Section 3 develops a conceptual framework to investigate the determinants of optimal committee size in case of monetary policy formulation. Section 4 discusses our survey of 85 central banks and also the stylized facts obtained from the survey. Section 5 presents the econometric analysis of our conceptual framework. Finally, Section 6 concludes.

2. Literature review

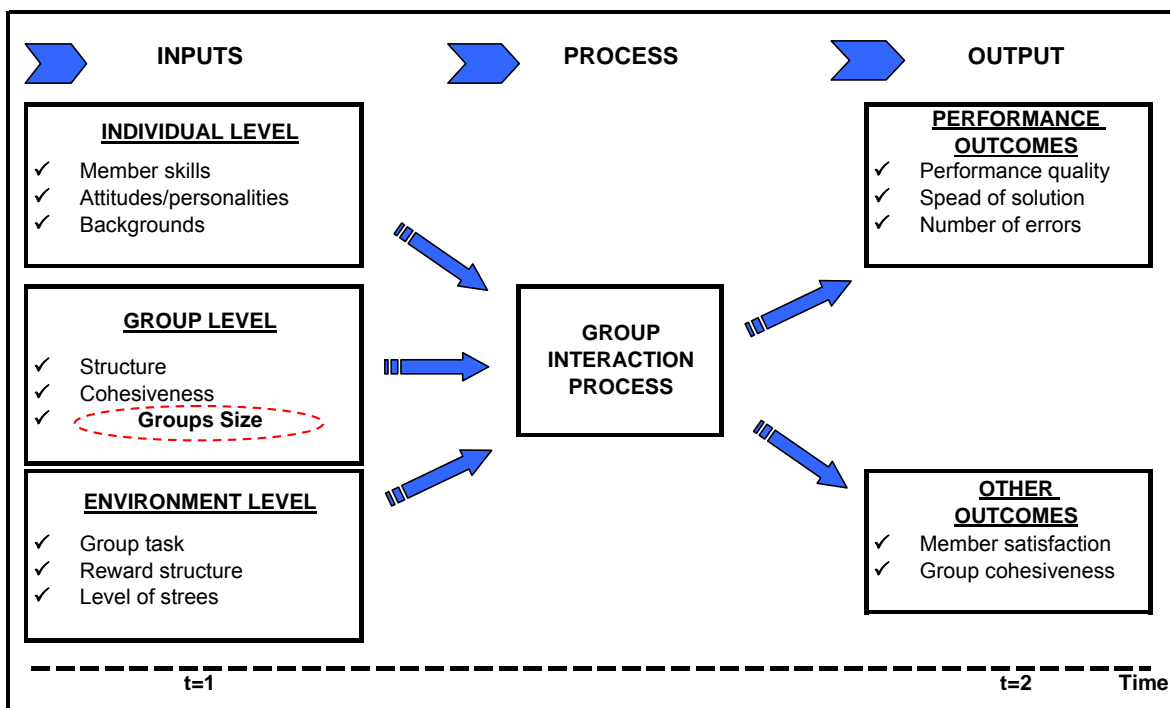
Several factors impact the decision-making process (**Figure 1**). For instance, group size - defined as the number of persons in the group² - is an essential and very influential factor. The link between group size and efficiency with which they perform tasks was studied from the perspective of many sciences: medical sciences, sociology, psychology, business administration, economics, etc. Most of the studies concluded that group size is

² There is another definition used in the literature: the “functional size”. See Fay (2000).

closely related to the effectiveness and quality of solutions and affects directly the group's performance³.

Following the traditional paradigm developed by Hackman and Morris (1975), group size is an input of group interaction process which takes place between two moments in time.

Figure 1: Inputs, outputs and dynamics of group interaction



Source: Hackman and Morris (1975).

It is important to mention that the relationship is mutual and every element affects and is affected by the other factors in the interaction process. This kind of recycled interaction enriches the analysis because it endogenizes the concept of optimal size of a group and opens more interesting questions.

Interdisciplinary approach

Table 1 offers a brief summary of the theoretical literature concerning the relationship between size and performance of groups from the point of view of several sciences, apart from economics. The reviewed studies cover not only theoretical considerations but also empirical evidence from works establishing links between the performance of groups and the number of individuals involved in the group interaction.

³ From social psychological point of view, a task can be additive, disjunctive or conjunctive. For an interesting discussion see Sibert (2006).

Table 1: Optimal committee size (interdisciplinary approach)

Year	Field	Method	Results	
			Size n	Conclusion
1951	Sociology	experiments	3, 5 or 7	Odd groups perform better than even groups.
1955	Psychology	experiments	2 or 4	Group performance was superior to individuals.
1957	Sociology	survey of experiments	n is endogenous	Size depends on the type of task assigned.
1975	Psychology	statistical model	n is endogenous	Group size is an input into the interaction process.
1992	Infor.System	computational experiments	6 or 12	Larger groups generate unique and high quality ideas.
1993	B.A.	firm comparison	n is endogenous	Large teams are better in turbulent environment.
2000	Psychology	experiments	5	Communication in 5 person groups is a dialogue.

In an early work, Bales and Borgatta (1951) studied the effects of the group size on the interaction patterns. An important result of their experiments was that groups with odd number of member reach out to their decisions sooner than groups with even number of members, not only because the former breaks more easily into a majority/ minority but also because even number of people show lower agreement.

Using group experiments, Taylor and Faust (1955) discussed how the efficiency in solving problems varies with changes in group size. They found that the performance of individuals working alone, was consistently inferior to individuals working as group members (groups were better to achieve accurate answers). But in terms of speed, individual performance was superior to groups (individuals found the solution faster).

Caplow (1957) summarizes the following “stylized facts” after having analysed several empirical works:

- Group size may affect the quality of performance as well as the activity of members.
- Small groups are relatively more effective than larger groups.
- The size may affect individual performance as well as group effort (negative correlations between individual output and group size).
- The stability of the group (network of relationships) increases with the size.

The paper concludes that the size is an important element in determining the way how any human organization adapts to its environment but the adaptation efficiency also depends on the type of task assigned.

Gallupe et al. (1992) carried out two group experiments and tested the generation of free ideas (brainstorming) in different group sizes using electronic devices (computers). They concluded that larger groups tend to perform better than smaller ones. Haleblan and Filkenstein (1993) studied the importance of the team size as a determinant of CEO's capabilities during both turbulent and stable environments (industries). Using data from computer industry (turbulent) and natural gas industry (stable), they found that team size was more positively related to performance in the computer industry than in the natural gas industry. This shows that business environment represents a complementary factor affecting the relationship between size and performance.

Fay (2000) analyzed two kinds of groups (five and ten person groups) and found that 5 person groups tend to enter in constructive dialogues with more interaction among members (pair conversations, interruptions, and shorter turns), meanwhile communication within 10 person groups tend to be a monologue (influence of the group by a dominant speaker). However, participants are better able to understand the utterances produced by speakers in 10 person groups because in 5 person groups participants tends to concentrate on their own "pair" relationships.

