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The monetary-policy regime and the development in central macroeconomic variables in the OECD countries 1970-2005

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Resumé
Betydningen af skift i pengepolitisk regime for udviklingen i centrale makroøkonomiske variabler undersøges med en differens-i-differens estimation af OECD-landene i perioden 1970-2005. Vi finder, at såvel skift til en konsekvent fastkurspolitik som til inflationsmål har medført et fald i inflationen ud over den globale trend i de efterfølgende år. Vi finder desuden en signifikant reduktion i volatiliteterne i både inflation og produktionsgab, ud over den globale udvikling, efter overgang til en konsekvent fastkurspolitik, mens overgang til inflationsmål ikke er forbundet med en tilsvarende effekt. Resultaterne er robuste over for en række ændringer i klassifikationen af de enkelte lande. Resultaterne er på vigtige punkter i modstrid med nyere litteratur om pengepolitik og inflation targeting. Det rejser flere spørgsmål, herunder om valutakursen i praksis dæmper eller skaber chok, om finanspolitikkens rolle fortjener at blive genovervejet, og om begreberne robusthed og optimalitet blandes uhensigtsmæssigt sammen. Svarene kan forhåbentligt findes via fremtidig forskning.

Abstract
The impact on central macroeconomic variables from changes in the monetary-policy regime in the OECD countries in the period 1970-2005 is estimated using the difference-in-difference method. We find that both shifts to a fixed-exchange-rate policy and to inflation targeting have led to a decline in inflation beyond the global trend in the following years. Furthermore, we find a significant reduction in the volatilities in both inflation and output-gap, beyond the global trend, after the adoption of a consistent fixed-exchange-rate policy, while no such effect can be found from a move to inflation targeting. The results are robust to several changes in the classification of the individual countries. In important respects, the results are at odds with recent literature on monetary policy and inflation targeting. This raises some questions: Does the exchange rate in practice absorb or create shocks? Should the role of fiscal policy be reconsidered? Are the concepts of robustness and optimality inadequately mixed? The answers can hopefully be found via future research.

The monetary-policy regime and the development in central macroeconomic variables in the OECD countries 1970-2005[1]

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1. Introduction

The design of monetary policy has been subject to intensive research in recent years. The theoretical starting point in monetary economics is that there is no long-term trade-off between inflation and economic activity. Monetary policy can influence the output gap, not the potential output. The average rate of inflation can thus be controlled by the central bank without long-term costs like lost output or employment. The central bank's loss function is often expressed by a combination of the volatilities in inflation and in output gap.

Furthermore, during the last 10-20 years different practices in monetary policy have been seen across countries. A large number of European countries have formed a currency union while others conduct a consistent fixed-exchange-rate policy vis-à-vis the euro. Other countries have adopted a monetary policy based on an inflation targeting approach with a flexible exchange rate.

Nonetheless, surprisingly few empirical studies look at the consequences of a change to one regime or the other in terms of the inflation level and the volatility in inflation and the output gap.

There have been numerous studies of the consequences of a change to inflation targeting, cf. e.g. Pétursson (2004), Levin et al. (2004) and the review by Berg (2005), but these studies primarily consider whether the countries' key economic indicators improve after the change of regime. As pointed out by Ball and Sheridan (2005) most OECD countries have achieved low inflation irrespective of their monetary-policy regime. The fact that countries with inflation targeting have improved their performance does not document *per se* that this regime has had a particularly beneficial effect, since improvement has also been seen in the countries that have opted for other regimes. The most obvious conclusion is therefore that this reflects certain overall common characteristics of the OECD countries.

To our knowledge no previous studies have assessed within an integrated framework whether there is a difference between the consequences of changing to inflation targeting or changing to a consistent fixed-exchange-rate policy including participation in a monetary union. There are, however, a number of descriptive statistics concerning the Nordic countries in Christensen and Hansen (2003), but this was a benchmarking exercise, not an econometric analysis as such. In the following we contribute to a closing of this gap using a panel data set for the period since 1970 comprising countries that were members of the OECD at that time. This means that no developing countries or emerging economies are included in the analysis. The econometric method is a difference-in-difference estimation. We investigate whether we can identify an effect from the change to either inflation targeting or a consistent fixed-exchange-rate policy through

comparison with a control group of countries that have not changed their regime in the period. The method applied in this paper is similar to Giavazzi and Tabellini (2004) and Persson (2005) who study the impact of various types of reform policy on macroeconomic performance. Compared to these and many other studies of treatment affects across countries, our panel data set is fairly homogenous which ceteris paribus reduces estimation uncertainty.

We find that both countries that have changed to a fixed-exchange-rate policy and countries that have changed to inflation targeting have subsequently achieved a significant decline in inflation. Furthermore, countries that have opted for a consistent fixed-exchange-rate policy have in the ensuing years achieved a significant decrease in the volatility of both inflation and the output gap beyond the general tendency across countries, while this has not been the case for countries that have changed to inflation targeting. Changing to a fixed-exchange-rate policy has thus led to a more favourable trade-off between the volatilities while no such effect was found from a change to inflation targeting for the period under review.

The analysis is structured as follows: Section 2 gives a brief review of elements of the related literature. Section 3 considers the econometric method. Section 4 contains descriptive statistics and makes a classification of the regimes. In section 5 we present the empirical results and perform a number of additional estimations that show that the results are robust to a number of changes in the classifications. In section 6 we summarise and interpret the results in the light of the existing literature and experience from a number of central banks, and it leads to some proposals for future research.

2. Background and related literature

Since the beginning of the 1990s a number of countries have changed their monetary policy to explicit inflation targeting. New Zealand introduced inflation targeting at the beginning of 1990, and Canada followed suit one year later, to be followed by e.g. the UK in 1992 and Australia and Sweden in 1993. Today more than 20 countries have adopted an inflation-targeting regime, including 7 of the original OECD countries and 4 new EU-member countries from Central and Eastern Europe. Concurrently, an extensive body of predominantly theoretical literature concerning inflation targeting has developed while comparative empirical studies of the macroeconomic effects of inflation targeting are scarcer.

Under inflation targeting, monetary policy is delegated to an independent central bank that is responsible for keeping inflation close to a well-defined target without unnecessary fluctuation in the real economy, cf. e.g. Svensson (2002) for a description of the framework. The model assumes that monetary policy, like other types of demand management, does not

affect the level of real-economic activity in the longer term. The objective of monetary policy is thus to stabilise inflation around target and output close to its potential. The focus in the present study is therefore on both the inflation level and the volatility in inflation and in output. Svensson summarises this by stating that with an inflation targeting strategy one can be on the Taylor curve that depicts the efficient combinations of inflation and output variability.

At first glance it is evident that countries that have adopted inflation targeting have seen a large decrease in the inflation rate as well as in inflation volatility. It is also evident that many inflation targeting countries had a starting point of high and varying inflation, see e.g. Mishkin and Schmidt-Hebbel (2002), and that in the first years strong emphasis was put on reducing inflation in these countries in order to build up credibility of the new policy, cf. Corbo et al. (2002), who show that during the 1990s the inflation targeting countries reduced inflation beyond the general international decline in inflation.

This is confirmed by Neumann and von Hagen (2002) among others who find that both the level and variability of inflation was reduced during the 1990s in inflation-targeting countries to levels similar to those in comparable non-inflation-targeting countries, who managed to get inflation under control in the 1980s. This leads them to conclude that inflation targeting was a fruitful device for countries with high inflation rates in the beginning of the 1990s to bring the inflation performance in line with those other countries, but does not give support for the claim that inflation targeting is a superior strategy. This is also pointed out by Ball and Sheridan (2005) who show in an analysis of OECD countries[2] that, although during the 1990s the inflation-targeting countries may have reduced the inflation level and variability beyond the general international decline, this is due to a poorer starting point. The inflation-targeting countries have not reached a better performance on this front than non-inflation-targeting countries with an equivalent starting point, and they conclude that this is likely to be a regression-to-the-mean effect. Gertler (2005), commenting on Ball and Sheridan, agrees that previous studies of the effect of a change to inflation targeting generally suffer from an endogeneity problem since a change to inflation targeting has often taken place in situations where the development in inflation had not been satisfactory. He also emphasises, however, that Ball and Sheridan's results may reflect an equivalent problem if the effect of e.g. an initial high inflation rate on the subsequent development in inflation goes via the decision to change to inflation targeting. In the present study this endogeneity problem is explicitly taken into account.

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[2] Ball and Sheridan (2005) disregard countries that since 1984 have seen an annual inflation rate above 20 per cent, i.e. Greece, Iceland and Turkey, as well as Luxembourg, that did not have its own currency. This gives a sample of 20 countries.

More recently, Pétursson (2004) and Vega and Winkelried (2005) using different samples and country sets have compared the macroeconomic performance of inflation-targeting countries to a set of control countries by estimating treatment effects from panel data sets. They generally find positive effects of inflation targeting beyond the global decline in inflation and inflation variability. However these results hinge crucially on the inclusion of emerging markets. Lin and Ye (2007) show in a recent paper focusing solely on industrialised countries and taking into account the self-selection problem in policy adoption that inflation targeting has no significant effects on either inflation or inflation variability. Mishkin and Schmidt-Hebbel (2007) reach the same conclusion in a similar analysis of both industrialised and emerging-market countries, but with no emerging markets among the control countries.

