

Have central bankers become more efficient?

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Abstract :

This paper examines the influence of the biographical experience of monetary policy committee members on their performance in managing economic volatility. Our sample covers major OECD countries in the 1999 to 2010 period. The results show that policy makers' backgrounds influence the volatility management, and that some monetary policy committees have been able to get back to efficiency sooner than others during the crisis. The role of committee members from the academia contrasts strongly with the one of members whose career was made in the central banks, especially in turbulent times.

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1. Introduction

We aim at empirically assessing the impact of the characteristics of central bankers on the efficiency of their institution in managing the inflation-output volatility trade off. In other words, we seek to identify how the leadership structures of central banks impact their macroeconomic performance.

More precisely, the question is how to measure the potential influence of a monetary policy committee's composition and biographical characteristics of its members on monetary policy efficiency. The problem notably comes from the fact that the management by a central bank of the inflation-output volatility trade off is dealt with differently by various committees, with different compositions, and those can be considered equivalent in term of social welfare. The identification of an efficiency frontier capturing the best performances is therefore of paramount importance. Furthermore, it is not at all clear that with the same resources all the central banks would manage to reach a point on this desirable frontier. Thus, it is clear that a crucial question in the management of central banks is how efficient a given structure is at reaching its objective and also how, in a given structure, the resources mix is able to lead to an optimal policy. Consequently, the objective of this paper is to identify the performance of different structures at managing the inflation-output volatility trade off and how in a given structure is able to reach the frontier given the composition choices of the board.

Our research hypothesis is that leaders matter. What was a common sense intuition has been backed by rigorous empirical work. E.g., Jones and Olken (2005) show that individual leaders can play crucial roles in shaping the growth of nations, while Besley et al. (2011) show that more educated leaders generate higher growth. A potential mechanism for this could be that more educated leaders are more inclined towards reform (Dreher et al., 2009).

As our hypothesis goes, in central banking also, leaders matter. Chappell et al. (2005) study the voting behavior of the Federal Reserve's FOMC members and find an explaining power for their educational and professional achievements. Göhlmann and Vaubel (2007), for a panel of almost 400 central bankers covering the period 1973–2000, show that their occupational background carries a more significant weight than their educational one. Farvaque et al. (2011), comparing central bankers from the OECD countries in the more recent period, reveal that, while academics and private sector backgrounds are influential (and hawkish) in inflation-targeting committees, the (dovish) impact of a public sector background is important in non-targeting ones. These studies generally put a greater emphasis, in the case of central bankers, on professional experience than on educational background. However, they mostly looked at the inflation performance of central bankers, when it can be considered that the central bank's mandate covers more than one goal.¹

The ability of central banks at managing a multidimensional objective function, more precisely the inflation-output growth volatility trade-off has been the focus of, e.g., Cecchetti and Krause (2002), who derive performances for 24 central banks from inflation and output volatilities, then construct efficiency frontier for each of them and finally regress the policy-implied loss of performance on independence, transparency and accountability indexes. In a subsequent work Cecchetti et al. (2006) estimate efficiency frontiers for two periods (1983-90 and 1991-98), and find monetary policy to have become more efficient in most countries. Krause (2007) finds a similar result for pre-EMU period among the prospective members. Mester (2003) reviews the available techniques for estimating central banks' efficiency, and

¹ For a renewal of the debate on central banks' goals in the wake of the crisis, see the reflections by Blinder (2010) or Mishkin (2011).

highlights the relevance of the efficiency techniques when measuring the performance of central banks, but notes that monetary policy is probably the most complex of their activities. Finally, Hasan and Mester (2008) use inflation variability as a single performance measure, and regress it on (among others) the number of governors and their turnover. They find a positive impact for both variables but only in developed countries. The main lessons from these studies are, first, the importance of both inflation and output variability for the assessment of central banks performance and, second, that the impact of the precise composition of the monetary policy committees on this performance remains unexplored.

Our dataset covers 194 central bankers, who served during the period 1999-2010 in the nine world's major central banks. These are: the European Central Bank, the Reserve Bank of Australia, the Bank of Canada, the Bank of Japan, the Reserve Bank of New Zealand, the Swedish Riksbank, the Swiss National Bank, the Bank of England and the Federal Reserve System of the USA. Among these central banks, some of them follow inflation targeting regimes, which will be acknowledged in the empirical study, as it may prove influential when assessing how the central bankers in our sample have dealt with the crisis period, in particular.

Our contribution to the literature is thus twofold. First, we provide efficiency measures for nine major central banks before and during the crisis period. Second, we estimate the impact of the composition of the central banks' committee members characteristics on the estimated efficiency measures.

Our results show that there are large differences among the central bankers in terms of efficiency in spite of the broad similarity of the institutions we consider (comparable degrees of independence, transparency and credibility). It does confirm however, that behavioral differences persist in the world of central banking.² Second, they show that efficiency can evolve in time, and they notably establish that some central banks have reacted quicker than others in front of the current crisis. Third, the econometric analysis exhibits that, among the determinants of the central banks' efficiency, the proportion of academics and of central bankers stands out. Moreover, their respective role evolves: if academics matter more than central bankers before the crisis period, this event offers central bankers an occasion to reveal their expertise.³

The reminder of the article is organized as follows. Section 2 presents our approach and the underlying model and section 3 reviews the original elements of the data we explore. In section 4.1 we assess the efficiency of the central banks under scrutiny whereas in section 4.2 we explore the determinants of these obtained efficiency scores.

2. The model

In this section, we present the methodology used in this paper to assess the efficiency of the central bankers at using resources in order to manage the economy, and compare it with the

² See Blinder et al. (2008) who show that such discrepancies also exist in central banks communication.

³ This lies in conformity with Jean-Claude Trichet's words: "When the crisis came, the serious limitations of existing economic and financial models immediately became apparent. Arbitrage broke down in many market segments, as markets froze and market participants were gripped by panic. Macro models failed to predict the crisis and seemed incapable of explaining what was happening to the economy in a convincing manner. As a policy-maker during the crisis, I found the available models of limited help. In fact, I would go further: in the face of the crisis, we felt abandoned by conventional tools. In the absence of clear guidance from existing analytical frameworks, policy-makers had to place particular reliance on our experience. Judgment and experience inevitably played a key role." (cited in Kirman, 2011)

ones formerly used by the related literature. The basic principle of monetary policy-making can be roughly described as central bankers using resources to promote their analysis to influence monetary policy decisions and to steer the economy.

2.1. General framework

Starting from a standard framework, the central bank's loss function assumes that it aims at minimizing a weighted sum of inflation and output variability. Using standard notations, the usual quadratic form for such a loss function writes:

$$L^{CB}(\pi_t, y_t) = \lambda \pi_t^2 + y_t^2$$

Knowing that the quadratic loss functions describing the central bank's preferences imply that the expected losses can be reduced to the weighted sum of the variances of inflation and output growth, it writes:

$$E[L^{CB}(\pi_t, y_t)] = \lambda^2 \text{var}(\pi_t) + \text{var}(y_t).$$

The key element to the success here is the way in which the central bank minimizes the expected loss function. This simple view implicitly supposes that the central bank will have to manage some resources to become more or less efficient, something on which we will focus on below, by looking at the composition effect of the monetary policy committee (whose members can rely on their own capacity, built through professional experience, education, cultural background, and so on). Monetary policy is thus described, in a standard way, as an attempt to reduce the volatility of the economy, as perceived through inflation and (a measure of the) economic activity.

An output-oriented measure of each central bank's efficiency is obtained by measuring the distance between an output mix given an input level⁴, and the frontier of the production possibility set for that same input level. That is, $\theta^* = \text{Max}_{\theta} \{ \theta : (x, \theta z) \text{ is feasible} \}$ where θ is a scalar (interpreted as the largest factor by which output can be increased given the input level x such that the production θz is still feasible) and z is a vector of the precisions of inflation and GDP growth (*i.e.* the inverse of inflation and GDP growth variances, respectively). That is, minimizing inflation and GDP growth variances is considered as equivalent to maximizing the precisions of these measures.

In the language of production method analysis, the practical problem is to implement this procedure is that the true frontier is not observed and needs to be estimated. Data Envelopment Analysis (DEA) offers a method for approximating the production possibility set. The basic principle of the methodology is that each policy-maker is compared to all the others (including herself) and her performance is compared to the best practices (that might be hers). For a central bank under scrutiny, called decision making unit (DMU) "0", the local approximation of the relevant production set and her performance is obtained by solving the linear program:

⁴ Note that x is unique and set equal to 1 at each point considered in the sample.

$$\text{Max}_{\theta > 1} \{ \theta : \sum_{d=1}^D \gamma_d z_{dj} \geq \theta z^0, \forall j = 1, 2; \sum_{d=1}^D \gamma_d = 1; \gamma_d \geq 0 \}, \quad (1)$$

where D is the number of DMUs, J , the number of outputs. The constraint on the sum of γ s ensures that the frontier is the smallest convex envelope of the data.⁵

The most important consequence for us is that, in practice, the performance of a given central bank is compared to the best practices of the others, so the performance is just an estimate of the true performance, as we do not know if the best practices are really on the frontier or just “close” to it.

2.2. Relation to the extant literature

The literature mentioned above attempts, implicitly or explicitly, to evaluate how efficient central banks are and / or the determinants of the estimated efficiency. So doing, the literature generally has to make some assumptions, auxiliary or fundamental, that may curb the estimation process. The use of the production view provides a different approach.

First, although it may appear as surprising, the DEA method considers that a central bank is not fundamentally different from a shoe factory. However, in fact, one has to acknowledge that a central bank uses inputs such as interest rate, knowledge of the economy identified with human capital of board members, and so on, to produce outputs such as low inflation and GDP volatility. Consequently, the performance of such decision units can be analyzed and compared (Mester, 2003). Data Envelopment Analysis (DEA) methods are tools that can be used to weighted the relative performance of central banks identified as decision making units.

A central bank is often considered to be an optimizing agent and DEA allows us to test this claim. DEA methods allow us to exploit database on the backgrounds of the central bankers in office at decision time. In other words, we can assess the efficiency of their management based on their "human capital" (perceived as an input in the production process). Hence, we can assess the productivity of a producer endowed with several inputs when she has to transform those inputs into an output vector, i.e. the volatility of inflation and GDP growth. It is important to note that the method proposed allows us to study the ability of central bank at managing the trade-off between inflation and GDP growth volatility without relying on a parametric assumption about the trade-off. The frontier of the best practices is estimated non-parametrically from the data. This frontier is then used to compare the other central bankers to those used to define the best practices. One central innovation that DEA allows us to provide is an estimation of the arbitrage central bankers do over alternative policies.

As a consequence, an important difference with the extant literature is that we do not have to rely on the, official or (worse) supposed, objectives of the central banks under scrutiny. Cecchetti et al. (2006), for example, have to assume an inflation target equal to 2%, and the minimization of the variability of GDP around its potential. They further have to check the robustness of their results by testing several alternative scenarios. The DEA method we make use of afterwards avoids the need for such assumptions, by comparing each central bank to

⁵ In a standard DEA model, we would introduce the inputs through a constraint of the form $\sum_{d=1}^D \gamma_d x_m \leq x_{0m}$, $\forall m = 1, \dots, M$. But, in our case, because $x = 1$ for all m and d , and with the constraint on the γ s, this constraint reduces to $\sum_{d=1}^D \gamma_d = 1; \gamma_d \geq 0$.

the best behavior in the sample. More precisely, each performance is compared to the best radial projection (on the frontier), and the latter may not belong to the performance of the same central bank. For example, this permits to compare the Reserve Bank of Australia to the European Central Bank, and not only each central bank with herself.