Economics

After this brief interdisciplinary literature review, we will focus on specific economics literature related to committee size (**Table 2**). Blinder and Morgan (2000) developed two laboratory experiments: a purely statistical (urn experiment) and a monetary policy experiment (electronic model) in order to answer two questions. Do groups make decisions slower than individuals do? Are group decisions better or worse than individual decisions? They found that groups not only reach out decisions faster, but also make better decisions. The authors concluded with a question: If groups make better decisions and they are on average superior, why not assigning many important tasks to committees?

Following Blinder's work, Lombardelli and Talbot (2002) used a model of two equations (Phillips Curve and IS curve) to complete an experimental analysis of monetary policy decision-making under uncertainty. They found that decisions made by groups (committees) were superior decisions when compared to those of single individuals. Indeed, the study provides evidence that group performance was on average better than the performance of the best individual.

Table 2: Optimal committee size (economic approach)

Author	Year	Method	Type		Results	
			Theoretical	Applied	Size N	Conclusion
Blinder & Morgan	2000	statistical urn problem / monetary policy experiment		✓	n=5	Group decisions are in average superior.
Lombardelli & Talbot	2002	experimental analysis		✓	5 better than 1	Groups of 5 persons made better decisions.
Berk & Bierut	2003	binary model of uncertainty	✓		unbounded	Size is related to skills of members.
Gerling et al.	2003	survey of literature	✓		unbounded	Size depends on the cost of information.
Kang	2004	optimization model	✓		n.d.	The less diverse the information, the smaller the size.
Lybek & Morris	2004	survey of central banks		✓	Range of 7 - 9	To balance behaviour of its members.
Gerlach-Kristen	2005	economic model of uncertainty	✓		n > 1	Under uncertainty committees are better.
Berger	2006	survey of countries		✓	n ~ 10 - 20	Optimal MPC size should be large (Fed, ECB)
Berger et al.	2006	survey of central bank boards		✓	Range 7 - 9	Country's and central bank's characteristics matter.
Sibert	2006	survey of literature	✓		n ~ 5	Optimal size should not have more than 5 members.

Berk and Bierut (2003) investigated the implications of setting interest rate by committee assuming that a subset of members can meet prior to the voting (open the possibility to reach consensus ex-ante). They found that pre-meetings have a marginal effect on interest rate setting if members have the same skills, but substantial effect if skills are different. The same year, Gertling et al. (2003) provided a wide overview of the game theory literature applied to committees from both theoretical (strategic voting, incentives for information acquisition, etc.) and empirical (committee decisions) evidence. A main conclusion of the study is that size is closely related to the degree of exogeneity of individual information: large size is associated to exogenous/costless information (Condorcet Theorem) meanwhile finite/smaller size is associated to endogenous/costly information. The authors remark that a central bank committee's decision need not necessarily improve as the number of committee members increases because information is a public good.

Kang (2004) emphasized the trade-off between decision-making costs and benefits in order to analyze the optimal size of committees. The paper focuses on the sluggishness in a group decision, in opposition to the accuracy of decision-making due information pooling. He found that the greater the cost of time delay and the less diverse the information, the smaller the optimal size of committee. He also concluded that the optimal committee size should be smaller if it faces the similar decision-making problems more often.

Lybeck and Morris (2004) surveyed 101 central banks to identify issues in the structure, size and composition of their MPCs. They found that optimal committee size should assure an informed, balanced and professional committee but it also should maintain the effectiveness and responsibilities of its members (no free rider behavior).

Gerlach-Kristen (2005) using a model of uncertainty, analyzed the interaction process followed by a committee to set interest rate. The study found that groups are better able than individuals to form a view of the appropriate policy under economic uncertainty. Specifically the study states that “the larger a monetary policy committee, the smaller the policy error”. But because of coordination cost and decreasing effort of members, the number is finite.

Berger (2006) in an applied work for the Eurosystem developed indicators to analyze the possibility of reforming the ECB Governing Council. His empirical analysis suggests that, while a single person committee is not efficient in the decision-making process, the cost of increasing the size is convex with respect to the number of members, and consequently the optimal size has to be finite. The evidence provided by Berger’s study suggests that a reasonable upper bound for committee size seems to be around 20 for federal central banks as the ECB.

Berger et al. (2006) analyzed empirical differences among 84 Central Bank boards and concluded that the board size is strongly associated with some country characteristics: country size, institutions and central bank features, such as autonomy, history, staff and term length of the members.

Sibert (2006) provided an ample revision of the literature related to monetary policy by committees, in particular studies investigating the relationship between the size and the performance of the committee. The paper shows strong evidence that the larger the group, the better the potential outcome, but also the greater the losses and coordination failures. Sibert’s literature review summarizes findings of both economic literature and other sciences and provides evidence that a reasonable size for a monetary committee should not have many more than 5 members.

On the basis of our review we have reached the following general conclusions:

- There is tangible evidence to confirm that “a head” is not enough: groups seem to perform better and make decisions faster than individuals.
- There are costs and benefits of enlarged committee size: the former relates to time and resources spent on communication/interaction, while the latter implies better information pooling ability.
- The optimal committee size has to be a finite and odd number: theoretical consensus number of members is 5, but empirical evidence shows an average of 7-9 members.
- The optimal size is endogenous and not unique: it varies according to several factors, including decision making rules, characteristics of the problem to be solved, interaction process of the group and the availability of information.

3. Conceptual framework of optimal size

In this section, we develop a simple theoretical framework of committee size. First, we define the cost and benefit functions in order to derive optimal committee size. Second, we put our apparatus to work and show how different aspects of a monetary area (size, heterogeneity etc.) might influence the optimal size.

Benefit function

Following the studies of Kang (2004) and Berger (2006), we argue that the main benefits of committee enlargement are associated with information pooling. At meetings, committee members basically decide on the change of the interest rate (hold, increase or decrease)⁴. All decision makers receive a signal x_i about the right value of the interest rate change which would help to achieve monetary policy targets. These signals are independently drawn from a normal distribution with mean μ and variance σ^2 , which is known by the decision maker. Pooling the information of “ n ” committee members, the

⁴ Most central banks build monetary policy on a simple operational framework (Borio (1997)). The members of monetary policy committees in general decide only on the level of the key policy rate, so as to react to exogenous shocks and achieve the final goal of price stability.

sample mean signal \bar{x}_n - the signal of the committee- follows a normal distribution with mean μ and variance σ^2/n ⁵:

$$\bar{x}_n \sim N\left(\mu, \frac{\sigma^2}{n}\right) \quad (1)$$

Notice that the larger the committee (n), the smaller the uncertainty (variance) of the group's signal.

The performance of monetary policy is related to the ability of the monetary authority to set inflation (π_1) to its optimal/targeted level (π_1^T)⁶. As the monetary policy transmission operates with lag the subindex means the next period to which monetary policy has an impact.