Bernanke et al. (1999) among others consider the costs of reducing inflation in terms of lower growth and employment (the sacrifice ratio). They find a weak tendency for inflation expectations to react more slowly to actual inflation in inflation-targeting countries, i.e. a better anchoring of expectations, but with no systematic difference in the costs of reducing inflation between inflation-targeting and non-inflation-targeting countries. On the basis of a more extensive data set Levin et al. (2004) also consider the anchoring of inflation expectations and find that in a number of countries with well-established inflation-targeting regimes – Australia, Canada, New Zealand, Sweden and the UK – these expectations do not react significantly to movements in actual inflation, in contrast to the euro area, Japan and the USA, where actual inflation significantly affects expectations. In the same way a clearly lower persistence in actual inflation is found for the inflation-targeting countries. Similar results are also found by Mishkin and Schmidt-Hebbel (2007). However, as pointed out by Uhlig (2004) both results can be explained by the fact that in the period considered the inflation targeting countries have seen considerably higher inflation volatility, and hence he repudiates the claim that a change to inflation targeting has been proven to lead to more successful monetary policy.

The number of developed countries with some kind of a fixed-exchange-rate policy has declined since the ERM crisis at the beginning of the 1990s, and today there is only a modest research in this field. Empirical analyses of the macroeconomic effects of exchange-rate management are often directed at developing countries and emerging economies, as e.g. Levy-Yeyati and Sturzenegger (2003), who do, however, find that fixed-exchange-rate regimes are characterised by lower output volatility in industrialised countries, but not in non-industrialised countries. One has to go back to the end of the 1980s to find more extensive empirical analyses of the significance of a fixed-exchange-rate policy in developed countries. One example is Giavazzi and Giovannini (1989), who find that in connection

with the reduction of inflation in the 1980s the ERM participants achieved a considerable credibility gain from pursuing a fixed-exchange-rate policy in relation to DEM.

To our knowledge, empirical comparisons of inflation targeting and fixed-exchange-rate policy have not been made previously. Svensson (1997) explicitly discusses the choice between inflation targeting and fixed-exchange-rate policy with special reference to Norway and with little reservation recommends that a small open economy chooses inflation targeting since it gives less volatility in inflation and output, and since it avoids the costs of defending a fixed exchange rate against speculative attacks, but the conclusions are primarily based on theoretical arguments, not on empirical studies.

3. Methodology

Our objective is to estimate the effect of a change to either a fixed-exchange-rate policy or inflation targeting. Three groups of countries are considered, namely a group of 9 countries that changed to a consistent fixed-exchange-rate policy during the sample period, 7 countries that changed to inflation targeting, and a control group of 6 countries that did not have a clear change in monetary policy during the period. Regime change is thus a rare event. Finland is the only country considered a candidate for two changes in its monetary policy regime.

How can the effect of such a rare event be measured? One method is a *cross-section* regression, by which the macroeconomic performance, i.e. inflation or the variability in inflation or output gap, is regressed on an indicator of the monetary-policy regime across countries. There are well-known statistical problems with this approach, including the impact of omitted (non-observable) variables. Moreover, an estimated relation does not necessarily express an effect of the monetary-policy regime, but possibly an inverse causality or merely a correlation.

Some of these problems can be overcome by using panel data, where the cross-section information is combined with the time variation in the data. To estimate the effect of a regime change we employ a *difference-in-difference* estimation. A change of monetary-policy regime is perceived as a treatment, and countries without a change of monetary-policy regime are perceived as a control group that makes it possible to estimate the effect of the change of regime (treatment effect). The difference-in-difference estimation has become common for the analysis of the effect on individuals' behaviour of various political measures, e.g. social and labour-market policy. Giavazzi and Tabellini (2004) and Persson (2005) apply the method to assess the impact from political and economic liberalisation on the economic development in a large number of countries, using affluent and democratic countries, as well as less developed countries that do not have democracy

and market economy, as a control group. Pétursson (2004) applies a similar approach in his analysis of the effect of a change to inflation targeting, but as far as we know the method has not previously been used to make a distinction between the significance of various monetary-policy regimes.

Let macroeconomic performance represented by the variable, y_{it}, i.e. the inflation rate or the variability in inflation or output, be determined by the following equation

$$(1) \qquad y_{it} = \alpha_i + \beta_t + \gamma_{FER}\, regime\_FER_{it} + \gamma_{IT}\, regime\_IT_{it} + \varepsilon_{it}$$

where α_i is a country-specific dummy and β_t a time-specific dummy (i.e. respectively *country* and *fixed time effect*), $regime\_FER_{it}$ is a dummy variable, that takes the value 1 if country i at time t pursues a fixed-exchange-rate policy, and otherwise the value 0, $regime\_IT_{it}$ is a dummy variable that equivalently indicates whether a country pursues an inflation targeting strategy, and γ_{FER} and γ_{IT} are the respective coefficients that measure the effect of having changed to the regime in question. ε_{it} is an error term assumed to be independently and identically distributed with the mean value of zero[3].

The specification leaves room for permanent country specific effects like different statistical practices among countries and/or genuine differences related to structural differences between the economies.

On the basis of (1), that is assumed to be correctly specified with identical and independently distributed error terms, the difference-in-difference estimator can now be derived. To see this consider two countries, one country from the control group ($i=CO$) and one country that changes to a fixed-exchange-rate policy ($i=FER$). Let $\ddot{y}_b^{FER}$ be the average of the macroeconomic variable for the fixed-exchange-rate country in the period up to the change to the fixed exchange rate and $\ddot{y}_a^{FER}$ the equivalent average for the period after the change to the fixed exchange rate. For the control country the equivalent averages are given by $\ddot{y}_b^{CO}$ and $\ddot{y}_a^{CO}$. On the basis of (1) the expected values of these averages can now be written as

$$E[\ddot{y}_b^{FER}] = \alpha_{FER} + \beta_b \qquad E[\ddot{y}_a^{FER}] = \alpha_{FER} + \beta_a + \gamma_{FER}$$

$$E[\ddot{y}_b^{CO}] = \alpha_{CO} + \beta_b \qquad E[\ddot{y}_a^{CO}] = \alpha_{CO} + \beta_a$$

How do we now estimate the effect of a change to a fixed exchange rate, i.e. the treatment effect? A first approach could be to compare the result in the fixed-exchange-rate country before and after the change to fixed exchange rates. This estimator $E[\ddot{y}_b^{FER}] - E[\ddot{y}_a^{FER}] = \beta_b - \beta_a + \gamma_{FER}$ will only be unbiased as long as there is no time-dependent effect. Another estimator

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[3] Heteroscedasticity across countries and over time is allowed. In the same way, by applying robust estimators account can be taken of any serial correlation within the individual countries, cf. below.

could be the difference in the macroeconomic variable for the fixed-exchange-rate country and for the control country in the period after the regime change, $E[\ddot{y}_a^{FER}] - E[\ddot{y}_a^{CO}] = \alpha_{FER} - \alpha_{CO} + \gamma_{FER}$, which will only be unbiased as long as there is no country-specific effect.

This leads to the difference-in-difference estimator, where the change in the response variable on the change to the fixed exchange rate is compared with the simultaneous change in the control country, i.e. a double difference. The estimator is

$$\begin{aligned}\gamma_{\Delta\Delta} &= \{ E[\ddot{y}_a^{FER}] - E[\ddot{y}_b^{FER}] \} - \{ E[\ddot{y}_a^{CO}] - E[\ddot{y}_b^{CO}] \} \\ &= \{ \alpha_{FER} + \beta_a + \gamma_{FER} - \alpha_{FER} - \beta_b \} - \{ \alpha_{CO} + \beta_a - \alpha_{CO} - \beta_b \} \\ &= \gamma_{FER}\end{aligned}$$

This estimator is unbiased given the assumptions.

Possible problems in relation to difference-in-difference estimations

It is important that the model does not omit variables that influence the left-hand-side variables and at the same time develop differently for the various groups of countries, or in other words, that the variation in the response variable can be described by a country-specific effect and a time-specific effect. This means that it is not in itself a problem in relation to the model if some countries e.g. due to their business structure are more vulnerable to particular types of shock and will therefore experience greater fluctuation, for as long as this structural difference in relation to the other countries has not changed over time. Fundamentally, it is assumed that the underlying time trend in e.g. inflation volatility is the same for all countries, so that e.g. the group of control countries is comparable with the two groups of countries with a change of policy. Persson (2005) corrects for a possible difference in time trend between different groups by introducing a variable that combines continent and trend. In our study a simple visual inspection seems to confirm that this is not an important problem, cf. charts in the Appendix. With the exception of Iceland there is a clear parallel development across countries, with relatively high inflation in the 1970s, and thereafter declining inflation towards the 1990s, when inflation is considerably lower. Besides being by far the smallest country with a special business structure, Iceland is distinguished by for some periods reaching inflation rates that are 3-4 times higher than the highest inflation rates in any other country. A priori Iceland must be expected to dominate the estimations due to very large residuals, and the country is therefore omitted from the base model, but included in alternative calculations.