A second, related, difference of the method we use is that we do not have to rely on filters to measure potential output, a notoriously tricky process. Here, we do not impose the differentiation between the trend and the seasonal component of the series, but make use of the statistical properties of the series themselves, through a GARCH estimation procedure. This also means that we do not have to estimate the dynamics of inflation and output for each of the countries we study to be able to define the policy rule followed by each central bank, but only use the predicted volatility from the GARCH.⁶ This necessarily comes at the cost of further identifying assumptions, something we bypass by resorting to GARCH estimates. Importantly, so doing, we do not have to impose neither a policy rule nor a policy instrument, which is especially valuable as our sample period includes the financial and economic crisis periods, where several central banks have changed their policy course and modified their intervention methods (given the zero lower bound on interest rates, the ECB and the Fed, in particular, have implemented large quantitative easing measures, which would spoil the results, would they be based on estimated policy rules). Moreover, the issue of real-time data, as raised since the contribution by Orphanides (2001), can be overlooked with this method. The reason is simply that, any existing bias in the real-time data would be expected by the central bankers, and be integrated in their decision process. More technically, the noise brought by the revision of data would be a process with an average equal to zero.

A third difference comes from the fact that, in the traditional approach, the quadratic loss function has to be estimated, which raises the question of the relative weight of the two objectives (λ). Two possibilities are in order here: either one has to estimate the policymakers' preference parameter (as Krause and Méndez, 2008, do for a sample of central banks⁷), or has to assume that the preferences do not shift over time (as in Cecchetti et al., 2006). As the DEA method compares each central bank with her peers, the relative weight of the two objectives can evolve over time and does not have to be over-imposed on the estimation procedure.⁸

A final difference is that the peers that are considered by the DEA method are those who pursue (implicitly or explicitly) the same kind of objectives. For example, central banks that tolerate high GDP growth volatility will be compared together, and not with central banks that accept high inflation volatility. Moreover, the upper bound of the performance is determined in this example by those that minimize the variance of inflation, given the same output growth volatility.

3. Data

⁶ To save on space, the results from the GARCH estimates are not provided, but are available upon request from the authors. The estimated model is an AR(1) in mean and a GARCH(1,1) for the variance. Exceptions are for Canada's inflation and Japan's output (we have used an AR(1)-ARCH(1)) and for inflation in the USA (we have used an AR(1)-ARCH(5)) model. All processes have been estimated over the 1971:1-2010:4 quarterly data except for New Zealand output (1983:2-2010:4) because of data availability and for the UK 1990:1-2010:4 for output and for the UK and USA over the 1991:2-2010:4 for inflation because unconstrained convergence was not achieved otherwise. We have used the predicted values of the variance of the estimated process to construct the precision measure.

⁷ See, for estimates of preferences that focus on a single bank, e.g., Favero and Rovelli (2003) for the Fed, and Berger et al. (2005), for the Bundesbank.

⁸ The variances are estimated around zero, and not around the target of the variable.

The dataset covers the nine most important central banks (as in Eijffinger and Geraats, 2006): the European Central Bank (ECB), the Reserve Bank of Australia (RBA), the Bank of Canada (BC), the Bank of Japan (BJ), the Reserve Bank of New Zealand (RBNZ), the Swedish Riksbank (SR), the Swiss National Bank (SNB), the Bank of England (BE) and the Federal Reserve System of the USA (Fed). This sample covers major OECD countries: all G7 countries plus other countries of the euro area, New Zealand, as well as Switzerland and Sweden.

The time span contains quarterly observations from 1999Q1 to 2010Q4. As such, the dataset updates the one used in Farvaque et al. (2009, 2011). This time span is limited by the activity of the European Central Bank and data availability - e.g. BJ and SNB publish their annual reports on their website since 1999, BE since 2000 only. However, this time span also ensures consistency and comparability. Moreover, in most countries and notably the Euro zone and the United States this period covers one full “interest rate cycle”. Namely, interest rates moved generally upward approximately during the first two years (until the end of 2000) and then a remarkable tendency to cut them emerged, being reinforced by the “dot-com” crisis, September 2001 attacks and the general subsequent economic slowdown. Finally, after a relative stability in 2003 and 2004, an equally marked upward movement is easily perceivable. This last tendency moved interest rates in most countries to a level equal or comparable with the one in the beginning of the period. The penultimate period (2007 – 2008) corresponds to the outbreak of financial crisis, which has seen policy rates driven to very low levels. During the last two years of the sample (2009-10) the main interest rates in all of the analyzed countries remained at historically low levels, in some of them facing the zero lower bound.

In order to assess the impact of central banks’ elites on their outcomes, the analysis relies on a databank including macroeconomic data and the CVs of monetary policy committees’ (MPCs’) members. The former comes from the IMF's International Financial Statistics database retrieved in May 2011, the latter was constituted by the authors and contains 195 entries. Most of the data have been retrieved from the websites and especially annual reports of the analyzed central banks. Nevertheless, some details of certain biographies come from other sources: *Who's who* website, *Central bankers in the news* (www.centralbanking.co.uk), *Forbes*, *Quid* and finally directly from press or personnel services of central banks.

The database allows for taking into consideration some external factors (which do not depend on the individual members’ characteristics), such as: the number of members and measures of MPC dynamics (number of changes and turnover, i.e. the number of changes related to the size of the MPC). However, its focus is on the internal characteristics of MPCs: demographic characteristics (age and gender) as well as social ones (professional profile and educational background).

3.1. Monetary Policy Committees size and dynamics

We first consider the size of the committee by itself. This feature is both empirically important (as the debates around the enlargement of the Euro area have shown), and theoretically (as there is a presumption, dating at least to Condorcet, 1785, that an increase in

the number of members of a committee could lead to better informed decisions⁹).

However, one of the distinctive features of the database is to take into account the real number of appointed policy makers and not the statutory number of MPC members. For example, while the FOMC has twelve voting seats, during 1999-2001, most of 2005 and 2007-8 two positions were vacant. Here, we consider the number of members to be 10 and not 12 during that period.¹⁰ This choice influences the analysis (and especially the shares of different categories presented below) as the total number of members in the sample varied between 69 in 2006:Q3, and 73, when all positions were filled (during 2003-2004), and 76 in the last observed period (2010:Q4), when one seat was vacant in the board of the BC, one at the Fed, while the Governing Council of the ECB has already been enlarged by representatives of Malta, Cyprus and Slovakia (but not yet Estonia).

The second characteristic we consider is also linked to the number of members and is the turnover of MPC members. In the corporate governance literature, this feature has been shown to influence the work of any committee. In the case of MPCs, turnover might be even more important for a number of reasons. On the one hand, the turnover is linked to the tenure of MPC members which is used as one of the factors influencing central bank independence, and this interaction has already been investigated.¹¹ Similarly, an excessive turnover might endanger the MPC credibility, which is probably equally important. On the other hand, from a principal-agent perspective and depending on the appointment process, an increased turnover may be an incentive to work harder, for example by acquiring additional information.

Within the whole sample, the New Zealand Reserve Bank is the only one where monetary policy is decided by a single decision-maker. The largest MPCs are the ECB's (21 members since 2008 and 22 since January 2009, when Slovakia joined the euro area) followed by the FOMC (12 members). In most of the analyzed countries the number of members is absolutely stable and equal to the statutory number of members, though, in some countries like the USA, Great Britain or Australia, some seats remained unfilled during relatively long periods.

In most of the analyzed countries the replacement of MPC members is quite smooth and, usually, the terms of office overlap and each year there are a few changes, without affecting the overall composition of the committee. However, in a country with a single decision maker, one change signifies a "total turnover" of the committee. Moreover, in the FOMC, due to the rotation scheme of Federal Reserve Banks' Presidents, each year in January at least 4 voting members change. In order to assess the impact of these MPC dynamics two variables are computed: the number of changes and turnover. A replacement was counted as one change, whereas a resignation without replacement (or a nomination to an unfilled position) was counted as "half a change"¹². However, as the sizes of MPCs differ, to take into account the relative impact of the change, the turnover variable is defined as the number of changes with regard to the effective number of members of the committee.

As the total number of MPC positions in analyzed OECD countries equals 78 and the number of decision-makers who served during the analyzed time span is 195, the average turnover in the sample approaches 1.5 for the whole period. This means that, on average, in all the analyzed MPCs, each member was replaced at least once.

⁹ The presumption is now severely contested in the literature; see for example the survey by Gerling et al. (2005).

¹⁰ However, as the frequency adopted for the whole analysis is quarterly, it was decided not to pay attention to members present and absent during any particular MPC meeting.

¹¹ See e.g. Cukierman (1992) and the more critical study by Dreher et al. (2008).

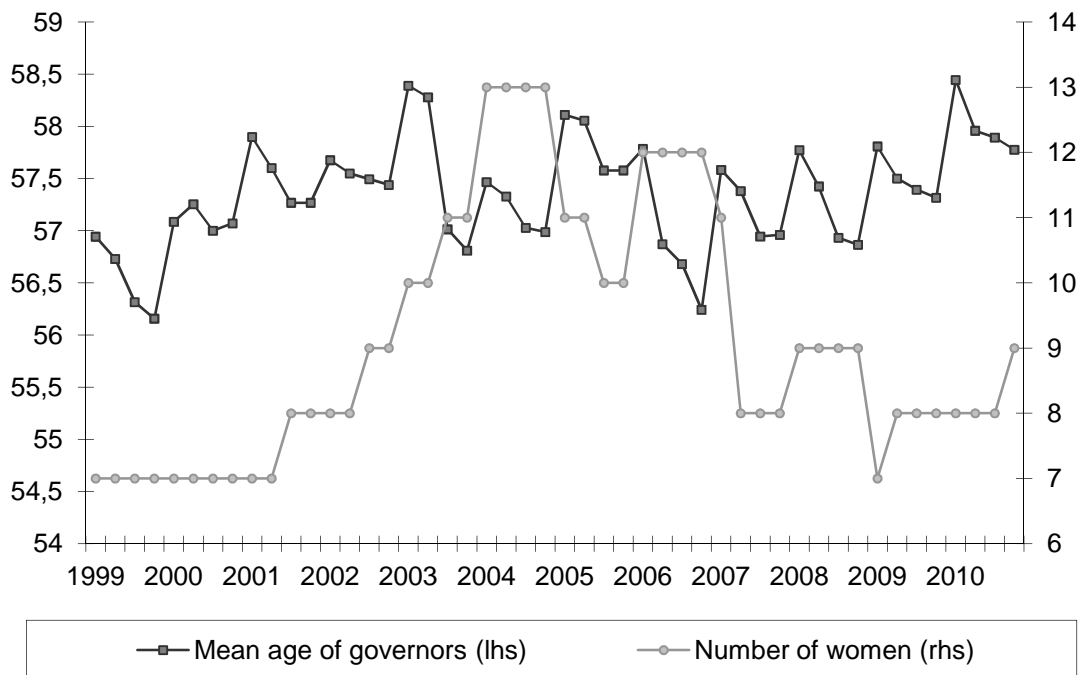
¹² Thus, e.g. the joining of the President of Bank of Greece to the Governing Council of the ECB in 2001 or Bank of Slovakia (related to the enlargement of the euro area) was counted as "half a change".

3.2. Monetary Policy Committees' demography

We study the link between the age structure of central banks' elites and their inflationary performance, on the premise that age may influence the degree of conservatism. For the age variable, the "average year of birth" of the surveyed central bankers was 1947.¹³ However, the average age varied only slightly for the whole sample (between 56.2 in 1999:Q4 and 58.5 in 2010:Q1) during the analyzed time span, being equal to 57.1 in 1999:Q1 and to 57.8 in 2010:Q4. These two evolutions, completed by the number of women (discussed below) are illustrated in figure 1.