In our conceptual framework the monetary policy decisions simply follow aggregated signals. Beyond that, failures in monetary policy decisions spill over through the transmission mechanism, leading the monetary policy target to be missed. The ability of the monetary authority to meet its target is related to the uncertainty of signals of the committee ($\frac{\sigma^2}{n}$).⁷ The greater the uncertainty, the higher the probability that the central

bank will not be able to achieve its goal of price stability. As follows, we define the total social benefit (TSB) of monetary policy as the central bank's ability to achieve the targeted optimal level of inflation:

$$\text{TSB} = \gamma + \beta \cdot \frac{\sigma^2}{n} \quad (2)$$

where γ denote the effect of all other factors - the expertise of the staff and decision makers, for example - influencing future inflation, β is the coefficient of signal errors and both parameters are strictly negative ($\gamma < 0$, $\beta < 0$) because of the inflation loss minimizing

⁵ For simplicity we assume here that decision makers only pool the information and individual members can not use signals from other decision makers to update his/her signal.

⁶ In case of a non-inflation-targeting central bank the performance is linked to its ability to minimize inflation loss. For the sake of simplicity it is assumed in the following that the central bank follows an inflation target.

⁷ Sibert (2006) also argues that "using elementary sampling theory, it can be demonstrated that the expected loss to the committee from choosing the wrong policy is decreasing and convex in the number of members who choose to become informed".

nature of monetary policy. In summary, by using more signals, decision makers can improve the chance of making better decisions.

The cost function

We showed clear incentives for enlarging monetary committees, especially concerning disposable information. But are there any costs related to increasing committee size? The answer is affirmative, and the sources of cost can be pecuniary, or related to the probability of postponing a meeting (delay in achieving a decision).

Obviously, the wage bill of the monetary authority is increasing as more members are appointed. More importantly, as the already referred studies of Caplow (1957), Lybeck and Morris (2004), Mahadeva and Sterne (2000) argue, the efficiency criterion is crucial to find optimal solutions.

We start the cost curve derivation with a framework developed by Berger (2006). He argues that the cost of decision making increases as the committee is enlarged. First, he assumes that the size of the monetary policy committee is relatively small and all committee members enter into dialogue during the debate before voting in order to process information. Second, he defines an interaction between members as a one-way information flow. Here, we assume that the number of interactions between decision makers is a two-way information flow. It follows that the interaction increases as the committee becomes larger.

Figure 2: Committee interactions

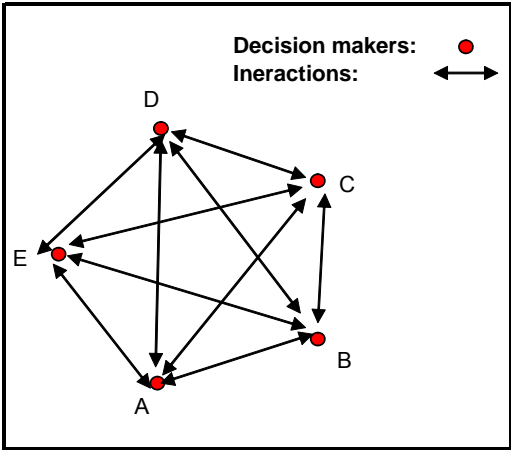


Figure 2 is an illustration of a committee of 5 members. If the committee size grows, the speed of decision making slows down, and the marginal product of decision makers

drops because of the increasing demand for interaction and debate. Let us denote the number of decision-makers with n , their hourly wage with w , the inflation loss related to sluggishness of decision making with l , and the time needed for a one-way interaction between decision makers with t . Taking into account that all pairs of decision makers need to communicate in both directions to exchange views than we obtain the total social cost (TSC):

$$TSC = n(n-1) \cdot t \cdot (l + w) \quad (3)$$

The first two factors in the expression describe how the coordination becomes more and more difficult as the number of necessary interactions grows. The third factor, the time needed to communicate in the committee, is a proxy for the speed or efficiency of group interactions. The last factor sums inflation loss (macro-loss) and wage costs (micro-loss). As the decision making becomes more complicated the quality of the decisions gets worse. In case of monetary policy, the worsening quality of decisions can be converted into increasing inflation loss, or into the higher probability that the central bank misses its inflation target.

Optimization problem

Defining the welfare function (W) as the difference of the total social benefits and total social costs, the optimal committee size can be obtained by maximizing the welfare function with respect to the committee size (n):

$$Max_n \quad W = TSB - TSC = \gamma + \beta \cdot \frac{\sigma^2}{n} - n(n-1) \cdot t \cdot (l + w) \quad (4)$$

For simplicity, we approximate the discrete optimization problem here by continuous optimization. Differentiating the expression with respect to the size “ n ” we get the first order condition:

$$FOC: -\beta \frac{\sigma^2}{n^2} - 2n \cdot t \cdot (l + w) + t \cdot (l + w) = 0 \quad (5)$$

Let's define the marginal social benefit and marginal social cost as follows:

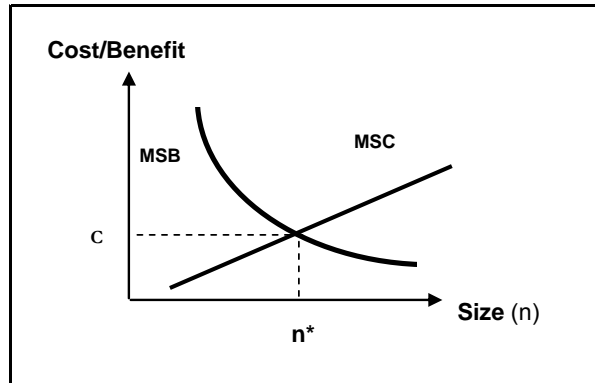
$$MSB(n) = \frac{\partial TSB}{\partial n} = -\beta \frac{\sigma^2}{n^2} \quad (6.a)$$

$$MSC(n) = \frac{\partial TSC}{\partial n} = 2n \cdot t \cdot (l + w) - t \cdot (l + w) = (2n - 1) \cdot t \cdot (l + w) \quad (6.b)$$

Figure 3 shows the graphical visualization of our results. As σ^2 is strictly positive and $\beta < 0$, it follows that the marginal social benefit is decreasing as the committee size increases

$$\left(\frac{\partial MSB}{\partial n} = 2\beta \frac{\sigma^2}{n^3} < 0 \right).$$

Figure 3: Marginal costs and benefits of committee size



In other words, the gains from information pooling decreases as members are added to the committee. Moreover, as w, l and t are positive numbers, the marginal social cost is increasing with committee size,

$$\left(\frac{\partial MSC}{\partial n} = 2t \cdot (l + w) > 0 \right).$$

Results of our framework

Now we can put our apparatus to work and see how it helps us to understand monetary policy committees. On the basis of our framework the optimal size arises from the intersection of the marginal costs and marginal benefits curves ($MSB=MSC$). According to our analysis, the marginal benefit of committee size is increasing in the signals of committee members $\left(\frac{\partial MSB}{\partial \sigma} = -2\beta \frac{\sigma}{n^2} > 0 \right)$. So, what are the factors that may affect the dispersion of the signal?

- **Information heterogeneity** is of crucial importance. For example, one could argue that information in large countries is, in general, less homogenous and therefore the dispersion of the MPC member's signal can be also larger.