A change of policy is assumed to take place at random, conditional on the country- and time-specific effects. This presupposes that the change of policy is not endogenous in relation to the left-hand-side variables, i.e.

inflation and volatility in the output gap and inflation, cf. Besley and Case (2000). If the change to a fixed-exchange-rate policy or inflation targeting is e.g. a reaction to high and varying inflation, this may lead to biased estimates.[4] The effect can naturally also be the opposite, if e.g. a change of monetary-policy regime is primarily undertaken by responsible politicians that also prior to the change were focused on ensuring stable economic development. Following the approach by Persson (2005), in the estimations below, we take account of the problem by investigating whether the estimated effects of a change of policy are robust to the introduction of a dummy variable for 5 years up to a regime change.

Serial correlation is likely to occur since the dependent variables, i.e. output gap and inflation volatility, are relatively persistent in each country. This is not necessarily captured by the time-specific effect. This does not lead to bias in the estimated effects of a change of policy but can lead to an underestimation of the standard deviation of error terms, cf. Bertrand et al. (2004), and thus to erroneous conclusions regarding levels of significance. As a supplement to traditionally derived variance levels the Tables below also show variances based on robust methods as proposed by Arellano (1987), where both heteroscedasticity across countries and random serial correlation between the error terms within each country are allowed.

4. Descriptive statistics and regime classification

We consider data for 22 OECD countries for the period from 1970 to 2005. We use the countries that formed the OECD in 1970 excluding Luxembourg and Turkey. We thus only consider the impact of changes in the monetary-policy regime in developed economies.

The countries are classified into three groups according to their monetary-policy regime: 1) Countries that changed to a consistent fixed-exchange-rate policy during the sample period: Belgium, Denmark, Finland, France, Greece, Ireland, Italy, Portugal and Spain. Today all of these countries except Denmark have adopted the euro. 2) Countries that changed to inflation targeting during the sample period: Australia, Canada, Iceland, New Zealand, Norway, Sweden and the UK. 3) Countries that did not change regime (control group): Austria, Germany, Japan, Netherlands, Switzerland, and the USA.

There is no clear way to classify the countries by monetary-policy regime. This is reflected in the various approaches to this in the literature. Levy-

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[4] The phenomenon is analogous to the Ashenfelter dip or pre-programme dip, which is well-known in evaluation of e.g. labour-market programmes where the participation of individuals is not random, but governed by self-selection, and is thus endogenous in relation to the dependent variable, e.g. personal income. Gertler (2005) discusses how the decision to change to inflation targeting can be endogenous in relation to the development in inflation.

Yeyati and Sturzenegger (2005) conduct a *de facto* classification for different types of foreign-exchange-rate regime based on a cluster analysis of the development in exchange rates and foreign-exchange reserves, while e.g. Reinhart and Rogoff (2004) also take into account information on the officially declared monetary-policy regime.

We only consider regime changes to a clear and consistent regime. This implies, however, that we need to make certain judgements, in some cases based on discussions with staff from the central banks of the countries concerned. Fortunately, the classification of any individual country does not affect the results, cf. below.

In several surveys, Spain is considered as an inflation targeter after the ERM crisis in 1993, but is not stated here as having changed to inflation targeting during the 1990s because it also maintained an exchange-rate target and furthermore had a target for credit expansion, i.e. a very mixed strategy. Therefore we place the Spanish regime change as a change to a consistent fixed-exchange-rate policy in 1997 prior to the commencement of economic and monetary union in 1999. It should also be noted that throughout the period the Spanish yield spread to Germany narrowed as an indication of convergence trading, which is not in harmony with the assumption of an independent monetary policy based on inflation targeting.

The classification of Finland is more problematic. When Finland joined EU in 1995 preparation for EMU membership became the dominant consideration in Finnish monetary policy, but in the years from 1993 to 1996 Finland can be considered an inflation targeter. In our basic specification we place Finland as doing a consistent fixed-exchange-rate policy from 1997 onwards, but we test whether a classification of Finland as an inflation targeter from 1993 to 1996 with a change to a fixed-exchange-rate policy in 1997 affects the results.

Germany is classed as a country with an unchanged strategy throughout the sample. One could claim that Germany in fact has seen the largest change in monetary policy from being the anchor for monetary policy in several European countries throughout the 1970s, 1980s, and 1990s to now being one of several EMU-members. However, the monetary-policy strategy adopted by the ECB reflects to a very large degree the former strategy of the Bundesbank and euro-area statistics will be highly influenced by developments in Germany, by far the biggest economy in the area. Apart from the fact that the Bundesbank now has less of a say in the overall European monetary policy, continuation is considered dominant, which is the reason for having Germany in the control group.

Similarly, Switzerland is considered as belonging to the control group of countries with no changes of strategy throughout the period because the sustained dominating characteristic has been to maintain low inflation.

Therefore it would be incorrect to describe this as a change of regime even though important elements from inflation targeting have been included in monetary policy in recent years. Berg (2005) does not include Switzerland in his overview of inflation-targeting countries either.

From the beginning of our sample up to the start of EMU Austria and the Netherlands had a stable exchange rate vis-à-vis the D-mark as the main priority of monetary policy. Exchange-rate adjustments were minor and rare, and in the Dutch case the result of multilateral negotiations between EEC countries, and not of a Dutch wish to devalue the currency. Likewise, Gnan, Kwapil and Valderrama (2005) underline the continuity of Austrian monetary policy. Therefore the Netherlands and Austria are also included in the control group without a change of regime.

Furthermore, we do not consider as consistent fixed-exchange-rate regimes the many cases of an announced fixed-exchange-rate policy with less than full commitment, meaning that factors besides the exchange rate were given weight in monetary policy. Therefore we do not include cases that could be dubbed fixed-exchange-rate policy light[5], as in the UK, Sweden, Norway and Iceland, as consistent fixed-exchange-rate policy. Likewise we do not class Ireland, Portugal, Spain and Italy as fixed-exchange-rate countries before 1997, prior to the formation of EMU. Finally, it is open to discussion when the change of regime in France, Belgium and Denmark took place. The central rates have been unchanged since January 1987, but it can be argued that these countries did not separate from the softer ERM countries until 1993. On the other hand, one could also argue that the change occurred earlier in the 1980s as announcements of a fixed-exchange-rate policy and an orientation towards a more rigorous economic policy in general was made in these countries. However, some realignments of these countries' currencies took place until 1987[6]. Hence, we consider 1987 as the year where the regime shifts were implemented. As stated, these choices are not unambiguous, so we supplement the basic analysis with a sensitivity analysis in order to consider the importance of changes in the classifications.

The analysis below focuses on the development in inflation and output gap volatility across the three categories of countries, just as developments in the inflation levels are considered. This is in accordance with the above theoretical outline. For the same reason the analysis does not include economic growth that in the longer term primarily is determined by

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5 By this we mean a half-hearted fixed-exchange-rate policy, often introduced in order to get interest rates down in the short run, without a subordination of fiscal policy to meet the demands from the exchange-rate objective.

6 In particular, the French franc was depriciated by as much as 17 per cent vis-à-vis the D-mark over the years 1983 to 1987, whereas the Belgian franc and the Danish krone were depreciated by 7 and 8 per cent, respectively.

structural factors. The Appendix presents a more detailed description of the OECD-data used as well as a classification of monetary-policy regimes and time of regime change, cf. Table A.1. Data is shown as charts for each country with inflation level and variability in inflation and output gap, as well as an indication of the period in which a country pursued inflation targeting or a fixed-exchange-rate policy in accordance with our categorisation, cf. Chart A.1. With the exception of Iceland, which, for example, has had a far higher inflation rate than the other countries, cf. above, the axes are the same for all countries. Finally, it deserves to be underlined that the methodology demands as high a degree of harmonisation of the statistics as possible with the consequence that preferred national measures of inflation, e.g. RPIX in the UK from 1993 to 2000, cannot be employed.

Table 4.1 shows averages for these three variables for each country for four sub-periods of roughly similar length. Despite its summary nature, the Table shows some clearly shared characteristics of the countries, as well as a number of differences. In all countries inflation is lower in the period after 1987 than before 1987, and for most countries it is lowest after 1995. The same pattern is seen for inflation volatility, emphasising the well-established empirical fact that inflation volatility declines with the inflation level.

TABLE 4.1. DESCRIPTIVE STATISTICS, AVERAGES IN SUB-PERIODS.