Moreover, the frequency of years of birth of the 184 governors roughly followed a normal distribution, which is illustrated in figure 2. Nevertheless, it seems important to remark that there were important differences between countries, with the oldest on average MPCs to be found in Japan and the United States, followed by the ECB, while the youngest was in Sweden in the beginning of the sample period and in Switzerland towards the end.

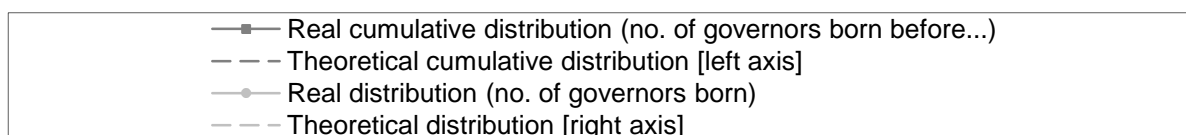
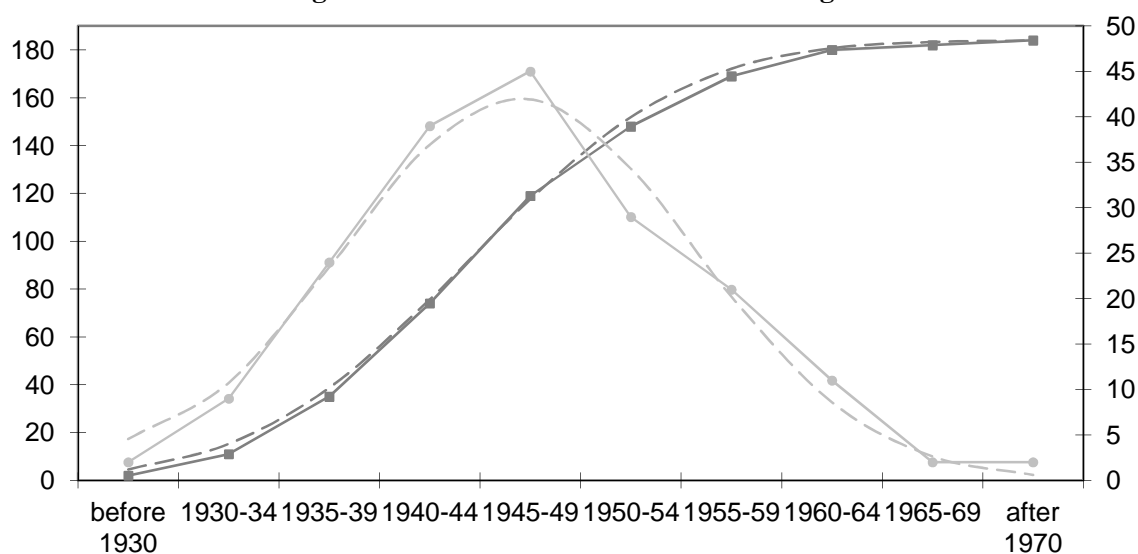
Figure 1. Demographic features of MPC members



Source: authors

¹³ It was possible to find the years of birth for 184 out of the 195 surveyed MPC members in OECD countries. It was due, among others, to the Bank's of Canada privacy policy, whose press service did not provide years of birth for two Canadian governors. Hence, for the following empirical analysis, the year of birth of governors for whom we had no precise information was approximated by the year of their graduation minus 21, which seems a plausible assumption and turns out to be an innocuous choice.

Figure 2. Distribution of MPC members' age



Note: Theoretical distributions were plotted using mean and variance computed from the sample: theoretical values follow $N(1947, 74)$.
Source: authors.

We consider another sociologically interesting demographic feature – gender –, as it may also have an impact on MPC members' preferences. Chappell and McGregor (2000) for example remark that female members of the FOMC tended to be on the dovish side of the preference spectrum.

Among the 195 decision makers who were in charge of monetary policy in the 9 surveyed central banks, only 23 were women (11.8 %). The number of women varied more, between 7 in 1999-2001 as well as in 2009 and 13 in 2004-5 (on about 75 positions). We can see that central banking remains dominantly a men's world.¹⁴ The most feminized MPC is Sweden's where, since 2003, the council includes 50% of women. During some periods, women represented a third (3 out of 9 committee members) of the Bank of England's MPC. On the other hand, in Switzerland as well as in New Zealand there were no women during the whole period, while in the ECB, the RBA, Bank of Canada as well as in the Bank of Japan, one of the MPC members was female (not necessarily the same during the whole period, but usually female members are replaced by other women¹⁵).

3.3. Central bankers' social characteristics

As in Göhlmann and Vaubel (2007), we suppose that the socialization processes the central bankers undergone throughout their professional career can influence monetary policy. In order to assess this impact, we first analyze their dominant type of professional experience.

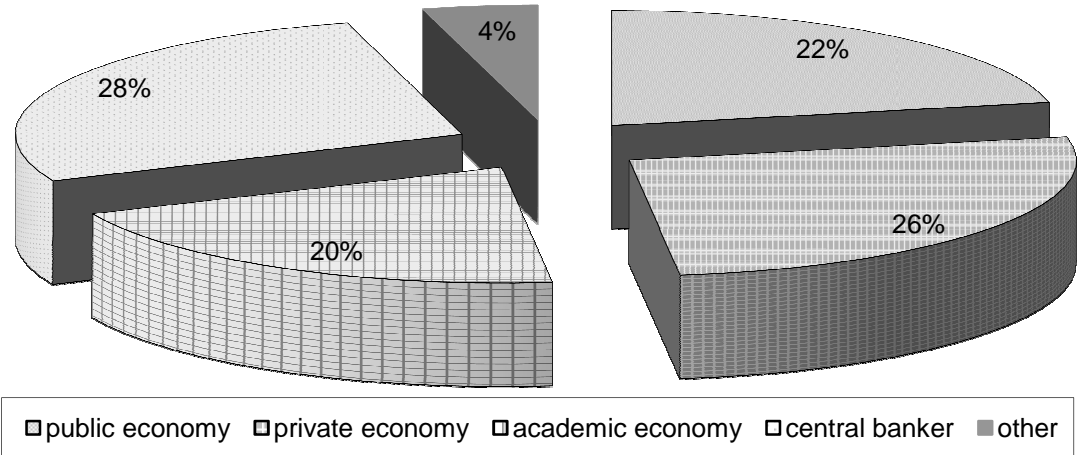
¹⁴ Note that the appointed women presently tend to be younger than their male counterparts, which impacts on the average age.

¹⁵ E.g. in the Board of the ECB Gertrude Tumpel-Gugerell replaced Sirka Hamalainen in May 2003 and in Japan Miyako Suda replaced Eiko Shinotsuka in 2001.

This variable is classified into five categories: public economy (meaning that the MPC member worked for the government, e.g. as the finance minister, treasurer or, very rarely, for a state-owned enterprise); private economy (if the MPC member worked mainly in the private sector); academia (if the member followed an academic career); central banker (if the main part of the professional life was spent within the central bank); and, finally, other (mainly professional politicians, but also a few jurists and journalists).¹⁶ The structure of these categories for the 175 MPC members of our database is presented in figure 3.

This structure, however, is not stable, even in the relatively short (44 quarters) time span of the present analysis. The share of public economists varied between 24.6 and 28.4%. Remarkably, the share of academics increased from about 16% in the beginning of the period (11 out of 70) to slightly more than 20% (15 out of 74). This evolution was first detrimental to central banks insiders, whose share decreased from 30% in 1999 to slightly more than 21% in 2007, before coming back to more than 27% in 2008. The participation of private economists in the beginning was close to 24% and increased to ca. 28%. The share of members classified as “others” was very restrained (3-6%) during the whole period. These evolutions are presented in figure 4. Details on individual MPCs compositions are presented in figure 4A in Appendix.

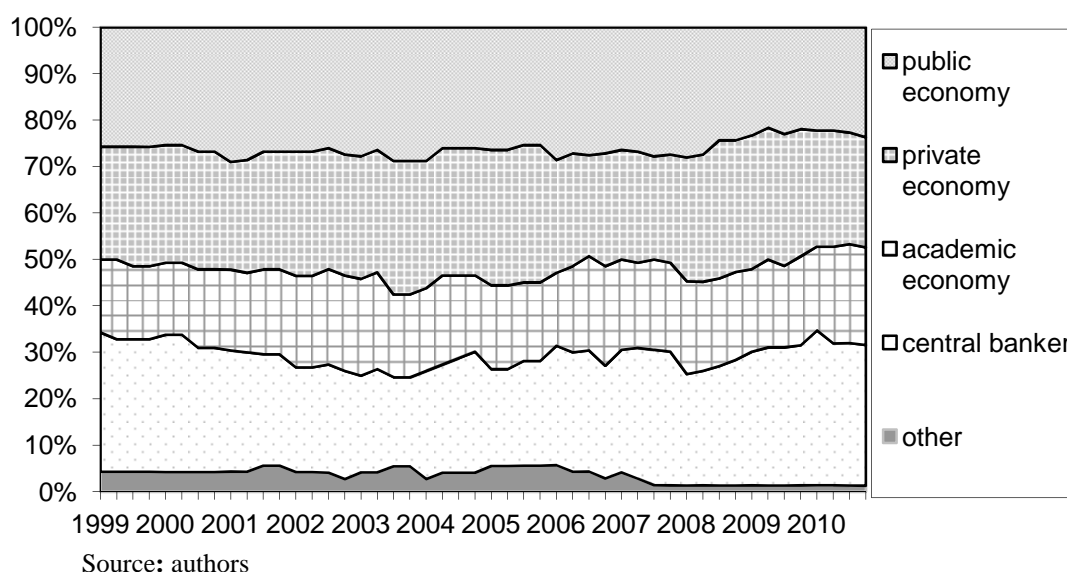
Figure 3. Structure of MPC members’ professional affiliations (1999 - 2010 average)



Source: authors

¹⁶ As in the further analysis the focus of attention will be given to heterogeneity of committees, it seemed inappropriate to allow for different types of career for individual members. We decided to consider the dominant (and not the last) type of occupation because the last job was in some cases very short-lasting in which case the socialization process would have been limited. In a few cases, when a member worked during similar periods in e.g. academia and government, the last experience was chosen.

Figure 4. Shares of professional categories over time



However, one has to notice that these proportions significantly differ between countries. Some central banks have the obligation to include active professionals in their MPCs (e.g. Australia), while some others interpret the general clause (present in virtually all central bank acts and statutes) that the MPC members must be recognized specialists as a quasi-obligation to appoint mainly professors of macroeconomics and finance. Hence, for example, the Governing Council of the ECB is dominated by “public economists” (their number varied between 10 and 13 on the total 17-22 members), in Australia “private economists” systematically represent half of the Reserve Bank Board members (4 or 5 out of 9) while the Bank of Canada is governed mainly by “central bankers”. Some MPCs have significantly evolved during the period: in 1999, the British MPC was constituted mainly of central bankers (4) and academics (3), while in 2006:Q3 it was composed in equal numbers (2) of academics, central bankers and public economists, all these being completed by a private economist. In 2008 once more, central bankers (3) and academics (3) dominated the rest of the council (1 public and 2 private economist). Heterogeneity is also a characteristic feature of the Swedish MPC.