Figure 4: Signal dispersion and the optimal committee size

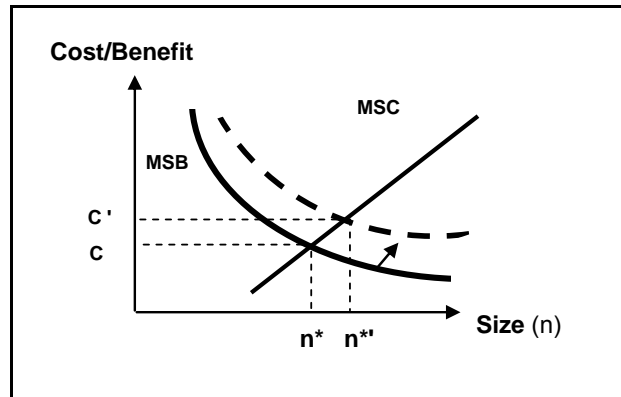


Figure 4 shows the impact of more heterogeneous signals. The MSB curve tilts upward to the right and as a consequence the optimal cost increases to C' from C which allows the enlargement of the committee to n^{**} members from n^* . Goodfriend (2005) also argues that more heterogeneous monetary zones may benefit from larger committee size. For example, the Federal Reserves (FED) and the European Central Bank (ECB) have far more members in their monetary policy committees (12 and 19, respectively) than other central banks which have around 7 members on average in their MPCs. We will show later in the empirical sections that larger countries have significantly more members in their monetary policy committee.

However, we should also emphasize the role of other potential factors which might cause the shifts in information heterogeneity and the tilts of the MSB curve:

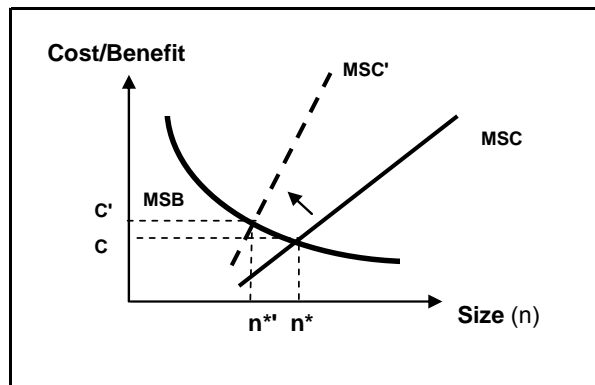
- **Development** may have an impact on optimal committee size through various channels. Berger, Nitsch and Lybek (2006) argue in their recent paper that developed countries may opt for more complex monetary regimes requiring larger committees. In our opinion, there is another channel of development. In general, economic development goes hand in hand with the development of information technology. The better information technology and statistical standards may decrease the uncertainty of monetary policy signals. Therefore, as a country is getting more developed and able to process information more efficiently the MSB curve may tilt downwards, and the optimal MPC size decreases. In other words, information is pooled not by MPC members but via information technology if the country becomes more developed.
- **Turbulent economic environment** increases the dispersion of policy makers' signals; as such, the MSB curve tilts upwards and optimal committee size increases.

This result is consistent with that of Haleblan and Filkenstein (1993) who argue that the optimal committee size is larger during turbulent environments.

- **Monetary policy regime** also plays a major role. Different regimes leave central banks with smaller or larger room for maneuver. If a country pegs its currency, then it gives up independent monetary policy. As a result, the interest rate and the foreign exchange policy follows simple automatic rules and monetary policy formulation does not require too many experienced members. Also, more sophisticated monetary policy needs more efforts from decision making bodies and may require larger committees.

Similarly, there are several factors that can lead to movements in the MSC curve:

Figure 5: Tilting marginal social costs and the optimal size



- **Wages:** if the wage of committee members increases, the MSC curve tilts upward ($\frac{\partial MSC}{\partial w} = 2n \cdot t - t = (2n - 1) \cdot t > 0$), C increases to C', while the optimal committee size decreases to n*' from n* (Figure 5)..
- **Decision making procedures:** such as voting rules, interaction between members, frequency of meetings etc. also influence the shape of the MSC curve. For example, if committee members communicate more efficiently and need less time for discussion then the monetary policy decision making can be faster and perhaps less costly ($\frac{\partial MSC}{\partial t} = (2n - 1) \cdot (l + w) > 0$). As a result, the MSC curve tilts downwards and the optimal size increases.

4. Lessons from central banks' practice

*"A famous University decides to field a rowing team. But they lose race after race. After couple of weeks spying on Harvard, the coach finds the answer: We should have fewer guys yelling. The others should row." **Joke by an anonymous author***

In this section we survey central banks and compare the size of their monetary policy committees. Firstly, we are interested in describing and understanding the similarities and differences between central banks. Secondly, we also attempt to find benchmark solutions and reconcile the theoretical considerations with empirical data.

Survey – how to measure the size of committees?

Our survey covers 85 central banks around the world and was carried out in November, 2006. We used both legal documents (in most cases central bank acts) and also the official information of the authorities provided on their website. In order to minimize the risk of data errors we also contacted central banks and double-checked our information with them.⁸

In our survey we defined the size of monetary policy committees as the number of members entitled to decide on monetary policy formulation. We used the following three indicators to measure committee size:

- ***“De jure”* size**

The most straightforward indicator is *“de jure”* size which can be found in the central bank acts. Most empirical studies so far used this indicator (Lybek and Morris (2004), Mahadeva and Sterne (2000)). We also gathered information about this essential measure so as to compare our findings with previous works and also with other measures of committee size.

- ***“De facto”* size**

While *“de jure”* size is a natural measure for empirical work, *“de facto”* size potentially is a superior indicator. In reality, the actual committee size may differ from that of set by the law. Therefore, our survey also covers the number of

⁸ Appendix 1 provides a list of the surveyed countries. The survey data can be downloaded from: http://www.erhartsz.extra.hu/publ_en.html.

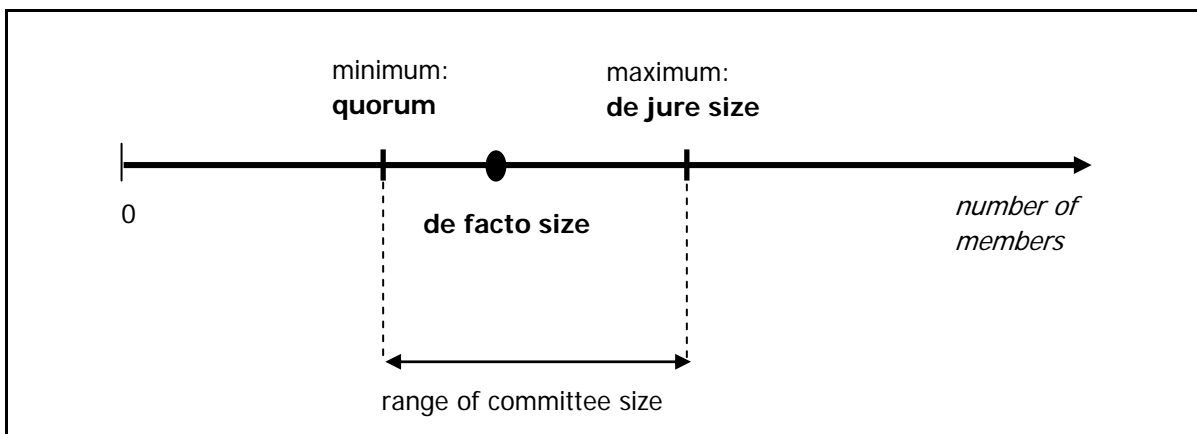
committee members which have been in reality appointed and entitled to participate in monetary policy formulation.