	Inflation level, per cent p.a.				Inflation volatility, per cent p.a.				Output gap volatility, per cent of GDP			
	71-78	79-86	87-94	95-05	71-78	79-86	87-94	95-05	71-78	79-86	87-94	95-05
Fixed-exchange-rate countries												
Belgium	7.87	5.96	2.51	1.85	1.11	0.67	0.35	0.39	-	1.15	1.20	0.89
Denmark	9.60	8.17	2.96	2.13	1.69	1.14	0.35	0.31	-	1.86	1.26	0.72
Finland	11.73	7.94	4.06	1.28	1.33	0.95	0.55	0.43	-	1.14	3.18	1.44
France	9.07	9.38	2.76	1.58	0.72	0.78	0.23	0.28	-	0.86	1.02	0.66
Greece	12.65	21.28	15.58	4.57	2.86	1.71	1.42	0.51	-	1.60	1.94	0.52
Ireland	13.24	12.21	2.85	3.02	1.75	1.73	0.48	0.53	-	-	2.10	1.35
Italy	12.92	13.84	5.34	2.69	2.12	1.05	0.29	0.30	2.10	1.31	1.15	0.88
Portugal	18.35	21.06	9.64	3.04	4.63	3.25	0.85	0.46	-	1.78	2.76	1.32
Spain	14.97	12.66	5.59	3.08	1.93	0.79	0.46	0.41	-	-	1.54	0.57
Countries with inflation targeting												
Australia	10.67	8.74	4.81	2.68	1.42	0.96	0.67	0.67	1.11	2.21	1.41	0.57
Canada	7.66	7.61	3.41	2.04	0.92	0.60	0.39	0.62	1.29	1.64	1.65	0.93
Iceland	29.56	46.76	12.08	3.23	5.51	8.28	2.49	0.97	-	1.95	2.55	1.50
New Zealand	11.81	13.07	5.07	2.13	1.10	1.86	1.35	0.46	-	-	1.62	1.01
Norway	8.55	8.52	4.19	2.07	0.69	0.88	0.46	0.58	-	1.17	1.35	0.94
Sweden	8.94	8.77	5.71	1.32	1.28	0.91	0.75	0.49	1.31	1.24	1.57	1.08
UK	13.34	8.86	4.99	2.64	1.73	1.42	0.73	0.40	-	1.63	1.70	0.44
Control countries												
Austria	6.63	4.53	2.89	1.77	0.59	0.51	0.30	0.38	1.58	1.25	0.94	0.91
Germany	5.17	3.62	2.62	1.46	0.43	0.59	0.40	0.29	1.54	1.55	1.41	0.75
Japan	9.97	3.24	1.63	-0.07	1.52	0.66	0.53	0.41	2.10	1.09	1.41	1.05
Netherlands	7.84	3.98	1.91	2.28	0.60	0.49	0.33	0.26	-	1.00	1.12	0.97
Switzerland	5.30	3.74	3.24	0.89	0.81	0.70	0.53	0.31	-	1.61	1.47	0.96
USA	6.73	6.78	3.85	2.54	0.88	0.75	0.47	0.40	2.19	1.85	0.92	0.90

The similarities of inflation levels across countries are greatest in the period after 1995, whereas the differences are more apparent for years in the early 1970s up to the mid-1990s. Germany and Switzerland have seen moderate inflation rates and low volatility in all sub-periods: Both countries announced a monetarist monetary policy from the mid 1970s to counter the greater inflationary pressure around the first oil crisis at the beginning of the 1970s, although it has been disputed how dogmatic they were. The same applies to Austria and the Netherlands that have been closely linked to the D-mark throughout the sample period. The two largest economies, the USA and Japan, have also each had a relatively moderate inflation rate, although a little higher than Germany's. At the top end of the inflation spectrum are countries such as Italy, Spain, Greece, Ireland and New Zealand with high and varying inflation up to the end of the 1980s, and not least Iceland, whose inflation history is incommensurable with any other country in the sample. These countries all have double-digit average annual inflation rates in the first two sub-periods. A relatively large intermediate group includes all other Nordic countries as well as e.g. France, the UK and Australia. A common characteristic of this group is a moderately high inflation rate and equivalent volatility, showing a decline to a modest level in the last sub-period. A significant variation within this group of countries is seen in the period 1987-94 when the inflation level and volatility were reduced in countries like France, Belgium and Denmark, that had all changed to a fixed-exchange-rate policy, while some of the other countries that today have adopted inflation targeting did not get their inflation under control until after 1995.

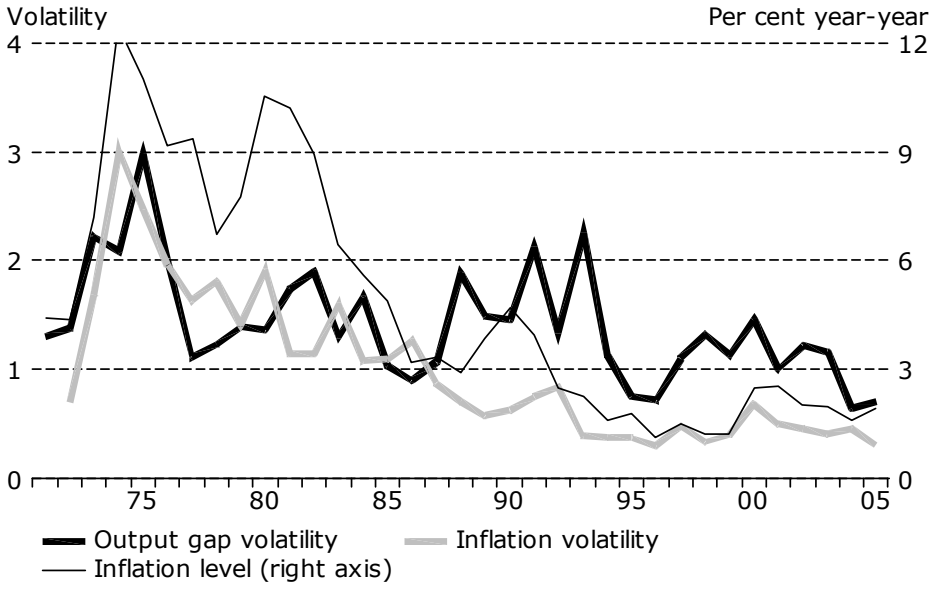
The output gap volatility, compiled as the absolute annual change in the OECD's compilation of the gap, does not show the same clear pattern across countries. Clearly, changes in the output gap are generally smallest after 1995, but it is difficult to pinpoint particular countries with their own development. The collapse of the Finnish economy at the beginning of the 1990s, which was the biggest economic slump in any western country since World War II, is apparent, and other important episodes can also be identified. The output gap is the difference between actual GDP, which is subject to considerable uncertainty and often undergoes substantial revision, and potential output, that is unobservable. Accordingly, the output gap is subject to far greater uncertainty than the rate of inflation.

In the estimations recorded below, where the effects of changing to respectively a fixed-exchange-rate policy and inflation targeting are compared, explicit account is taken of the broadly similar course across countries from a situation of high and varying inflation in the 1970s to the situation in the 1990s with more stable macroeconomic conditions as well as of differences concerning the timing and other details. The decline in the variation of the output gap and the more marked decline in inflation

volatility associated with a lower level of inflation being a general feature across countries is reflected in the fixed time effect, β_t, as estimated according to equation (1), cf. Chart 5.1. It reflects a general shift of the Taylor curve towards the origin over the last 3-4 decades. According to the analysis of the G-7 economies in Stock and Watson (2003) the 1960s and 1970s represent an inefficient point off the Taylor frontier due to e.g. monetary policy being too accommodative[7], whereas the further reduction of cyclical volatility is considered of a more transitory nature due e.g. to a more favourable international, macroeconomic environment.

Against this, the relevant question to be answered is whether a regime shift to either a consistent fixed-exchange-rate policy or inflation targeting has led to a macroeconomic performance that is more favourable than the general international development, i.e. has there been a more marked reduction in the level of inflation, inflation and/or variations in the output gap? This question is addressed in the next section.

INFLATION LEVEL AND VOLATILITY IN INFLATIONAND OUTPUT GAP, ESTIMATED COMMON TREND ACROSS COUNTRIES — CHART 5.1



Note:: The graphs depict the estimated time effect, β_t, that follows from estimations of equation (1).

[7] See also some of the references in Stock and Watson (2003).

5. Monetary-policy regime and macroeconomic performance

Below estimates of the impact to inflation and output gap volatility, as well as to the inflation level, from a change in the monetary-policy regime are reported. The classification of monetary-policy regime and the time of the regime change, where relevant, are stated in Table A.1 of the Appendix. of a change in the monetary-policy regime To illustrate sensitivity to these choices, alternative estimations are also considered, where for some countries other assumptions are made on the monetary-policy regime. In addition a number of other tests of robustness are made, cf. below. These tests show that the results do not depend on any single choice made.

Monetary-policy regime and inflation level

Inflation has fallen significantly after the change to both a consistent fixed-exchange-rate policy and inflation targeting, cf. Table 5.1. The effect is greatest for the fixed-exchange-rate countries, but the difference between the two groups does not appear to be statistically significant.

Introducing indicators for the period up to the change of regime does not change the results qualitatively. Even though these indicators are clearly significant – low inflation in the years until a country changes to a fixed-exchange-rate policy, and somewhat higher inflation before a country changes to inflation targeting – the result cannot be explained by inverse causality. In most cases the estimated effects become insignificant when Iceland is included in the calculations, reflecting big residuals that make Iceland the single most important country for the analysis, which does not appear to be meaningful.