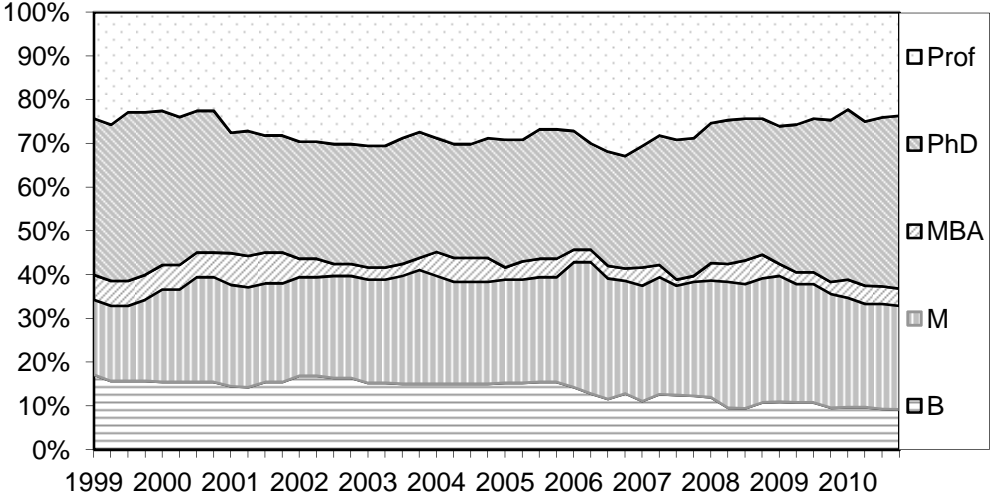
The second social feature we consider is education, as it is an eminent factor shaping the general outlook of people and thus also their preferences¹⁷. Similarly to the professional background, educational attainments were dispatched into five categories: Bachelor (including LLBs), Master (of both science and arts), MBA, PhD and, finally Professors. A few comments on this categorization are in order: First, it was decided to distinguish MBA as a separate category, even if it turns to be the smallest one, because such a specifically entrepreneurial formation may matter in shaping policy preferences. Second, even if professorship is not a diploma, this professional title should prove an important capacity to analyze information and transmit knowledge to different kinds of public, which is important

¹⁷ We consider education by degree and not by field (as Dreher et al., 2009, or Göhlmann and Vaubel, 2007, do). As our sample contains both the diploma and the professional background of committee members, considering the field of education would have overlapped in many cases with the committee members' experiences, and would have led to colinearity problems. Moreover, a second argument is that a dominant part of the individuals in our sample held degrees in economics (about 90%).

in modern monetary policymaking. The communication skills of academics can also be an asset to improve the accountability of the monetary policy and thus increase its effectiveness.

Among the 195 monetary policy makers we surveyed, the biggest part (33%) is represented by PhD holders, followed by professors (24%), and masters (22%), further completed by a significantly smaller participation of bachelors (15%) and by the smallest group of MBA holders (6%). Nevertheless, the important observed evolution during the period relied on the constantly growing part of professors – mainly at the cost of PhD holders until 2006 - a trend which was reversed thereafter. Also, the participation of bachelors markedly decreased in the second half of the period (from 12 out of 70 in 2005:Q4 to 7 out of 76 in 2010:Q4)¹⁸. This trend is likely to persist, as the bachelors in MPCs are significantly older than other members and are probably close to retiring (the “average year of birth” is 1940 for all the bachelors). Moreover, the general and already mentioned trend in monetary policy making is to rely more and more on academics. These evolutions are illustrated by figure 5. Details on individual MPCs compositions are presented on figure 5A in Appendix.

Figure 5 Shares of education levels



Source: authors

¹⁸ Moreover, five of the bachelors serving in 2006 were at the BJ, two at RBA and one in the British MPC; in 2010 there were 7 Bachelor holders, out of which 4 were at the BJ and three at the RBA.. Another interesting remark is that the majority of bachelors (18 out of 29) represented the private sector. As such, they were probably expected to bring into their respective MPC the private economy's point of view.

4. Results

The results are displayed in two steps: we first discuss the degrees of (in)efficiency and their evolution, in particular since the crisis period, before turning to the estimates of the impact the composition of the MPCs can have on efficiency.

4.1. Efficiency analysis

Efficiency results are displayed, for the whole sample, in figure 6 and their descriptive statistics appear in table 1. As can be seen from the figure, the distribution is relatively dense. The frontier is built from four points, three belonging to the Bank of England's performance, one to the ECB's. There are very few extreme (i.e. very inefficient) values, although it can be noted that the last point too belongs to the BoE.

More interesting results come from the cross-country comparison. For that purpose, we display each central bank's performance in figure 7. As can be seen, except for the Federal Reserve and the Bank of England, the distribution of the efficiency estimates does not show strong dispersion of the efficiency index. Moreover, some central banks clearly show high average efficiency results. This is in particular the case of the ECB and of the Swiss National Bank. Another striking feature is that, in the cases of the ECB, the Bank of Japan and the Bank of Canada, the observations are relatively grouped towards the frontier, even if, as for the BoJ notably, the frontier is never reached. Worth noting is of course the performance profiles of the Fed and the Bank of England, who are clearly different from the other central banks of the sample. The BoE shows at the same time a large frequency of observations at the frontier, or close to it, and several points dispersed quite far from the frontier. The Fed's behavior shows a much larger proportion of its performance indexes quite far from the frontier.

Figure 6.

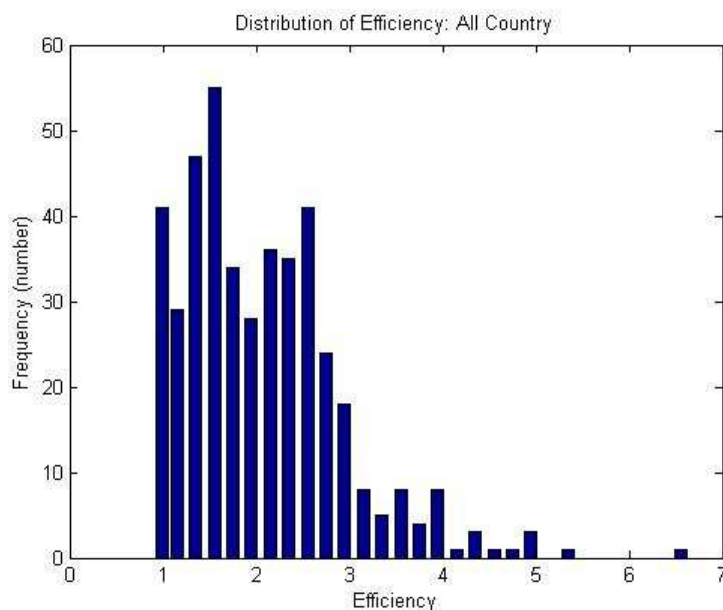


Table 1: Efficiency scores

	Whole sample	ECB	BoC	BoJ	RBNZ	BoSw	SNB	BoE	FRB	RBA
Mean	2.1581	1.4981	2.2859	2.0797	2.5502	2.7900	1.6620	1.6819	2.0847	2.7907
Median	2.0053	1.2247	2.0062	1.9240	2.5479	2.6184	1.5145	1.2679	1.7076	2.5322
Min.	1.00	1.00	1.6067	1.5230	1.8401	2.2367	1.3428	1.0000	1.0636	2.0586
Max.	6.7380	3.6396	4.0689	3.5313	3.6357	4.1343	2.6113	6.7380	5.1121	4.9807
Standard Error	0.8578	0.6447	0.6517	0.5103	0.4179	0.5028	0.3683	1.1980	1.0969	0.7180
Variance	0.7358	0.4156	0.4247	0.2604	0.1747	0.2528	0.1356	1.4353	1.2031	0.5155
Interquartile	1.0821	0.5122	0.8948	0.5760	0.6112	0.4872	0.1860	0.5304	0.5398	0.6370

Source: authors.

Of course, our results could be driven by the period we consider, which includes a deep financial and economic crisis. Hence, we also display the evolution of each central bank's performance in figure 8. Figure 8 shows the evolution across the whole period under review in the top panel, while the bottom panel focuses on the last four years (i.e. the crisis period).

As can be seen from the top panels of figure 8, some central banks show a relatively flat (i.e. a relatively constant degree of performance). This is particularly the case of the ECB and of the Swiss National Bank. On the contrary, some institutions show a more erratic performance, the Reserve Bank of Australia being a case in point, as well as the Bank of Canada. The New Zealand case is outstanding, in that the profile is relatively flat, but at a higher level of inefficiency. As a consequence, the efficiency index of the Reserve Bank of New Zealand is, on average, superior to the whole sample, but with a lower variance.¹⁹

As revealed by the bottom panels of figure 8, the last four years show a decrease in inefficiency for all the central banks under review, although the deterioration is stronger for some than for others. The BoE's profile is striking, being the central bank that reaches the highest degree of inefficiency in the sample during the crisis.

The steepest rise, however, is the ECB's. As this steep rise occurs after the other main central banks have already started to change their behavior, our results may feed the "too little, too late" criticism addressed to the ECB (see Gerlach-Kristen, 2005). However, this is contradicted by the fact that the ECB is also the first to come back to pre-crisis degrees of efficiency, reaching even lower levels than the other central banks under review. Strikingly, the UK and US institutions have not reached their pre-crisis levels by end-2010.

4.2. The determinants of efficiency

As explained in the introduction it is very likely that the composition and characteristics of the central bank committees has its influence on the conduct of the policy. The features that one would like to capture are multiple and we focus on some of them. Firstly, age is a key factor. The mean age of the committee is an indicator of the generational cohort impact, which could prove important. For example, Malmendier and Nagel (2011) show that being born in a depression period affects risk-taking, which would induce a central banker, in our context, to behave differently. Another justification comes from the difference between Göhlmann and Vaubel (2007) and Farvaque et al. (2009) on the degree of inflation aversion of academics, which probably can be attributed to the fact that the sample of the former study includes central bankers educated in a period strongly influenced by the most traditional Keynesian thinking. The justification for including the number of members of each committee

¹⁹ All the descriptive statistics are available from the authors upon request.

lies back to Condorcet's Jury Theorem and the value of information each extra member of a committee brings with her, although some costs may arise from increased transaction costs if the committee reaches a certain threshold (Berger et al., 2008).

The following regressors, that detail the professional and educational background of the members of each committee we consider, is the most related to the work of Jones and Olken (2005), Besley et al. (2011) or Dreher et al. (2009), that all show the importance of leaders' qualifications on their economy's performance.

Finally, we include two dummy variables, one for inflation targeting countries and the second for the crisis period. Although the latter does probably not need to be strongly justified, as the crisis period (2008 to 2010 in our sample) may have induced central bankers to change their assessment of their decisions on the balance of risks for the economy, the inflation targeting dummy is included to reflect the constraint the adoption of an inflation targeting regime imposes on the actions of a central bank, and thus on central bankers' assessments of the policy decisions to be taken in each situation (Walsh, 2011).

Understanding the sources of the differences in efficiency is the second contribution of this paper. Standard regression analysis is not the correct procedure to infer the impact of environment variables on the efficiency scores. It must be noted first that the efficiency score are bounded below by one and so a DEA estimator of the frontier is biased upward by construction as it envelops the observations. Secondly, the dependent variable is constructed using all the information on all central banks creating a correlation between the error terms when this variable is used in a regression. These two characteristics cannot be accounted for by a standard regression and inference procedure.

The bound at one is accounted for by a truncated regression procedure. The second problem is more troublesome as it creates a correlation in the error term and the estimator is biased upward. It is possible to show (Kneip et al. (1998)) that the estimator is asymptotically consistent. However, standard small sample inference is no longer available because the distribution of the regression parameters is not known. Simar and Wilson (2007) advocate for bootstrap simulation to obtain small sample distribution, arguing that it is possibly the only way to achieve meaningful inference.