– **Quorum**

We also tracked “*quorum*” regulations, which is the minimum number of members necessary to make decisions. The quorum defined by law reflects the intention of legal authorities to avoid that a too small committee makes decisions.

Applying our conceptual model to the three indicators mentioned above may help us identify the committee range targeted by individual countries. This range has to include the optimal committee size in practice. The quorum can be interpreted as a minimum set by legal regulations for the targeted optimal committee size (**Figure 6**). Fewer members than the quorum can be considered as suboptimal since the cost of postponing the decision making is lower than making decisions with too few members.

Figure 6: Range of committee size targeted by central banks



The upper limit of the optimal range is set by the “*de jure*” size. Finally, “*de facto*” size within the boundaries set by the law is the number of committee members in reality. In the best case scenario, “*de facto*” size is the best among possible outcomes or in other words it is the optimal size within the targeted range.

First look at the data: central tendency indicators

This subsection describes some of the main results of the survey. As shown in **Table 3**, the mean “*de jure*” committee has approximately 7 members which is a very similar result to previous surveys. Comparing our survey with other studies, it seems that the “*de jure*”

MPC size has decreased in the previous years. The study by Mahadeva and Sterne (2000) reported a mean of 7.7 and Lybek and Morris (2004) 7.6, both higher than our mean value, although not significantly.

Table 3: Descriptive statistics

	Mean	Median	Mode	Standard deviation	Skew	Minimum	Maximum	Sample size
Size de facto	6.85	7	7	3.11	0.54	1	18	85 (80)
Size de jure ¹	7.43	7	7	3.17	0.27	1	18	85 (82)
Quorum	4.38	4	4	1.85	0.78	1	12	85 (75)
Memo items								
Size (de jure)								
Mahadeva and Sterne (2000) ²	7.70							
Lybek and Morris (2004) ²	7.62							

Source: Central Banks

¹ In case the law defines a range for the number simple arithmetic average was used.

² Both studies classified central banks to ranges. The central value of ranges was used to averages.

³ To avoid the bias from partly different samples we estimated the missing indicators. For example, if only de facto and de jure size of the committee was available but not the quorum, we used the average quorum size of those countries with similar de facto committee size. Original sample size is given in parenthesis.

Other indicators of central tendency show that most frequent (mode) and also median committees consist of 7 members. All in all legal regulations aim at defining a committee size which is very close to the upper boundary of the range regarded as optimal (5-9 members) on the basis of theoretical considerations and scientific literature.

In the light of the mean “de facto” size, it is not surprising that legal regulations attempt to target above the optimal size because “de jure” size defines only the maximum for the MPC size. In fact, actual committees are usually smaller: the mean of “de facto” committees is 6.84 in our sample. Obviously, nomination and appointment procedures take time as they need the approval and cooperation of several entities. The difference is perhaps more tangible if the total number of members in monetary policy committees are compared. According to the law, 629 members could have been appointed as members in our sample of central banks but only 581 in reality were sworn in.

Corner solutions

Presumably the easiest way of governing is if there is only “one captain on board”. But there are only six central banks (Aruba, Israel, Madagascar, Malta, Papua New Guinea, New Zealand) in our sample which have chosen this option. As a matter of fact, there are clear theoretical arguments against single person committees. Several studies quoted in the theoretical review find that individuals, often even the best individual, perform worse

than small groups in decision-making⁹. The unpopularity of small committees is perhaps also related to other shortcomings of individual decision making as the reduced ability to process information and the higher risk of producing more extreme outcomes.

All countries that have only one decision maker to decide are small with regards to size or population, or both. In fact, this may reflect that the size of the country influences the optimal size of the committee, as pointed out in Section 3.

The impact of country size is also obvious if we take a look at the other end of the interval. One of the largest monetary zones, the Eurozone has the most members in the governing council of its central bank (ECB), although it is based on special institutional arrangements. Some other large countries prefer larger committee size as well, such as Russia (13), Egypt (15), and the USA (12). Indeed, the governing council of the ECB, which was comprised of 18 members at the time of the conduction of our survey, may swell even further as new countries are introducing the euro. Slovenia adopted the common currency in January 2007; consequently, there have been 19 members in the enlarged council since then. However, the ECB has also implemented reforms in order to accommodate further enlargements of the Eurosystem. The new Statute of the ECB set a ceiling for the number of representatives of national central banks (NCBs) at 15 (currently all 13 governors from NCBs are council members). As a matter of fact, the ECB is moving towards the system of the FED. In the FOMC, 5 seats out of the 12 members are rotated among presidents of Reserve Banks.

Quorum – minimum size requirement

The dislike of too small committee size is unambiguous since almost every law prescribes a minimum number of members, i.e. a quorum to be present at meetings to make decisions.

First and foremost, the quorum helps to avoid the disadvantages of individual decision making. It can also provide information regarding the floor of committee size under which the cost of decision making is higher than making no decision at all. In some countries, “*de jure*” size is given by a range (Hungary (9-11), Serbia (4-6), Guyana(4-6)) and the quorum is defined as a relative number (majority of the board members). In fact, the

⁹ Taylor and Faust (1955), Blinder and Morgan (2000), Lombardelli and Talbot (2002).

regulations almost always require that the quorum must include particular members, usually the Governor or the Deputy Governor.

Despite the differences regarding its definition, the quorum, either absolute or relative, is determined by 50-70 percent of the “*de jure*” members. The statistics of the quorum (**Table 3**) show that the mean “*quorum*” requirement is roughly 4 and equals the mode and median numbers. Consequently, central banks deem 4-5 members as a necessary minimum size for committees formulating monetary policy. As a matter of fact, the mean quorum size in our sample is roughly consistent with the bottom of the optimal range (5-9 members) we defined as optimal on the basis of the theoretical literature.

It should also be noted that “*de facto*” size does not necessarily mean that all appointed members are present at meetings. Although in several countries the regulation requires that members shall attend meetings, illness and other special circumstances may occasionally prevent certain members to participate in policy formulation. Once again, it is necessary to target at higher “*de jure*” committee size in order to ensure that the number of committee members in reality remains continuously within the targeted optimal range.

There are other ways to reduce the risk of too small committee size. For example, in case of the US Federal Open Market Committee if one of the 5 Reserve Bank presidents entitled to vote is away, then another president of the remaining 7 Reserve Banks presidents can vote.