TABLE 5.1. SIGNIFICANCE OF THE MONETARY-POLICY REGIME TO THE INFLATION LEVEL. DIFFERENCE-IN-DIFFERENCE ESTIMATION. 1972-2005

	(1)	(2)	(3)	(4)
REGIME_FER	-3.09	-4.34	-1.60	-2.83
	(-7.02)	(-9.16)	(-2.13)	(-3.41)
	[-3.32]	[-3.50]	[-0.89]	[-1.48]
REGIME_IT	-1.95	-2.43	-1.66	-2.82
	(-4.02)	(-4.67)	(-2.05)	(-3.19)
	[-2.15]	[-3.07]	[-1.50]	[-2.19]
FER_5y_before		-3.51		-2.64
		(-6.72)		(-2.90)
		[-3.41]		[-2.15]
IT_5y_before		0.66		-2.14
		(1.09)		(-2.18)
		[0.66]		[-0.82]
#obs	735	735	770	770
#countries	21	21	22	22
R2	.76	.78	.64	.65

Note: (1) and (2): Basic model. (3) and (4): Including Iceland. Conventional t values in round brackets. The equivalent adjusted for heteroscedasticity and autocorrelation in square brackets.. FER_5y_before and IT_5y_before are indicators of 5 years up to the regime change.

Monetary-policy regime and inflation volatility

The change to a fixed-exchange rate policy has entailed a clear and statistically significant decrease in inflation volatility, cf. Table 5.2 while the change to inflation targeting has not had significant effects. Again, the result is robust to the introduction of indicators for the period preceding the change of regime, hence ruling out that results are due to inverse causality, even if these indicators are significant. The positive coefficient to the dummy for the last five years up to the change to inflation targeting reflects that inflation volatility was high in the years before changing to inflation targeting. This indicates that the regime change is not chosen, but rather enforced, due to the unfavourable development in the preceding years. The opposite situation applies to the fixed-exchange-rate countries that have experienced low inflation volatility in the years before changing to a fixed-exchange-rate policy.

As it was the case for effects on the level of inflation, the estimated effects are insignificant when Iceland is included, although the estimates still show that it has been more favourable to change to a fixed-exchange-rate policy than to inflation targeting.

TABLE 5.2. SIGNIFICANCE OF THE MONETARY-POLICY REGIME TO INFLATION VOLATILITY. DIFFERENCE-IN-DIFFERENCE ESTIMATION. 1972-2005

	(1)	(2)	(3)	(4)
REGIME_FER	-0.49	-0.66	-0.08	-0.30
	(-3.26)	(-4.00)	(-0.34)	(-1.10)
	[-2.32]	[-2.12]	[-0.18]	[-0.64]
REGIME_IT	-0.02	0.09	0.03	-0.14
	(-0.11)	(0.47)	(0.10)	(-0.50)
	[-0.06]	[0.30]	[0.08]	[-0.34]
FER_5y_before		-0.62		-0.49
		(-3.43)		(-1.66)
		[-2.08]		[-1.64]
IT_5y_before		0.69		-0.25
		(3.29)		(-0.79)
		[1.68]		[-0.28]
#obs	714	714	748	748
#countries	21	21	22	22
R2	.51	.53	.48	.49

Note: Same as for Table 5.1.

Monetary-policy regime and variability in the output gap

As for inflation volatility the change to a fixed-exchange-rate policy entails a significant decrease in the variability in the output gap, cf. table 5.3. Changing to inflation targeting is also associated with a decrease in the variability of the output gap, but the effects are much smaller and not statistically significant. This conclusion also applies, when Iceland is included in the sample.

TABLE 5.3. SIGNIFICANCE OF THE MONETARY-POLICY REGIME TO VARIABILITY IN THE OUTPUT GAP. DIFFERENCE-IN-DIFFERENCE ESTIMATION. 1972-2005

	(1)	(2)	(3)	(4)
REGIME_FER	-0.28	-0.31	-0.24	-0.29
	(-1.72)	(-1.71)	(-1.46)	(-1.56)
	[-2.38]	[-2.10]	[-2.03]	[-1.95]
REGIME_IT	-0.12	-0.17	-0.04	-0.13
	(-0.65)	(-0.85)	(-0.24)	(-0.66)
	[-0.54]	[-0.79]	[-0.20]	[-0.64]
FER_5y_before		-0.06		-0.06
		(-0.29)		(-0.32)
		[-0.24]		[-0.27]
IT_5y_before		-0.12		-0.21
		(-0.53)		(-0.95)
		[-0.55]		[-1.04]
#obs	665	665	692	692
#countries	21	21	22	22
R2	.26	.26	.24	.25

Note: Same as for Table 5.1.

Robustness checks

The classification of the countries' monetary-policy regimes and the timing of changes can be questioned in several cases, cf. above. To illustrate the sensitivity to some of these choices Tables A.2-A.4 of the Appendix show the results of some alternative estimations. For example, it does not affect the results if Belgium, Denmark and France are assumed to change to a fixed-exchange-rate policy in 1983, nor if the change is assumed to occur in 1993 as discussed above. The last change in the exchange-rate parities of these three countries was in 1987, but the announcement of a fixed-exchange-rate policy took place in the first half of the 1980s, whereas it was not until 1993 that their exchange-rate-policy actions separated them from other ERM participants such as Ireland, Spain and Portugal, that all devalued their currency. In the same way, it is not of particular significance whether Sweden's or Norway's change to inflation targeting are supposed to take place in respectively 1995 and 2001, i.e. two years later than in the base model, based on the consideration that the new regimes were not fully in place until those dates. Furthermore, it does not affect the results if Finland is considered to be an inflation targeter in 1993-96.

Because the analysis is based solely on developed western countries a high degree of homogeneity across countries is provided. This is a precondition in the econometric model, but limits the sample, which is considerably smaller than for e.g. Giavazzi and Tabellini (2004) and Persson (2005). The small number of countries increases the risk that events in one single country determine the results. However, the results do not depend on data for any individual country, cf. Table A.5-A.7 of the Appendix. In these estimations, data for each individual country is omitted from the sample in turn. In no case any significant change in the central parameters and the respective significance probabilities compared to the base model can be

observed. It is a robust finding in our sample that changing to a fixed-exchange-rate policy has significantly reduced the inflation volatility by almost 0.5 percentage points, and likewise has reduced variations in the output gap, whereas in these cases the coefficient for the change to inflation targeting is close to zero and clearly insignificant.

6. Conclusion and areas for future research

Our econometric analysis of the impact of the change of monetary-policy regime in the OECD countries in the period 1970-2005 shows that the level of inflation fell significantly in the years after a change of regime, regardless of whether the country changed to a consistent fixed-exchange-rate policy or to inflation targeting. However, the estimated effect is greatest and most significant on the change to a fixed-exchange-rate policy. We also find that the volatility in both inflation and the output gap became significantly lower after the change to a consistent fixed-exchange-rate policy, but was not reduced by the change to inflation targeting. As documented, these results are fairly robust, both with respect to alternative assumptions on the regime classification and to the exclusion from the data set of data for any single country.

The overall effect on inflation in industrialised countries that have adopted inflation targeting are in line with previous studies, e.g. Pétursson (2004) Vega and Winkelried (2005), Lin and Ye (2007), and Mishkin and Schmidt-Hebbel (2007). In addition, unlike earlier studies, we also look at effects from changing to a fixed-exchange-rate regime. A regime change to a consistent monetary policy, whether it is to a fixed-exchange-rate policy or to inflation targeting, dampens inflation. This is in broad agreement with the results of Fatás, Mihov and Rose (2007), who conclude that the introduction of a quantitative goal, whether a monetary target, an exchange rate target, or an inflation target, lead to lower inflation.

Before going further we should underline two things.

First, our study is confined to the performance of a number of OECD-countries in a certain period and it is not possible on a scientific basis to draw conclusions beyond our sample, neither in the time dimension, nor in the country dimension.

Second, we wish to remind that changes in monetary-policy regimes in our sample only pertain to countries that are best classified as small open economies. The results do not necessarily apply to large economies like the US or the Euro zone taken as one. In particular, an important premise for the small European countries pursuing a fixed-exchange-rate policy has been the stability-oriented monetary policy of the ECB, and before 1999 that of the Deutsche Bundesbank. That policy has provided these small countries with a natural anchor to peg against. It has been argued that the Bundesbank

and presently the ECB, and the Fed as well, for years have conducted monetary policy in a way that respects several, but certainly not all, of the recommendations put forward in the inflation-targeting literature. We will not take issue with that position. Still, it is of interest what the best option has been for small European countries: To peg the euro in a consistent way or to do inflation targeting? In that respect our results are clear: A consistent fixed-exchange-rate policy did actually lead to better outcomes to do than inflation targeting. Whether this will be the case in the future as well, no one can tell on a scientific background. For the small non-European countries in our sample an important issue is whether a similar unambiguous anchor like the ECB exists or not.