Knowing that the first step estimator is consistent, the focus is on the second stage regression, when we try to infer the effect of environment variables on the efficiency estimates. The procedure to obtain consistent inference is as follows. First, let

$$\theta_i = \varphi(z_i, \beta) + \varepsilon_i \quad (2)$$

With φ a smooth differentiable function and we suppose that $\varphi(z_i, \beta) = z_i^T \beta$. Note that we do not have θ_i but only $\hat{\theta}_i = \theta(x,y)$ obtained from the envelop of the data calculated in (1). These estimated efficiencies are correlated in an unknown way by construction (since θ_i depends on all x and y through equation (1)). Then, by assumption (i.e. equation (2)) z_i must be correlated with x_i and y_i and so the error term in equation (2) must be correlated with z_i .

Figure 7. Central banks' performance

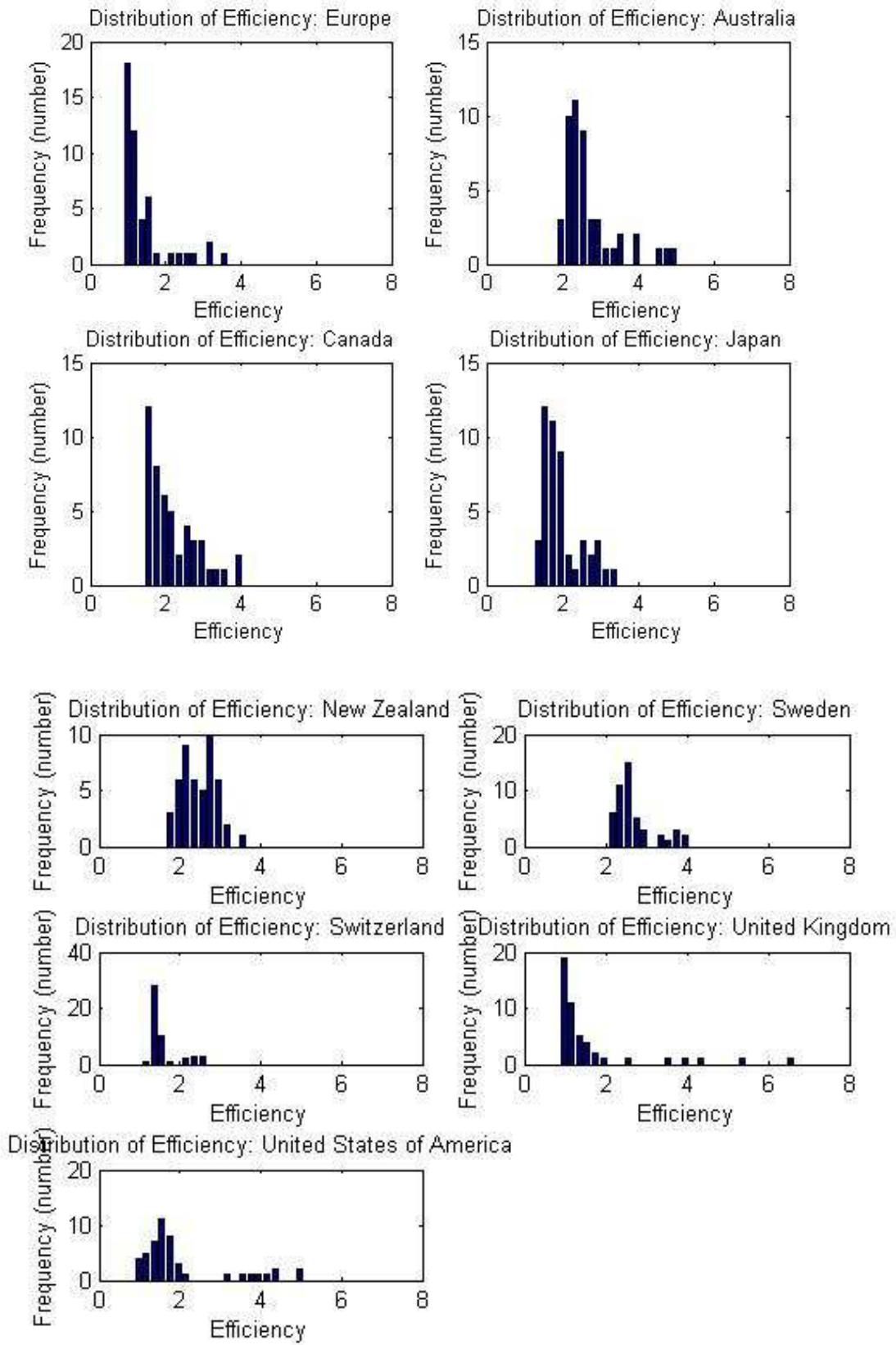
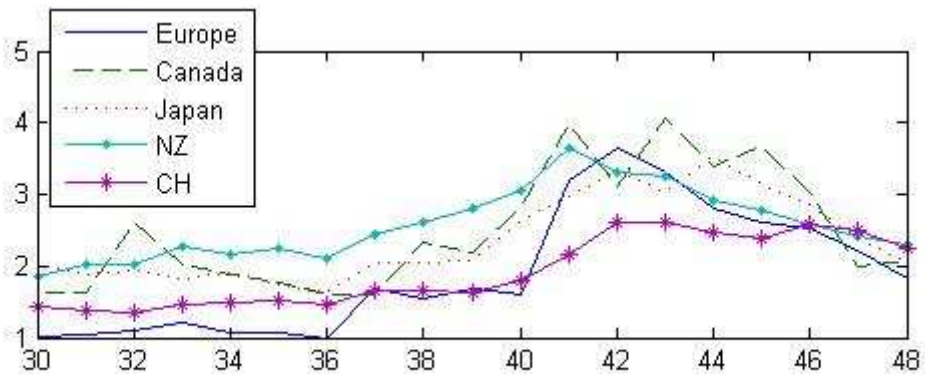
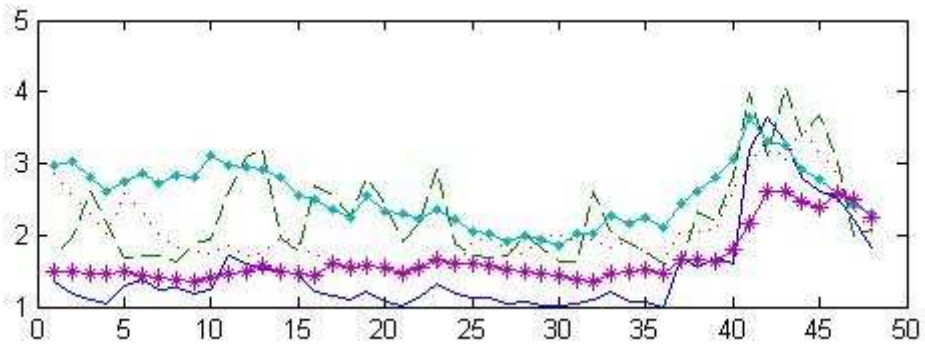
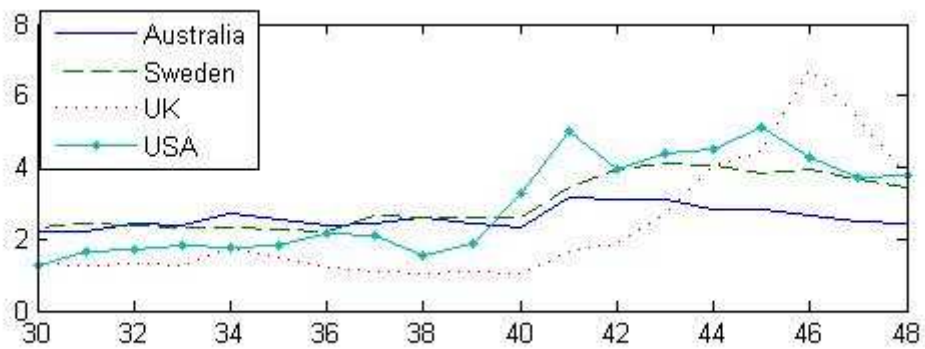
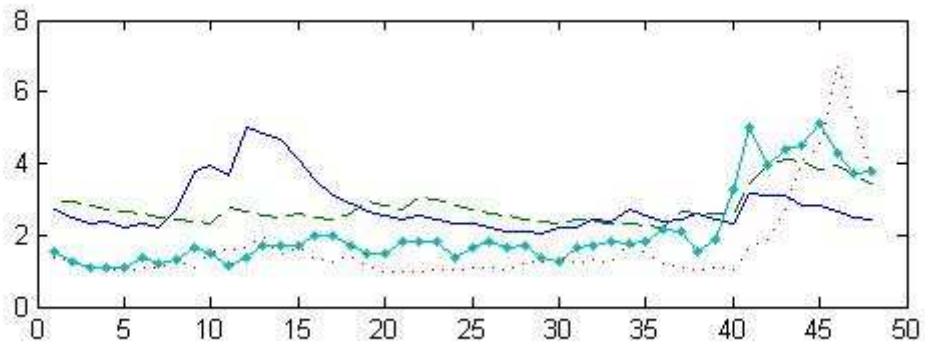


Figure 8. Central banks' performance evolution
 (top : 1999 – 2010 ; bottom: 2007 - 2010)



As pointed out by Simar and Wilson (2007), the correlation among the ε_i and between the z_i and ε_i do vanish asymptotically, but at a very slow rate. This implies that maximum likelihood estimates of β in the second stage truncated regression are consistent, but not *root-n* consistent. The correlation among the ε_i does not disappear rapidly enough to allow us to use conventional inference methods based on the inverse of the information matrix.

We mentioned above that the efficiency estimator is biased upward by construction in finite sample, although it is asymptotically consistent. Consequently, it would be wise to correct for the small sample bias before bootstrapping the distribution of the estimated β . Bootstrap methods can be used to estimate the bias and construct a bias corrected estimator of θ_i . This allows us to get a consistent estimate of β using maximum likelihood on the bias corrected estimates of θ_i on the following model:

$$\hat{\theta}_i \approx \varphi(z_i, \beta) + \varepsilon_i \quad (2)$$

where $\hat{\theta}_i$ is the biased corrected estimate of the efficiency parameter. Correcting for the bias should improve the performance of the inference procedure in small sample.

The algorithm we have used to account for these problems and solve them is the one recommended by Simar and Wilson (2007). It is as follows:

1. Use the original data to estimate by DEA the efficiency parameter θ_i for all DMU (the central banks at any decision time) using equation (1).
2. Use the method of maximum likelihood on the truncated model (2) to obtain estimates of β and σ^2 denoted $\hat{\beta}$ and $\hat{\sigma}^2$ using only the observations for which $\hat{\theta}_i$ is strictly greater than one. That is, for E sample points with $E < D$ where D is the total number of observations in the sample.
3. We use the following sub-procedure to obtain $B_1=300$ sets of bootstrapped efficiencies for all D DMU, $BS1_i = \left\{ \hat{\theta}_{ib}^* \right\}_{b=1}^{B_1}$ for $i=1, \dots, D$.
 - a. For each $i=1, \dots, D$ draw ε_i from the left truncated at $(1 - z_i \hat{\beta})$ normal distribution $N(0, \hat{\sigma}^2)$
 - b. For each $i=1, \dots, D$ compute $\theta_i^* = z_i^T \hat{\beta} + \varepsilon_i$
 - c. Set $x_i^* = x_i$ and $y_i^* = y_i \left(\frac{\theta_i}{\theta_i^*} \right)$ for all $i=1, \dots, D$
 - d. Compute $\hat{\theta}_i^*$ using the program defined in equation (1) by replacing the x and y by their bootstrapped version obtained in c.
4. For each DMU compute the biased corrected estimates of the efficiency parameter using the original estimates and the bootstrapped version obtained in 3 above using $\hat{\theta}_i = \theta_i - bias(\hat{\theta}_i)$ where $bias(\hat{\theta}_i) = E(\hat{\theta}_i) - \theta_i$ where we approximate the expectation by the mean of the bootstrapped efficiencies.
5. Use the method of maximum likelihood to estimate the truncated regression of $\hat{\theta}_i$ on z_i to obtain the original set of estimator for inference purpose, $\hat{\hat{\beta}}$ and $\hat{\hat{\sigma}}^2$.