Further aspects of committee size statistics

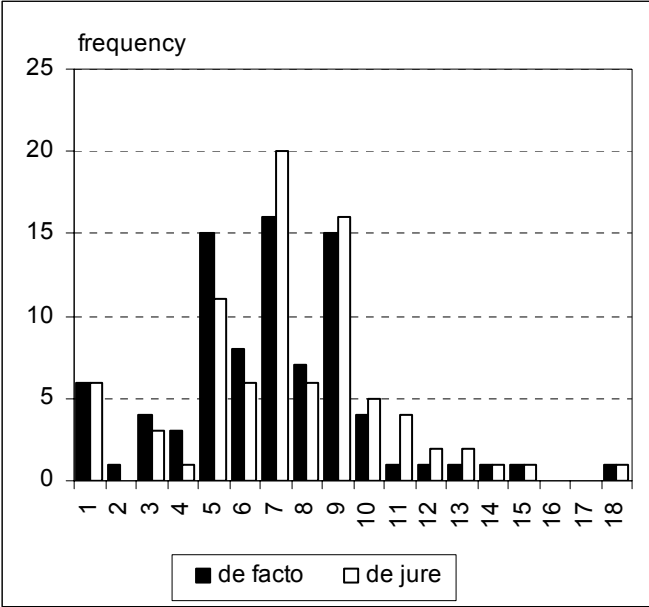
As far as the distribution of the committee size is concerned, it is worth remarking two further aspects that can be also linked to theoretical considerations. First, there is a clear sign of asymmetry in the distribution. Second, there is a bias towards committees with odd number of members.

– Asymmetry

The asymmetry of committee size distribution is clear at first glance (**Chart 1**). The simple statistical measure of skew reported in **Table 3** also illustrates this intuition. In case of “*de facto*” size the skew is 0.6, which means that the distribution has “fat” right tail.

The obvious reason of asymmetry is that there is a lower bound at 1 for the committee size but upper bound does not exist. However, in case of size, the asymmetry is also observable in the regions close to the mean. Based on the theoretical framework we have developed, we conclude that central banks may regard being below the optimal committee size indeed more costly than being above the optimal range.

Chart 1: Distribution of MPC size in the sample



– **Odd number of members bias**

The analysis of the histogram reveals an additional feature of committee size: committees having odd number of members are more frequent than committees having even number of members. And we can reach out the same result irrespective of the fact whether the histogram of “*de jure*” or “*de facto*” committee size is investigated. The bias towards committees with odd number of members is understandable taking into account that these committees can come to a decision more easily because the probability of indecisiveness is considerably higher if the committee has even number of members. Furthermore, as Bales and Borgatta (1951) argued in an early study, odd numbered groups arrive to decisions faster than even ones not only because the former breaks more easily into a majority/minority sub-groups but also because even number of members show more disagreement and antagonism.

In practice, central banks try to avoid the risk of indecisiveness by granting one of the members - usually the chairman – with the tie-breaking vote. While this can help reducing

the probability of indecision, it also puts the decision on the hand of a single person. Consequently, the committee size decreases below the bottom of the targeted optimal range.

5. Econometric analysis

Our survey in Section 4 suggests that one committee size does not fit all central banks. In this section we test our theoretical framework in order to evaluate whether our conceptual framework in Section 3 can provide explanation for the diversity in MPC size among central banks.

The section is organized as follows. First, we clarify the applied econometric methodology. Then we describe our dataset and summarize the indicators used to test the conceptual framework. Finally, test results are presented and reconciled with the conceptual analysis.

Methodology

In particular, the generic specification of the estimated equations is:

$$n_i = \alpha + \beta X_i + \varepsilon_i, \text{ where} \quad (7)$$

n_i is the size of the monetary policy committee, α is a constant, X_i denotes the vector of explanatory variables and ε_i is the error term.

We have estimated the above equation using three different methods: ordinary least squares (OLS), binary probit and also ordered probit models. While the clear advantage of the first method is that the estimated coefficient can be easily interpreted, the pitfall of least squares estimation in our case is that it assumes the continuity of the dependent variable. Therefore, we estimated the equation using probit models as well. To the binary probit specification we have transformed the “*de facto*” committee size into a binary variable that equals 1 if the MPC of the given central bank had more than 5 members and 0 otherwise. The application of different methods is also beneficial because it provides an opportunity to check the robustness of our results.

Data

The analysis is conducted for 85 countries. “*De facto*” committee size from our survey in Section 4 has been used as an indicator of committee size (n_i) to the econometric tests.

The choice of “*de facto*” size from our size indicators was not arbitrary because “*de jure*” and the “*quorum*” mean only the ceiling and bottom of the targeted range, while the “*de facto*” size can be considered as the expected value of optimal size which we wanted to quantify.

The aim of the empirical analysis was to test our conceptual model. Therefore, we grouped the explanatory variables according to the conceptual analysis (**Table 4**). We have used population, surface and GDP to proxy heterogeneity of countries that influence the committee members’ signal uncertainty.

Table 4: Explanatory variables

VARIABLES GROUPS	DESCRIPTION	EXPECTED SIGN
Size and heterogeneity		
- Surface	km ²	+
- Population	million population	+
- GDP	Current billion USD	+
Monetary Policy		
- Exchange Rate Regime		
Peg	dummy = 1 if peg	-
Crawling	dummy = 1 if crawling	-
Managed Floating	dummy = 1 if managed floating	+
Floating	dummy = 1 if floating	+
- Monetary Policy Framework		
Inflation Target dummy	dummy = 1 if Inflation Targetting	+/-
Monetary Targeting dummy	dummy = 1 if Monetary Targetting	+/-
- Decision Making procedures		
Frequency of MPC meetings	days between meetings	+
Term of MPC members	years	-
- Other features of Central Banks		
Number of workers of CB	number of employees in 2005	+
Age of CB	years	-
Development Degree		
- GDP per-capita	billion USD (constant 2000 prices)	-
- Internet Users	number of users/1000 population	-
- Information expenditures	Inform. and commun. expenditure per capita (USD)	-
- Degree of openness	exports and imports (%GDP)	+/-
- Political Regime	dummy= 1 if republic	+
Turbulence		
- GDP volatility	rel. standard deviation of (%)	+
- Consumption volatility	rel. standard deviation of final consumption(%)	+
- Inflation volatility	CPI (%)	+
- Hyperinflation(**)	dummy= 1 if country had hyperinflation since 1945	+

(*) WB: World Bank, IMF: International Monetary Fund, CF: CIA Factbook, Enciclopedia Salvat: Salvat Editores 2004.

(**) Hyperinflation: inflation exceeding 40 percent per year.

To control for the impact of monetary policy, concerning in particular monetary policy regimes, exchange rate arrangements, decision making procedures and other features related to central banks, we have used different dummy variables. The third group contains variables measuring the impact of economic development and the general ability of countries to pool and process information. Since turbulences may also influence the uncertainty of decision makers' signals, several proxies of economic instability have been included in the fourth indicator group (inflation volatility, GDP volatility, consumption volatility).