In monetary economics it has become common to see inflation targeting as best-practice monetary policy, often with reference to the experiences of several of the small countries that are part of this study to support the theoretical arguments. However, the theoretical literature mainly considers monetary policy in a closed economy which makes it highly problematic on such a basis to draw any monetary policy recommendations for small open economies. Nonetheless it is often stated, that, also in the real world, small open economies perform better under inflation targeting than under other monetary policy strategies, e.g. exchange rate targeting, with reference to actual developments in the theoretical arguments, i.e. inflation, volatility in inflation, and volatility in the output gap. A recent example is Svensson (2007) who states "So far, since its inception in the early 1990s, inflation targeting has been a considerable *success*, as measured by the stability of inflation and the stability of the real economy. There is no evidence that inflation targeting has been detrimental to growth, productivity, employment, or other measures of economic performance. The success is both absolute and relative to other monetary-policy strategies, such as exchange rate targeting or money-growth targeting." (p. 3, italics in original). This statement is, as demonstrated by our results, contradicted by the empirical evidence from our sample of small OECD-countries.

A full explanation of why the theoretical results from the inflation targeting literature are contradicted by the actual development up to the end of 2005 lies outside the scope of this empirical analysis. However, we will point out some aspects that we consider important to address in future research and give some hints of direction.

The exchange rate

It is normally assumed in the theoretical models that all or part of the exchange rate can be described by the uncovered interest-rate parity, so that an increase in the interest rate leads to an appreciation of the currency, implying that the expected future yields on domestic and international placements again correspond. This entails that the exchange-rate changes

affect the output gap in the same direction as interest-rate changes, i.e. the exchange rate works as a shock absorber that reduces the need for large interest-rate changes.

However, several empirical studies suggest that the exchange rate is not predominantly a shock absorber, cf. Artis and Ehrmann (2006) and references therein.

Theoretically, most models of exchange rate determination will include a shock-absorber mechanism, but an explicit formulation of the noise elements in the formation of the exchange rate will create a trade-off. A large noise element will increase the volatility in inflation and output gap in connection with inflation targeting, and dampen them in connection with a fixed-exchange-rate policy. Leitemo and Söderström (2005) present such a formulation of the exchange rate in a study of the robustness of certain monetary-policy rules, but they do not consider fixed-exchange-rate policy.

Irrespective of the theoretical model, a high degree of volatility in the exchange rate when exchange rates are floating can be an important element in explaining our results. Whether the exchange rate is best modelled by the uncovered interest-rate parity or by a process dominated by noise must in the end be a purely empirical issue, but with major consequences for the formulation of theoretical models in order to be of practical relevance.

Fiscal policy

Standard models in recent monetary economics typically see monetary policy as the only type of stabilisation policy. In countries pursuing a fixed-exchange-rate policy, the only economic-policy instrument, the short-term interest rate, is used to stabilise the exchange rate that does not enter the loss function. It is therefore obvious that according to models that disregard fiscal policy it can never be optimal to conduct a fixed-exchange-rate policy.

In recent years, however, considerable interest has been directed towards including fiscal policy in the analysis, cf. e.g. Calmfors (2003) or Beetsma and Jensen (2005) for two quite different approaches. Focus in this part of the literature has been whether fiscal policy in a country participating in a monetary union can compensate for the loss entailed by the absence of a national monetary policy, and more generally, whether a combination of active monetary and fiscal policy stabilises exogenous shocks better than monetary policy alone.

From an empirical viewpoint it would be interesting for the analysis to also include another aspect, namely what happens if the economic policy is sub-optimal and thus a major reason for shocks to the economy. This view is supported by Fatás and Mihov (2003) who in a multi-country study find that an active use of discretionary fiscal policy has a significant destabilising

effect on the macroeconomy, and by Andersen (2005) who argues on the basis of a theoretical model that discretion should be preserved for extraordinary circumstances. An interesting topic for future research is whether a consistent fixed-exchange-rate policy in practice leads to a more prudent, more forward-oriented and more careful design of fiscal policy than is the case under inflation targeting, so that the country avoids the detrimental effects that are easily entailed by a more discretionary fiscal policy, cf. Kydland and Prescott (1977).

Hence, it can become an additional task for the central bank under inflation targeting to control for the damage from unnecessarily large fiscal-policy shocks. A related topic is whether recent years lack of fiscal discipline in some of the EMU-countries will result in a higher volatility in inflation in those countries in the years ahead.

The role of EMU and ECB

Our sample of fixed-exchange-rate countries consists of eight countries now participating in EMU plus Denmark, and are hence of interest in itself. In terms of volatilities in inflation and output gap these countries have improved their performance beyond the global trend, while inflation targeting countries from the OECD area have not. This indicates, cf. below, that inflation expectations in the individual fixed-exchange-rate countries have been well anchored. By definition, this outcome cannot be due to the national monetary policy. It thus appears likely that the eurosystem has succeeded in anchoring inflation expectations in the individual member states. This represents the joint outcome of the communication of the ECBs Governing Council and of the individual national central banks.

It is a basic tenet in much of the recent theoretical literature on monetary economics, that monetary policy mainly operates via anchoring expectations while the actual short term interest rate does not matter much by itself. In a survey of optimal monetary policy Woodford (2004, p. 16) states “For not only do expectations of policy matter, but, at least under current conditions very little *else* matters.”(italics in original). A key instrument of the central bank is, according to this, its communication of its commitments and main considerations to achieve them. The communication regards objectives, assessment of the economy, of the short-term interest rate etc.

The successful performance of the small European fixed-exchange-rate countries is interesting in the light of continued criticism of the ECBs monetary policy from numerous researchers and market participants. The ECB has been strongly criticised for, among other things, its asymmetric inflation target, its two pillar strategy, and its way of communication, cf. e.g. Svensson (2003) for a very clear exposition. However, turning the argument around, the high degree of fulfilment of ECBs objective of price stability in the euro zone as a whole and the significant decline in volatilities

in the small countries does not provide empirical support for this criticism, on the contrary.

The criticism of the ECB from academia and financial markets is to a large extent related to shortcomings in its communication of the monetary policy framework to the sophisticated observers who emphasise the internal consistency of arguments in a certain class of models. However, in order to anchor inflation expectations, the central bank's communication with employers and employees, and the population at large is probably even more important than the communication with the sophisticated observers, i.e. Main Street matters more than Wall Street.

Finally, it can be argued that there is a higher degree of commitment in a consistent fixed exchange rate policy against an anchor actually achieving price stability than there is in inflation targeting. The argument relates to the correction of past mistakes. In the outlined fixed exchange rate regime the price level of the small country will co-integrate with that of the anchor, implying that if the small country has a higher inflation rate than the anchor for a period this will subsequently be reversed, e.g. via a deterioration of the competitiveness leading to a negative output gap for some period. This is almost equivalent to a commitment to a target path for the price level in order to increase confidence in the value of the currency as discussed by Woodford (2006).

Robustness versus optimality

In general, countries that have adopted inflation targeting are satisfied with their monetary policy regime. Our results show that in general this cannot be attributed to the macroeconomic performance of the regime in terms of improvements regarding volatility in inflation and output gap, i.e. in the factors that the theoretical literature includes in the central bank’s loss function.

The analysis thus points to a monetary-policy paradox: Why are inflation-targeting countries and central banks so satisfied with a regime that has been outperformed by consistent fixed-exchange-rate policy? There is no clear answer to this. One possibility is that inflation targeting guards the central bank against a collapse of the targets for its monetary policy to a greater degree than a fixed-exchange-rate policy does, e.g. if fiscal policy should at some point be designed inappropriately. More generally, inflation targeting is probably perceived as a more robust regime in which the central bank maintains a high degree of control over the economy, no matter how fiscal policy is conducted. A fixed-exchange-rate policy presupposes that a responsible fiscal policy is in place. A subject for future research is therefore whether the true argument for inflation targeting among central bankers is robustness, while the literature focuses on optimality. A remark by the governor of Bank of England, Mervyn King, suggests that in his

opinion protection against major mistakes ranks above optimality among the factors in support of inflation targeting: "First, I would be interested to know whether people would agree that inflation targeting makes it easier for the weaker brethren – that is, most people in central banking – to do the right thing." and "Second, why is it that countries that have adopted inflation targeting are generally very happy with it? Is it just that they have benefited from a very benign period, or have they found this a sustainable, healthy way of living?" (King, 2005, p. 16).

7. Literature

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8. Appendix

Data sources

Inflation: Percentage annual change in CPI. Source: OECD Main Economic Indicators.

Inflation volatility: Standard deviation of the annual change in CPI for the last 24 months up to the end of the year. For Australia and New Zealand CPI is only available on a quarterly basis. This is of almost no significance to the calculation of the standard deviation. Source: OECD Main Economic Indicators.

Output gap volatility: Absolute annual change in the output gap in per cent of GDP. Source: OECD Economic Outlook 80, Autumn 2006.

Monetary-policy regime

The classification of the countries' monetary-policy regimes is based mainly on our own assessment of the actual policy and does not fully correspond to other classifications such as Reinhart and Rogoff (2004) and Levy-Yeyati and Sturzenegger (2005), besides a number of others. These analyses share in common that they comprise a large set of countries that extends far beyond the group of OECD countries as here, and must therefore be based on various summary characteristics, regardless of whether they are *de jure* or *de facto* classifications. On the other hand, the number of countries is smaller and clearer in our study, which allows for a more nuanced evaluation of the countries that in some cases has been discussed with representatives of the central banks of the countries concerned.