6. We use the following sub-procedure to obtain $B_2=3000$ sets of bootstrapped efficiencies for all D DMU, $BS2_i = \left\{ (\widehat{\beta}, \widehat{\sigma^2})_b \right\}_{b=1}^{B_2}$ for $i=1, \dots, D$.
 - a. For each $i=1, \dots, D$ draw ε_i from the left truncated at $(1 - z_i \widehat{\beta})$ normal distribution $N(0, \widehat{\sigma^2})$.
 - b. For each $i=1, \dots, D$ compute $\theta_i^{**} = z_i^T \widehat{\beta} + \varepsilon_i$
 - c. Use the method of maximum likelihood to estimate the truncated regression of θ_i^{**} on z_i to obtain the original set of estimator for inference purpose, $\widehat{\beta}^*$ and $\widehat{\sigma^2}^*$.
7. We use the bootstrap value $BS2_i$ for $i=1, \dots, D$ and the original estimates $\widehat{\beta}$ and $\widehat{\sigma^2}$ to construct estimated confidence intervals for each element of β and σ^2 .

Building upon the above description of each central bank's monetary policy committee, in order to decipher the intricacies hiding behind the efficiency parameter, we have used this procedure with the following vector of regressors: a constant, the average age of each central bank's monetary policy committee, the number of governors, the share of central bankers, the share of members coming from the public sector, the share of members coming from the private sector, the share of members from the academia, the share of MBA holders, the turnover ratio, and a dummy indicating if the central bank has officially adopted an inflation targeting regime. In a second set of regressions, we add a dummy variable to control for the crisis period.

Table 2 contains the obtained parameters from the regression, the bottom panel adding the "crisis era" dummy to the estimations. To analyze the results, it has to be remembered that a negative sign means a reduction in inefficiency, and thus a positive impact on efficiency.

From the top panel (Panel a) estimates, it appears that the mean age of central bankers, the share of academics and of MBA holders all help managing a central bank towards efficiency. On the contrary, the number of members of the MPC and the share of members coming from the private sector reduce the efficiency of the central banks we survey. These results tend to confirm that leadership matters, in central banks too, but they also show that not all qualification levels are the same. If the role of academics in central banks is more and more acknowledged, to the point that being an academic is even sometimes considered as a pre-condition to an appointment to a monetary policy committee²⁰, our results give even more credentials to this fact. Interestingly, MBA holders seem to have a clout on efficiency, which would probably not surprise business schools' alumni. Nevertheless, the result on central bankers with a private sector background shows that their skills are not best employed in a monetary policy context. Our result on the number of committee members tends to confirm the literature's insight that a good committee is a relatively small one (e.g., Berger et al., 2008).²¹

Interestingly - and quite logically given our approach - central banks that have adopted an inflation targeting regime are less efficient than their counterparts. This is probably due to the

²⁰ For example, at the Polish National Bank (NBP), the constitutional requirement of "distinguished knowledge of financial matters" has often been confounded with the obligation to hold a Ph.D., and / or to belong to the academia.

²¹ Regressions introducing the squared number of members did not reveal significant non-linear effects.

fact that they focus their attention more on inflation stabilization than on output stabilization, a feature that reduces their global capacity to stabilize the economy. True, no central bank ever claimed to be an "inflation nutter", but most of the existing evidence tends to reveal that inflation targeting central banks put a larger weight on inflation than on output stabilization (see, e.g., Otto and Voss, 2011, for Australia, or Creel and Hubert, 2011, for Sweden²²). Hence, our results tend to add caution on the consensus that seems to build gradually towards the adoption of inflation targets.

The bottom panel (Panel b) reveals a disturbing impact of the crisis: the average age loses its significance (though not its sign) but the most remarkable result comes from the impact on the share of pure central bankers. Central bankers now appear significant, and strongly so, and improve the degree of efficiency of their central banks. Hence, everything happens as if the crisis had needed more input from the central bankers' skills and knowledge than from the one of academics, a result reminiscent of Mr. Trichet's words we quoted above. Moreover, here again, the inflation targeting central banks have been at a disadvantage compared with their peers that have chosen to follow broader strategies.

Table 2. The determinants of central banks' efficiency

Panel a.

Variable	Parameter	10% Confidence Interval		5% Confidence Interval		1% Confidence Interval	
		Lower	Upper	Lower	Upper	Lower	Upper
Constant	-30.0669***	-58.9857	-20.8995	-61.8417	-17.7536	-67.4643	-9.6831
M_Age	-0.2666***	-0.5497	-0.1928	-0.5821	-0.1702	-0.6488	-0.1174
N_Gov	0.3236**	0.1401	0.7103	0.0864	0.7500	-0.0375	0.8632
S_CB	4.0975	-0.5270	10.8217	-1.7761	11.7366	-4.3099	14.0438
S_PubS	1.3826	-3.0497	5.8556	-4.1083	6.5793	-6.3705	8.3254
S_PrivS	7.8309***	4.7173	14.8646	3.5969	15.8023	1.3909	17.8064
S_Acad	-5.6853**	-14.3696	-2.0003	-15.7450	-0.9051	-18.2517	1.1100
S_MBA	-9.8880**	-22.8578	-2.9310	-24.7603	-1.0171	-28.9928	2.0047
TURN	3.4184	-0.9799	11.2675	-2.1295	12.5830	-4.7825	14.8927
IT	4.5270***	4.0695	7.9370	3.7391	8.2341	2.8727	8.8635

Method: Truncated ML with bootstrapped intervals, Likelihood -521.9861, Sigma regression 14.3169. Bootstrap specification: Bias correction: 300 replications, truncated regression: 3000 replications.

Panel b. including the crisis dummy

Variable	Parameter	10% Confidence Interval		5% Confidence Interval		1% Confidence Interval	
		Lower	Upper	Lower	Upper	Lower	Upper
Constant	-1.8813	-17.0052	13.2384	-19.7628	15.8225	-24.8531	23.2122
M_Age	-0.0972	-0.2598	0.0058	-0.2864	0.0270	-0.3354	0.0806
N_Gov	-0.0421	-0.3061	0.1582	-0.3443	0.2007	-0.4559	0.2789
S_CB	-7.5982***	-14.3765	-5.2864	-15.3954	-4.3365	-17.1341	-2.6435
S_PubS	-5.8852***	-10.9144	-4.5008	-11.5318	-3.6441	-12.8512	-2.6746
S_PrivS	-0.9655	-4.9464	2.6046	-5.8238	3.4129	-7.3934	4.7971
S_Acad	-8.0850***	-15.4983	-6.5463	-16.3796	-5.7022	-17.8437	-4.0090
S_MBA	4.6134	-0.9247	14.7937	-2.2424	16.6497	-4.9984	21.3461
TURN	5.3532**	2.3573	12.4648	1.7255	13.4489	-0.2637	15.6250
IT	3.5026***	2.8539	5.8591	2.5691	6.1254	2.0063	6.6178
Crisis	6.5024***	6.7094	9.7309	6.3879	9.9946	5.8677	10.5506

Method: Truncated ML with bootstrapped intervals, Likelihood -469.2877, Sigma regression 10.3539. Bootstrap specification: Bias correction: 300 replications, truncated regression: 3000 replications.

²² Although Creel and Hubert (2011) claim that the Swedish central bank put a lower focus on inflation after the adoption of the inflation targeting regime, their results show that the *relative* weight of inflation with regard to the output gap has been strongly reinforced.

5. Conclusion

This paper builds on the literature focusing on the role of leaders to show that, in central banks, too, leaders matter. Our criterion is the efficiency of central bankers in managing the inflation-output volatility trade-off, relying on the DEA method to define the efficiency frontier.

We show that the educational and occupational background of leaders do influence their performance, with academics and central bankers influential in explaining their institutions' efficiency scores. We also show that the adoption of an inflation targeting regime may come at a cost, in terms of higher output volatility, compared to inflation volatility. Finally, it clearly appears that the crisis struck central bankers and derailed their efficiency performance, although some central banks have been able to recover sooner than the others, as the Bank of England exemplifies.

An avenue for further research could be to enlarge the scope of the outputs to be delivered by central banks and looking, for example, to the volatility of financial markets and asset prices. It is also possible to focus on the determinants of not only efficiency, but also preferences of monetary policy committees (i.e. the relative weight given to output vs. inflation stabilization), as revealed by the implied volatilities which served to compute efficiency scores.