Estimation results

Table 5 presents our estimation results. In order to arrive at plausible estimates, we have applied the three estimation methods simultaneously. The final specification contains only those indicators whose significance has been supported by at least one estimation method. In general, the vast majority of the collected indicators has not passed the econometric tests and our final specification included only five explanatory variables, in addition to a constant.

Table 5: Estimation results¹⁰

Model	OLS*		Ordered Probit**		Binary Probit**	
	β	Prob	β	Prob	β	Prob
Constant	6.3710	0.00				
GDP	0.0007	0.00	0.0003	0.00	0.0002	0.07
GDP_volatility	5.4847	0.08	2.5593	0.05	3.1097	0.00
Population	0.0198	0.00	0.0088	0.00	0.0061	0.09
Dumfloat	-1.8929	0.02	-0.7170	0.02	-0.3914	0.29
Frequency (MPC)	-0.0254	0.07	-0.0087	0.10	-0.0066	0.23
Sample		85		85		85
Inc. Observations		80		80		80
Iterations				6		5
Std. error of regression						0.46
Fit	R^2	0.31	Pseudo- R^2	0.08	HL statistic	8.8
Model significance	F- statistic	0.00	LR statistic	0.00		
Akaike criterion		4.77		4.63		1.29

*The reported standard errors are heteroscedasticity consistent.

** Robust covariance.

¹⁰ The indicators of goodness-of-fit and model significance confirm the success of our regressions in predicting the values of the dependent variable. The R^2 of the OLS is relatively large and according to the Hosmer-Lemeshow (HL) test, which compares the fitted expected values to the actual ones, we can accept that the ordered probit model provides sufficient fit to the data. The statistics of the overall significance of the models (both the F-statistic for the OLS estimation and the LR statistic for the probit estimation) show that our specification includes a substantive variable set.

Contrary to the OLS specification, the coefficient estimates from the binary models cannot be interpreted as the marginal effect because it is conditional on the value of all dependent variables. In addition, as Greene (1997) points out, the estimated coefficients of probit estimation must always be interpreted with care. For simplicity, in the remaining part of this section we refer to the coefficients of the OLS estimation to interpret the impact of each explanatory variable. However, we compare the signs of the coefficients from the different estimations, which shall coincide in all three estimations.¹¹

Constant

The constant represents the mean MPC size of the control group, assuming that the impact of all other explanatory variables is zero. According to the OLS estimation results, the coefficient is highly significant and the optimal committee includes around 6 members¹². Our estimate is consistent with the previous scientific literature in the field, suggesting that the optimal committee comprises roughly 5-9 members.

Heterogeneity indicators

As we have pointed out in the conceptual part of the paper, the uncertainty of information that decision makers use to formulate monetary policy is influenced by the size and heterogeneity of the monetary zone. Our estimates confirm this reasoning, irrespective to the method used, as both GDP and population variables are highly significant and have positive effect on the optimal committee size. The results also support the theoretical concepts of Kang (2004) and are consistent with the empirical evidence of Berger-Nitsch-Lybek (2006).

According to the OLS estimates, the coefficient of the population means that the optimal MPC size grows by 1 member if the population of the monetary zone increases by 50 million. The coefficient of the GDP indicator implies that the optimal committee contains 1 more member if the GDP increases by approximately 1400 billion dollars. With respect to the FED, the 2005 GDP of 12.5 trillion USD implies that the contribution of economic mass to the optimal FOMC size is roughly 9.

¹¹ In the case of the OLS estimation, the sign means the direction of change in optimal size as the given dependent variable increases, while in the case of the binary probit estimation the direction of change in probability that the optimal committee size includes more than 5 members. Finally, the sign of coefficients in probit models means the change in probability of falling in the upper endpoint ranking.

¹² We can not interpret this estimate as inconsistent with the optimal committee of odd number of members suggested in the theoretical literature because of the uncertainty of the regression results.

Monetary policy indicators

We are interested in how the design of monetary policy affects the optimal size. As a matter of fact, the econometric tests lead to unexpected results rejecting some of our previous hypothesis. Perhaps the most surprising finding is that central banks that peg their currencies do not have fewer members than other central banks. However, practical difficulties of exchange rate targeting (foreign reserve management, exposure to speculative attacks, etc.) may explain why this “robot-pilot” system does not require less efforts and fewer decision makers. Contrary to our expectations, the optimal size of central banks with floating exchange rate arrangements turned out to be significantly smaller. However, it should be noted that not all three specifications supported this result. The OLS estimate shows that the committees in floating countries are smaller by almost 2 members.

Moreover, we have not found evidence that the general design of monetary policy influence the optimal size, since neither monetary targeting nor inflation targeting dummies had significant explanatory power.

The estimated negative sign of our meeting frequency indicator also differs from our initial expectations. Lower frequency, i.e. more days between meetings, implies smaller committee size, while one could more easily accept that the relationship is the other way around. However, the reliability of this estimate is relatively weak because both probit estimations reject the hypotheses that the coefficient is significantly different from zero on standard significance levels.

As far as other features of central banks are concerned, we expected a positive relationship with respect to the number of workers (more effort spent in administrative issues instead of monetary policy) but a negative in the case of “age” of central banks (experience and learning). The first relation was confirmed with the data but the indicator was not included in the final specification given a high correlation of the GDP and the number of workers (multicollinearity problem).

Development indicators

The measures of economic development have not validated our hypothesis that improving information pooling capacities of developed countries leads to a smaller optimal committee size. Also, the significance of openness degree and political regime variables did not become proved. Our results confirm the findings of Berger, Nitsch and

Lybek(2006) who, using similar statistical methodology, also report insignificance of financial and economic development indicators.

Turbulence indicators

During periods of turbulence in the economy, the job of economic policy makers becomes more difficult because structural changes ruin previously well-shaped theories and economic forecasts based on historical data become less reliable. Under such condition, the marginal social benefit of decision making increases and, as a consequence, the MPC size also increases. For example, emerging countries have usually less stable economic environment and as a result the optimal size in their case may be larger. The econometric tests support the previous argument because the coefficient of GDP volatility is positive and significant in every specification. The slope estimate in the OLS specification indicates that roughly 20 percentage point increase in the volatility of GDP increases the optimal committee size by 1 member. Although our other three indicators of economic instability (inflation volatility, hyperinflation, consumption volatility) have no significant explanatory power, the GDP volatility can be regarded as a superior measure, as it gives the most precise picture about the overall macroeconomic stance used for monetary policy assessment.

Residual analysis – Which central banks do have too many or too few MPC members?

The final stage of our econometric investigation was the residual analysis that aimed to compare our model based estimation of optimal size with actual committee size. In the OLS specification n_i represents the actual size of the committee, while $\alpha + \beta X_i$ can be interpreted as the estimated optimal size, and the residual as a measure of divergence from optimum. Large differences between the estimated and “*de facto*” committee size, i.e., in econometric terms the large and significant errors, may indicate that the real committee size is not optimal for the given central bank. In addition, the residuals of OLS estimation allow for measuring how committee size should be changed to achieve optimal level.