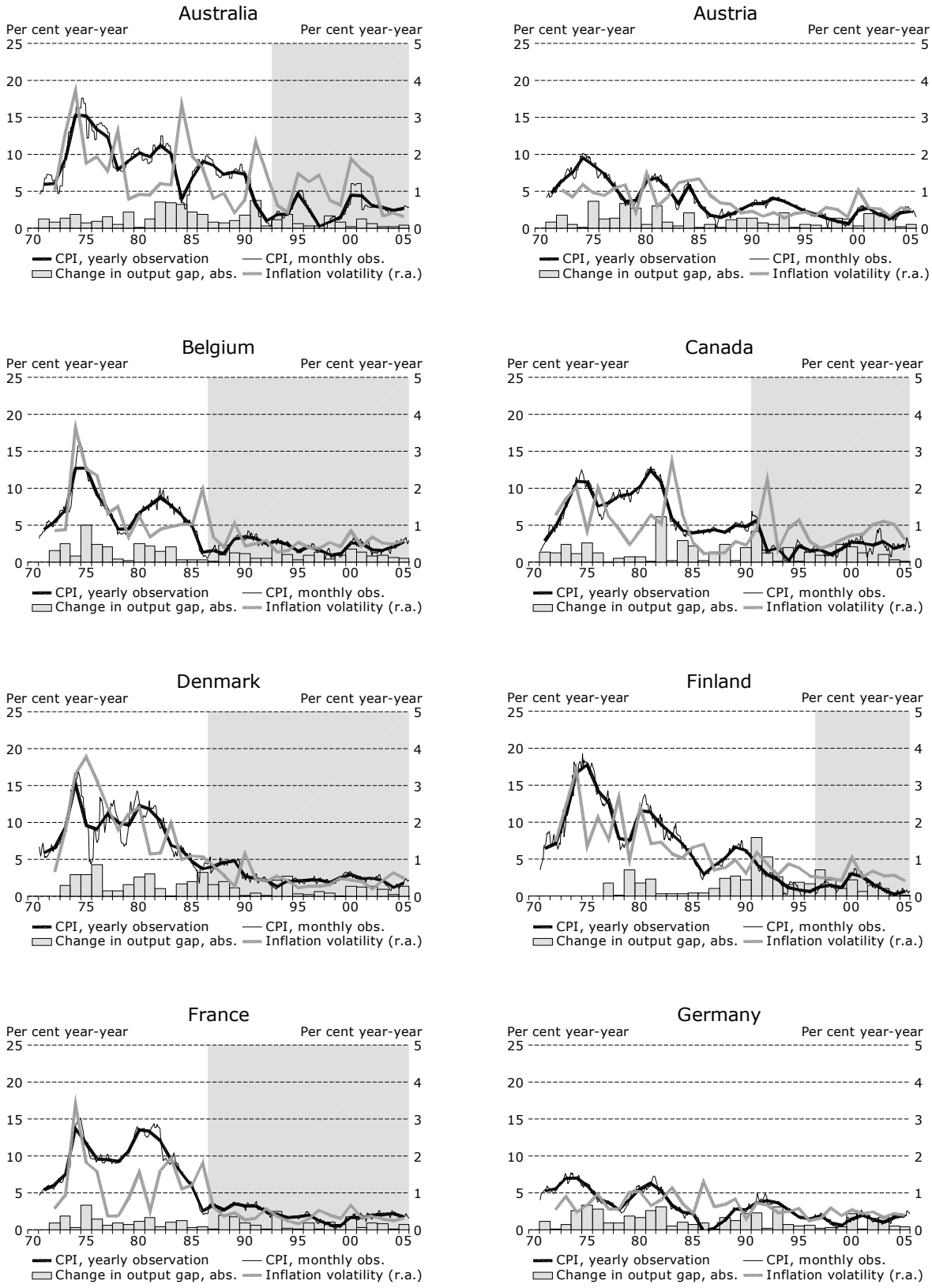
TABLE A.1. MONETARY-POLICY REGIME

Country	**Description**	**Regime change**
Australia	Since 1971 the AUD has floated in relation to dominating currencies, although up to 1982 it was officially pegged to USD. Change to inflation targeting in April 1993.	1993
Austria	ATS has de facto followed the DEM even before the start of the sample. Austria has been part of EMU since 1999.	-
Belgium	BEF was part of the "snake" in the 1970s and Belgium participated in the various stages of EMS. During the 1970s and the first part of the 1980s BEF was gradually devalued against DEM. From January 1987 the central rate against DEM was unchanged. Belgium has been part of EMU since 1999.	1987
Canada	Canada has had a floating exchange rate throughout the sample. Change to inflation targeting in February 1991.	1991
Denmark	DKK was part of the "snake" in the 1970s and Denmark participated in the various stages of EMS. During the 1970s and the first part of the 1980s DKK was gradually devalued against DEM. From January 1987 the central rate against DEM was unchanged. Denmark has not adopted the euro, but maintains a fixed exchange rate vis-à-vis the euro.	1987
Finland	In the 1970s and 1980s FIM was linked to a basket of currencies with occasional changes, primarily devaluations. After a major economic crisis in the early 1990s and the change to a floating exchange rate the FIM depreciated strongly. Finland hereafter changed to inflation targeting in 1993. In October 1996 FIM joined ERM, and Finland has been part of EMU since 1999 .	1997

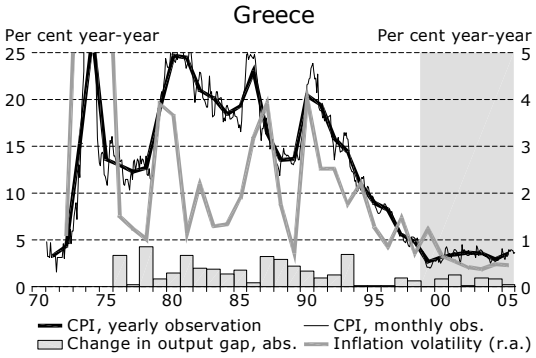
France	FRF was part of the "snake" in the 1970s and France participated in the various stages of EMS. FRF was linked to DEM throughout the period and France participated in the various stages of EMS. During the 1970s and the first part of the 1980s FRF was gradually devalued against DEM. From January 1987 the central rate in relation to DEM was unchanged. France has been part of EMU since 1999.	1987
Germany	In the mid-1970s Germany pursued a stability-oriented monetary policy directed towards maintaining low inflation through management of the money supply. In practice DEM was the hub of the ensuing decades' EMS. Germany has been part of EMU since 1999.	-
Greece	GRD weakened continually against DEM from the early 1970s until the late 1990s. In March 1998 GRD joined ERM prior to Greece's joining EMU in 2001.	1999
Iceland	For most of the period since 1970 Iceland pursued a fixed-exchange-rate policy against a basket of currencies, but with frequent and large devaluations. In March 2001 Iceland adopted inflation targeting.	2001
Ireland	IEP was linked to GBP in the 1970s, but joined ERM in 1979. IEP gradually devalued against DEM. Ireland has been part of EMU since 1999.	1997
Italy	Italy joined ERM in 1979 and was devalued frequently against DEM. In 1992 ITL left ERM, but rejoined in November 1996. Italy has been part of EMU since 1999.	1997
Japan	Japan has had a floating exchange rate throughout the period.	-
Netherlands	NLG was part of the "snake" in the 1970s and the Netherlands has participated in the various stages of EMS and closely followed DEM. The Netherlands has been part of EMU since 1999.	-
New Zealand	New Zealand has had a floating exchange rate throughout the period, but for some periods within a fluctuating band in relation to AUD. New Zealand changed to inflation targeting in March 1990.	1990
Norway	NOK was part of the "snake" in the 1970s but Norway changed to a peg against a basket in 1978 with frequent devaluations. From 1998 an inflation targeting regime was shadowed and Norway officially changed to inflation targeting in March 2001.	1999
Portugal	In 1992 PTE joined ERM, but was devalued on several occasions. Portugal has been part of EMU since 1999.	1997
Spain	In the early 1970s up to the mid-1990s ESP followed a fluctuating band in relation to first USD and then DEM, with ongoing depreciation against DEM throughout the period. For a period in the 1990s an inflation target was part of the official policy together with targets for the exchange rate and for credit expansion. In 1989 ESP joined ERM, and since 1999 Spain has been part of EMU.	1997
Sweden	SEK was part of the "snake" in the 1970s but Sweden changed to a peg against a basket in 1977 with frequent devaluations. In the period 1991-92 SEK was unilaterally pegged to ECU, but abandoned this in November 1992. In March 1993 Sweden changed to inflation targeting, but according to Sveriges Riksbank the system was not well-established and operational until the beginning of 1995.	1993
Switzerland	Throughout the sample monetary policy in Switzerland was directed at maintaining low inflation, as in Germany, with management of money supply as the intermediate target since the mid-1970s. The present monetary policy has elements of inflation targeting, but this cannot be classed as a change of regime.	-
UK	The UK had a floating exchange rate in the 1970s and 1980s. GBP joined ERM in 1990, but left the system in 1992 after a speculative attack. In October 1992 the UK changed to inflation targeting.	1993
USA	The US dollar has floated throughout the period.	-