Appendix Results including the National Bank of Poland

Figure 4.A: Evolutions of governors' dominant career type, by country

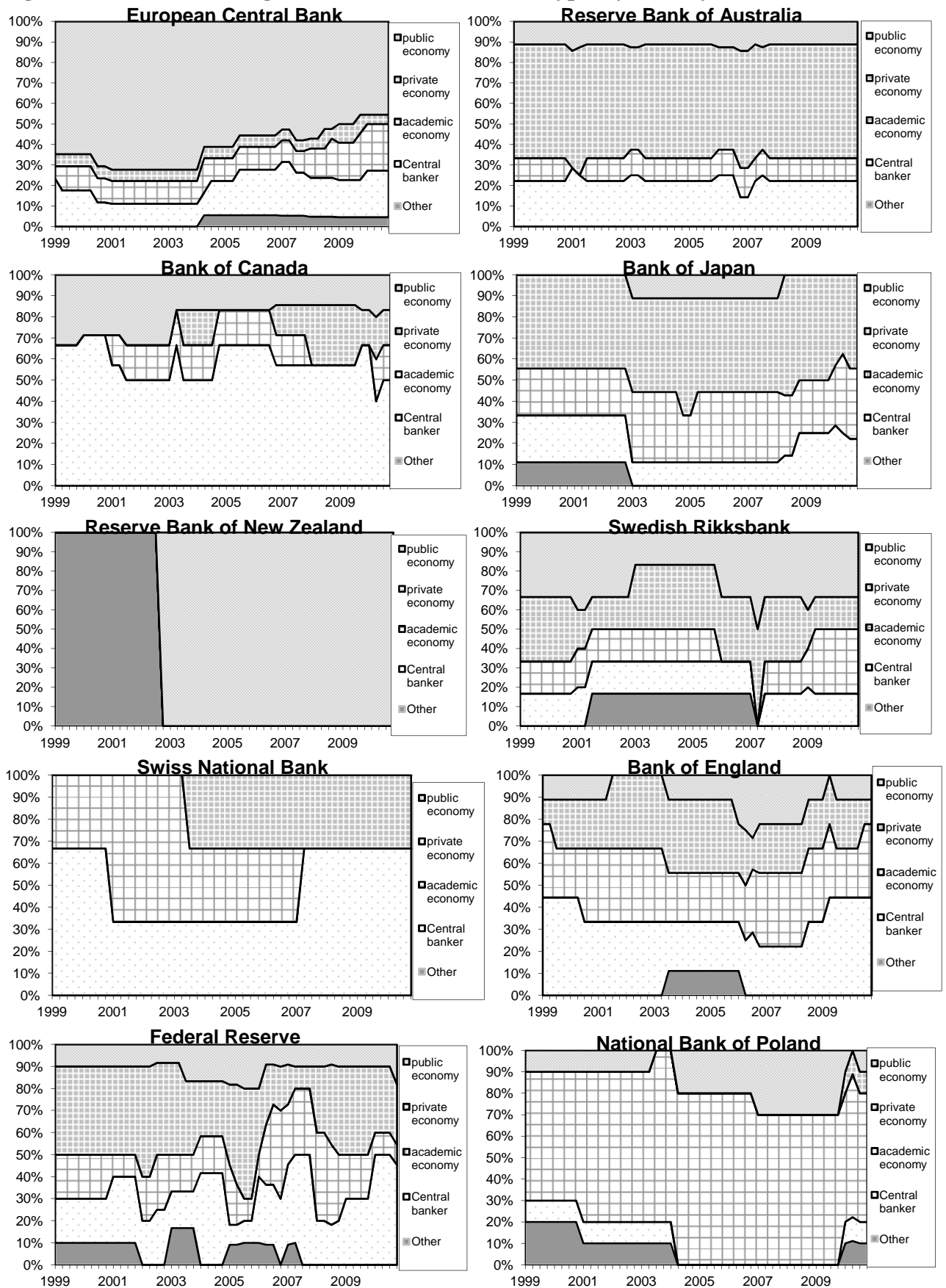
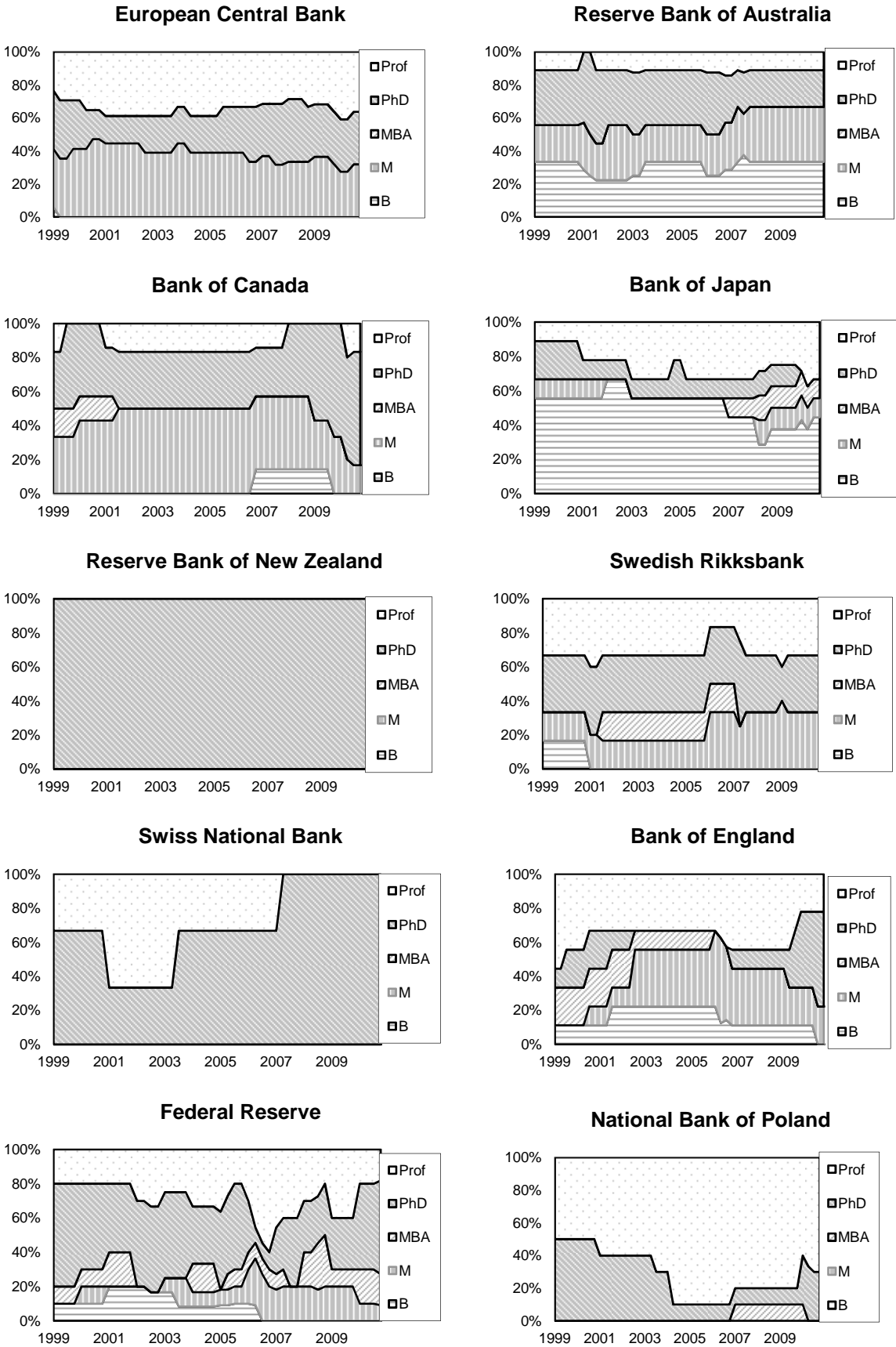


Figure 5.A: Evolutions of governors' education by country



A.1. The specificities of the NBP's monetary policy council

The Monetary Policy Council (MPC) of the National Bank of Poland has several characteristic features. It is composed of 10 members. The President of the National Bank of Poland, who is nominated by the Sejm (lower Chamber of the Polish Parliament) upon a proposal of the President of Poland, is ex officio a member of the MPC. The remaining nine members are appointed in equal number by the President, Sejm and Senat (upper Chamber of Polish Parliament). Such a political process does not contain serious checks and balances (except for the nomination of the President of the NBP) and makes the MPC potentially vulnerable to swings happening on political scene. This might be aggravated by the fact that the terms of office of all the MPC members expire almost at the same time. On the other hand, the constitutional requirement of “distinguished knowledge of financial matters” (art. 227.5 of the Constitution of the Republic of Poland) as well as the long term of office (6 years) attenuate to some extent this danger.

Demographic features

The fact of (quasi) simultaneous nomination of the great majority of the MPC members implies that the average age of MPC members has a natural tendency to increase during any given term of office and any sudden changes may occur only at the term of office. However, the changes from the “first” MPC (1998-2004) to the “second” MPC (2004-2010) in fact increased the average age by 0.5 years, whereas the beginning of the “third” MPC (2010-2016) decreased the average age by 3.4 years. More precisely, the average age of the MPC members increased from 52.7 in 1999 (which was well below the average for all the analyzed countries, 56.9) to 60.9 in 2009Q4 (which was above the overall average of 57.3) to finally decrease in 2010 to 58.6.

Gender

The Polish MPC, similarly to most of its counterparts in the other analyzed countries is not very feminized. However, at the beginning of the “first” MPC, the NBP was headed by the President Hanna Gronkiewicz-Waltz. Beside her, there was only one woman in the “first” and “second” MPC. In the “third” MPC, nominated in early 2010, there are three women.

Education

The above-mentioned constitutional requirement of distinguished knowledge in financial matters is seemingly interpreted as an obligation to hold a Ph.D. in economics or finance. Among all the 31 MPC members who served between 1999 and 2010, only President Sławomir Skrzypek (2007-2010) did not hold this title (he was an MBA holder). Additionally, in the “first” MPC there were 5 to 7 professors and in the second one as much as 9.

Professional experience

The Polish MPC is traditionally dominated by academics: between 6 and 8 of its members since its inception.

Changes and turnover

Because of the nomination process, changes in the composition of the MPC occur relatively rarely and usually imply a quasi-total turnover. Thus, our variables of changes and turnover are equal to 0 most of the time and register peaks every 6 years (2004Q1 and 2010Q1).

A.2. Descriptive statistics including the NBP

Figure 6.A. Distribution of efficiency – Whole sample, including the NBP

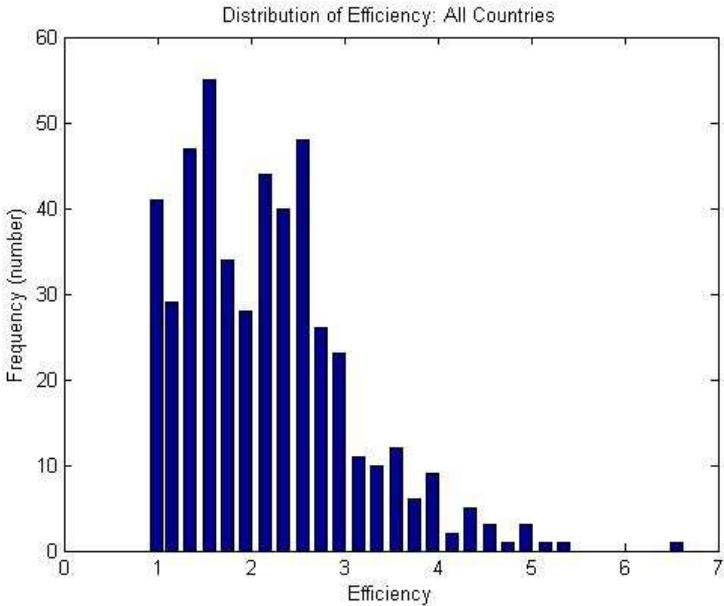
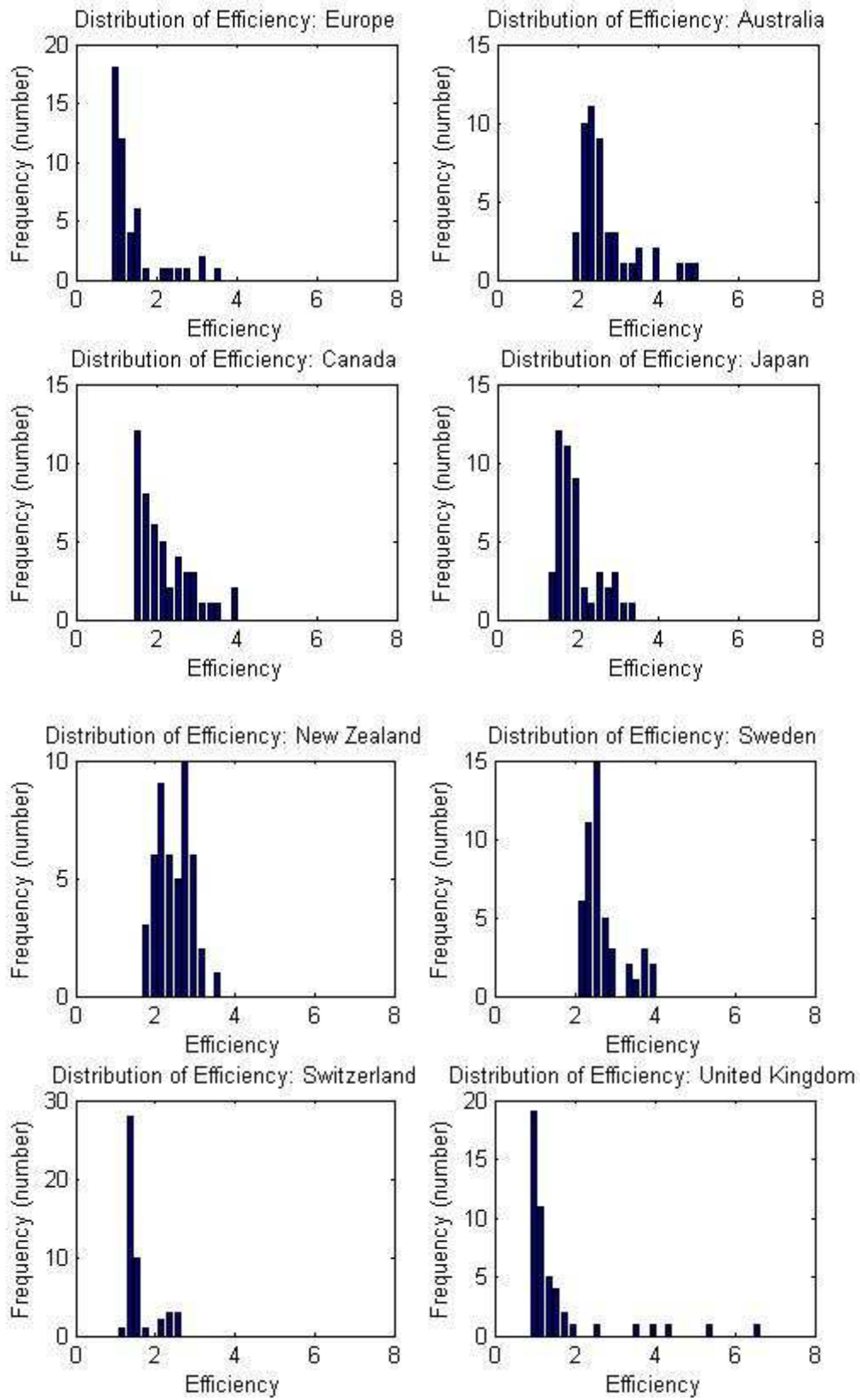