The null of normally distributed regression residual cannot be rejected using standard significance levels (p-value of 0.13). The standard error of the regression is 2.5. Therefore, if the difference between the estimated optimal and “*de facto*” size is larger than 1, this implies that the *de facto* size is suboptimal at the standard 95% confidence level.

Through our analysis we show that the MPC size of most large central banks nearly coincides with the estimated optimal size (Federal Reserves:13, European Central Bank:17, Bank of Japan: 9). The only exception is the Bank of England, whose MPC has almost 3 more members than the estimated optimal size (**Table 6**).

Our estimates suggest that one member boards are suboptimal because the value of the error term in these cases is significantly different from 0, in accordance with the theoretical literature (Taylor and Faust (1955), Lombardelli (2002), Sibert (2006)), giving evidence that individual decision making can be considered as suboptimal.

Table 6: Estimated optimal and “de facto” MPC size in selected central banks¹³

	Estimated Optimal Size	"De facto" Size	Difference
Major Central Banks			
United Kingdom	6	9	3
Japan	10	9	-1
Economic and Monetary Union	18	18	0
United States	12	12	0
Central Banks in Other Countries			
Malta	6	1	-5
New Zealand	5	1	-4
Papua New Guinea	5	1	-4
Madagascar	5	1	-4
Denmark	7	3	-4
Uganda	5	10	5
Croatia	7	14	7
Hungary	8	13	5
Egypt	8	15	7

There are also countries that present significantly more members in their committees than the estimated optimal level. The discrepancy between the “*de facto*” and estimated committee size is especially striking in the case of Croatia, Egypt, Hungary and Uganda, which have 14, 15, 13 and 10 members in their committees, while the estimated optimal size is 7, 8, 8, and 5, respectively. Although in the case of Hungary the size of the monetary council will shrink after a transition period to 11 due to regulation amendments, it will still remain well above the estimated optimal level.

The implicit assumption of our analysis is that the surveyed central banks on average have an MPC with optimal size. This assumption is very likely to hold, because our

¹³ The estimated optimal size of monetary policy committees for each central bank can be downloaded with the survey data from the web-address given on pp 16.

estimation results regarding the optimal size are consistent with the theoretical literature. However, it would be worth to conduct the analysis even if the estimated optimal size were biased. For example, if the optimal size is underestimated then it would mean that the deviation from optimal size is also underestimated in some cases (Malta), however overestimated in other cases (Hungary).¹⁴

Finally, it is an interesting issue why does central banks' "de facto" MPC size differ from the estimated optimal size. First, and foremost it is clear that the tradition of central banks' play an important role. Moreover, the optimal size changes continuously over time and the adjustment costs from changing the central bank act and internal regulations can be vast in the short run. Although central banks have become more and more independent in the past, political factors can still add to the observed discrepancy.

6. Conclusions

We raised the question whether the optimal size of a monetary policy committee can be quantified. In order to reach a plausible answer we investigated several aspects of the issue. Our review of the theoretical literature suggests that neither too small nor too large committee size is optimal. The main benefit of larger committee size is the higher information pooling capacity, meanwhile the major cost is related to the interaction process in solving tasks, such as performance and accuracy of decisions.

The paper also introduces a simple conceptual model, consistent with the theoretical considerations and also suitable to empirical tests. According to the model, if the uncertainty of the signals, which decision makers use to formulate monetary policy, increases, then the optimal committee size grows. As the uncertainty is influenced by several factors - features of each monetary area -, the optimal committee size may change from central bank to central bank.

In order to test our concepts, we carried out a survey with 85 central banks. In this sample, the average MPC, both "de facto" and "de jure", consisted of 7 members. The size of policy committees in practice is somewhat smaller than the "de jure" size, reflecting that the nomination and appointment procedure requires the cooperation of several authorities and entities. Therefore, central banks can protect against the undesired shrinking of the MPC due to the appointment procedures by defining higher

¹⁴ The bias may arise from omitting relevant explanatory variables related to the social costs and benefits of monetary policy committees.

MPC size by law. The survey gives us evidence that central banks dislike too small committee size as the average “*quorum*” MPC size is well above one, close to 4. There also exists a clear bias towards committees with odd number of members reflecting that it is easier to achieve majority and decisiveness if the committee has odd number of members.

Our MPC database has also been used to run an econometric exercise in order to capture whether there are differences in the optimal committee size among central banks. Overall, our concepts are supported by empirical evidence. The optimal committee has roughly 5-9 members. However, the estimated optimal size is usually larger for bigger countries because the pooling of more information needs the presence of more members. The economic stability represents also an important driving force. Turbulences impede information pooling, and countries with economic instability employ more MPC members.

The econometric analysis suggests that different monetary policy regimes and decision making procedures suit different MPC sizes. For example, if the monetary policy committee has less frequent meetings, then the size is larger. However, this result is not supported by all estimation methods. We also found that central banks with floating exchange rate regimes have fewer members in their committees. This result seems to contradict established theories on the subject because one could expect that floating regimes need more expertise and information pooling from decision makers than any other regimes, including for example “robot-pilot” pegged exchange rate arrangements.

The model based estimates are also used to draw conclusions whether the MPC size of individual central banks significantly differs from the optimal level. The residual analysis allows us to verify that the MPC size of large central banks (FED, ECB, BOJ) is very close to the estimated optimal level, while there are several smaller central banks (Croatia, Egypt, Hungary, Malta) which seem to have too many or too few members in their MPCs.

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APPENDIX 1: Surveyed countries and monetary areas

1	Albania	43	Macedonia
2	Argentina	44	Madagascar
3	Armenia	45	Malawi
4	Aruba	46	Malaysia
5	Australia	47	Malta
6	Barbados	48	Mauritius
7	Belarus	49	Mexico
8	Belize	50	Moldova
9	Bermuda	51	Nepal
10	Bhutan	52	New Zealand
11	Bosnia and Herzegovina	53	Nigeria
12	Botswana	54	Norway
13	Brazil	55	Oman
14	Bulgaria	56	Pakistan
15	Canada	57	Papua New Guinea
16	Chile	58	Peru
17	Colombia	59	Philippines
18	Croatia	60	Poland
19	Cyprus	61	Romania
20	Czech Republic	62	Russian Federation
21	Denmark	63	Saudi Arabia
22	Eastern Caribbean Central Bank	64	Serbia
23	Economic Monetary Union	65	Seychelles
24	Ecuador	66	Sierra Leone
25	Egypt	67	Singapore
26	Estonia	68	Slovak Republic
27	Guyana	69	Slovenia
28	Honduras	70	Solomon Islands
29	Hungary	71	South Africa
30	Iceland	72	Sri Lanka
31	Indonesia	73	Sweden
32	Israel	74	Switzerland
33	Japan	75	Tanzania
34	Kazakhstan	76	Tonga
35	Korea, Rep.	77	Trinidad and Tobago
36	Kuwait	78	Turkey
37	Kyrgyz Republic	79	Uganda
38	Latvia	80	United Arab Emirates
39	Lesotho	81	United Kingdom
40	Libya	82	United States
41	Lithuania	83	Vanuatu
42	Macao	84	Venezuela
		85	Zambia