Figure 7.A. Central banks' performance, w.r.t. the NBP



Distribution of Efficiency: United States of America Distribution of Efficiency: Poland

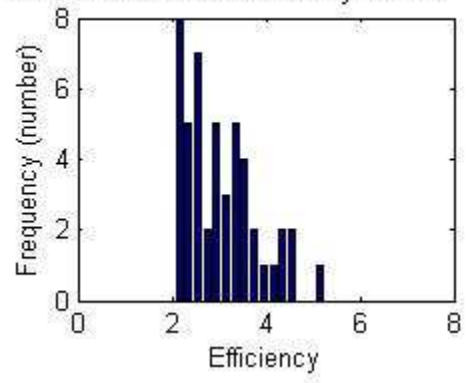
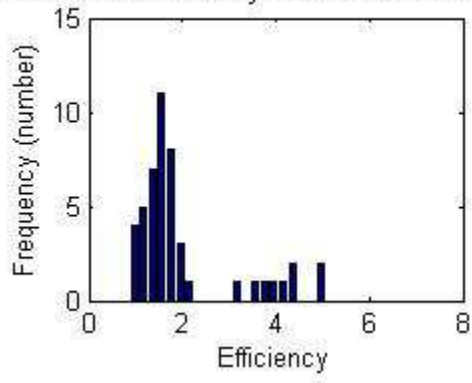


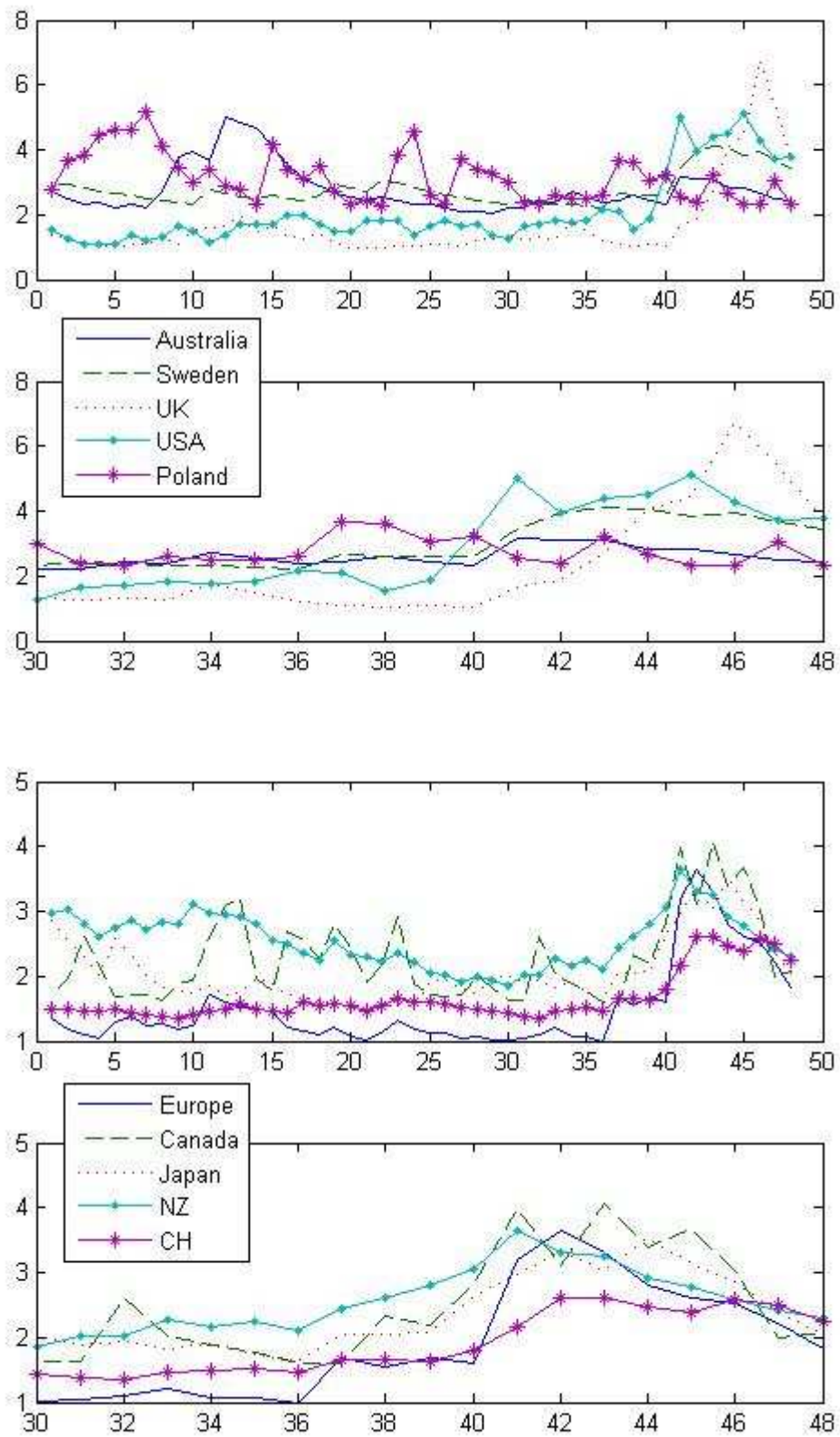
Table 1.A: Efficiency scores

	Whole sample	NBP	ECB	BoC	BoJ	RBNZ	BoSw	SNB	BoE	FRB	RBA
Mean	2.1581	3.1453	1.4981	2.2859	2.0797	2.5502	2.7900	1.6620	1.6819	2.0847	2.7907
Median	2.0053	3.0320	1.2247	2.0062	1.9240	2.5479	2.6184	1.5145	1.2679	1.7076	2.5322
Min.	1.00	2.2919	1.00	1.6067	1.5230	1.8401	2.2367	1.3428	1.0000	1.0636	2.0586
Max.	6.7380	5.1738	3.6396	4.0689	3.5313	3.6357	4.1343	2.6113	6.7380	5.1121	4.9807
Standard Error	0.8578	0.7510	0.6447	0.6517	0.5103	0.4179	0.5028	0.3683	1.1980	1.0969	0.7180
Variance	0.7358	0.5639	0.4156	0.4247	0.2604	0.1747	0.2528	0.1356	1.4353	1.2031	0.5155
Interquartile	1.0821	1.1637	0.5122	0.8948	0.5760	0.6112	0.4872	0.1860	0.5304	0.5398	0.6370

Source: authors.

The NBP shows a relatively flat profile of efficiency across the period we observe, but its degree of efficiency is, on average, inferior to the sample one. Interestingly, its behavior is relatively comparable to the Reserve Bank of Australia or the Bank of Sweden.

Figure 8. A. Central banks' performance evolution (including the NBP)
 (top : 1999 – 2010 ; bottom: 2007 - 2010)



A.3. Estimation results including the NBP

Adding the NBP of Poland to our sample does not dramatically affect the results, which can be seen in table 2.A. However, some changes are notable:

- the turnover rate is no longer significant, which is probably due to the appointment process at the NBP, which contrasts with the other central banks (see above).
- the share of academics is no longer significant, neither with nor without the crisis dummy, which is again probably due to the specificities of the NBP's MPC, where the large proportion of academics curbs the results.

It should be noted, however, that some caution should be kept while interpreting the results derived from the sample including Poland. The first reason is that, especially in the first years of the analysis (1999-2002) a significant disinflation process was on the way in Poland, which clearly drives the high inefficiency recorded in this period. Additionally, as indicated in the descriptive part of the appendix (A1), the characteristics of the Monetary Policy Council of the National Bank of Poland are in a number of aspects very distant from those observed in the MPCs of the core of the sample, which again necessitates some caution.

Table 2.A. The determinants of central banks' efficiency

Panel a.	Variable	Parameter	10% Confidence Interval		5% Confidence Interval		1% Confidence Interval	
			Lower	Upper	Lower	Upper	Lower	Upper
	Constant	-28.6361***	-58.9491	-20.0037	-61.9626	-16.0105	-67.9701	-9.2633
	M_Age	-0.1026	-0.3414	0.0281	-0.3738	0.0619	-0.4662	0.1135
	N_Gov	0.2407*	0.0353	0.6187	-0.0271	0.6791	-0.1320	0.7905
	S_CB	0.3091	-5.5094	6.3208	-6.7871	7.6104	-9.1284	9.8161
	S_PubS	-0.4100	-5.3394	3.8244	-6.4858	4.7522	-8.3803	6.4214
	S_PrivS	3.5706	-0.6322	9.4064	-1.8464	10.3562	-4.1312	12.2828
	S_Acad	5.6636**	2.0065	12.2051	0.7428	13.1219	-1.3101	14.8338
	S_MBA	-12.4515***	-26.6445	-6.5588	-28.1506	-4.8436	-31.5707	-1.8360
	TURN	0.5094	-4.5996	7.0094	-5.7399	7.9061	-7.3528	9.6162
	IT	7.2551***	7.7460	11.7082	7.4166	12.1551	6.8444	12.6598

- Method: Truncated ML with bootstrapped intervals, Likelihood -619.7442, Sigma regression 18.1242.
- Bootstrap specification: Bias correction: 300 replications, truncated regression: 3000 replications.

Panel b. including the crisis dummy

Variable	Parameter	10% Confidence Interval		5% Confidence Interval		1% Confidence Interval	
		Lower	Upper	Lower	Upper	Lower	Upper
Constant	4.5382	-8.7816	21.1730	-11.5301	23.9397	-18.1185	32.0196
M_Age	-0.1028*	-0.2922	0.0000	-0.3207	0.0259	-0.3801	0.0717
N_Gov	-0.1739*	-0.4721	-0.0042	-0.5193	0.0472	-0.6214	0.1381
S_CB	-9.4604***	-17.0722	-7.2646	-17.9821	-6.3842	-19.8164	-4.3805
S_PubS	-6.0478***	-11.2370	-4.3578	-11.8746	-3.7433	-13.2069	-2.2629
S_PrivS	-1.2302	-5.3937	2.5173	-6.1469	3.2513	-7.5830	4.8043
S_Acad	-0.7501	-4.7676	2.7912	-5.6077	3.4663	-7.4743	5.0014
S_MBA	-10.2046**	-20.9240	-3.8909	-22.4946	-2.2017	-25.5868	0.8897
TURN	-1.1030	-5.5722	3.5801	-6.4232	4.3836	-7.6664	5.6751
IT	4.4408***	3.9351	7.1199	3.6316	7.4138	3.0907	7.9319
Crisis	6.2365***	6.3208	9.3251	6.0209	9.5651	5.5029	10.0967

- Method: Truncated ML with bootstrapped intervals, Likelihood -592.9855, Sigma regression 12.5380.
- Bootstrap specification: Bias correction: 300 replications, truncated regression: 3000 replications.

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