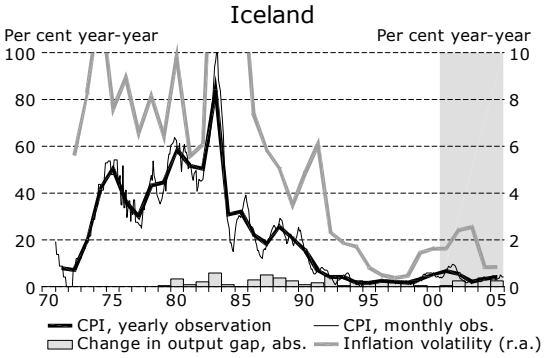
Data

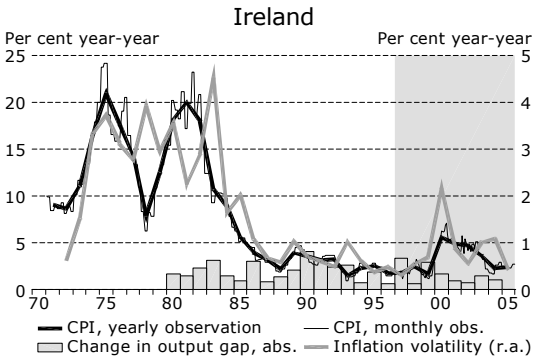
CHART A.1. INFLATION LEVEL, INFLATION VOLATILITY, AND OUTPUT GAP VARIABILITY, 22 OECD COUNTRIES, 1970-2005.[8]

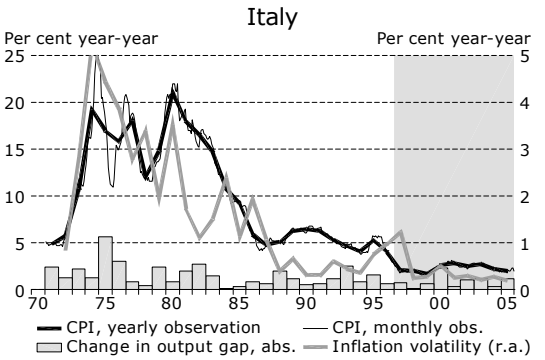


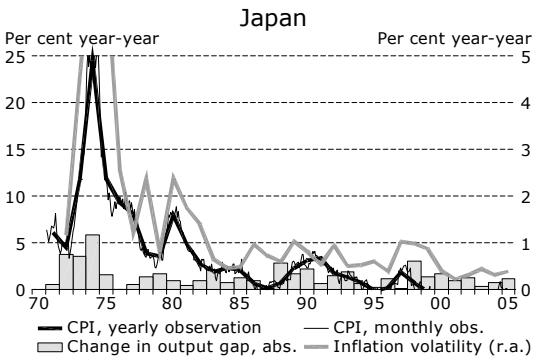
[8] Shaded areas depict the period, where a new monetary-policy regime is in force, cf. Table A.1.

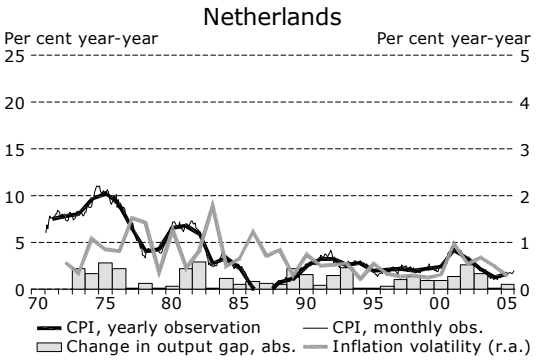

Greece
Per cent year-year
Per cent year-year
CPI, yearly observation
CPI, monthly obs.
Change in output gap, abs.
Inflation volatility (r.a.)

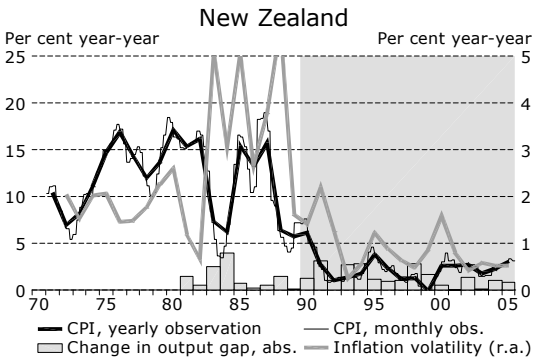

Iceland
Per cent year-year
Per cent year-year
CPI, yearly observation
CPI, monthly obs.
Change in output gap, abs.
Inflation volatility (r.a.)

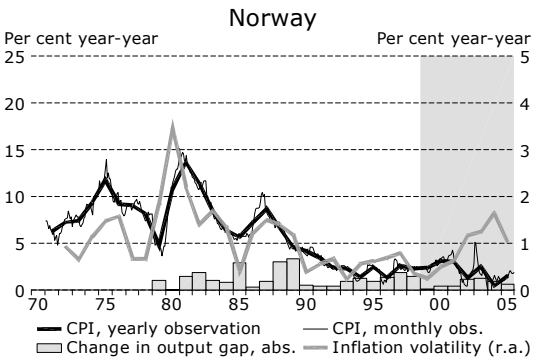

Ireland
Per cent year-year
Per cent year-year
CPI, yearly observation
CPI, monthly obs.
Change in output gap, abs.
Inflation volatility (r.a.)


Italy
Per cent year-year
Per cent year-year
CPI, yearly observation
CPI, monthly obs.
Change in output gap, abs.
Inflation volatility (r.a.)

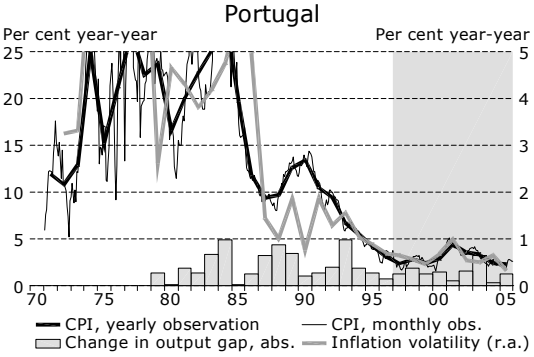

Japan
Per cent year-year
Per cent year-year
CPI, yearly observation
CPI, monthly obs.
Change in output gap, abs.
Inflation volatility (r.a.)


Netherlands
Per cent year-year
Per cent year-year
CPI, yearly observation
CPI, monthly obs.
Change in output gap, abs.
Inflation volatility (r.a.)

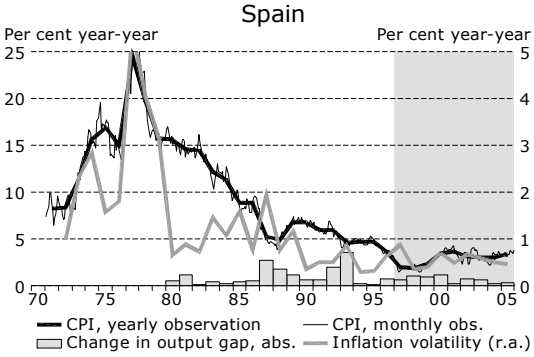

New Zealand
Per cent year-year
Per cent year-year
CPI, yearly observation
CPI, monthly obs.
Change in output gap, abs.
Inflation volatility (r.a.)


Norway
Per cent year-year
Per cent year-year
CPI, yearly observation
CPI, monthly obs.
Change in output gap, abs.
Inflation volatility (r.a.)

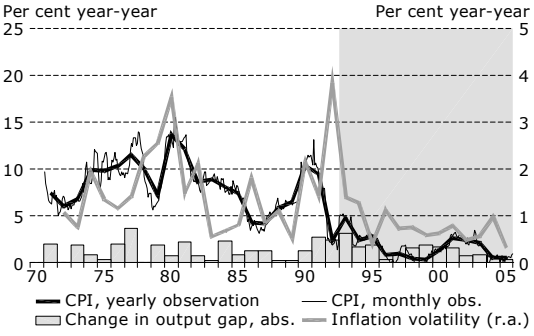
Portugal



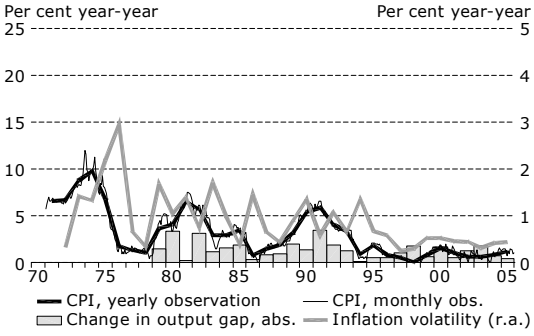
Spain



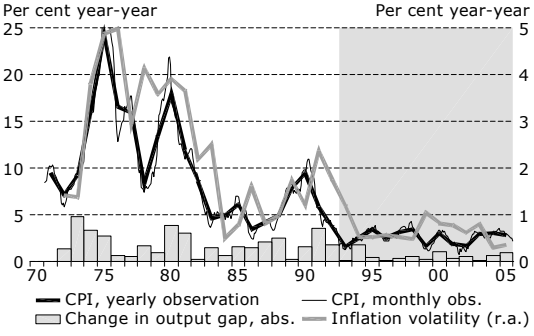
Sweden



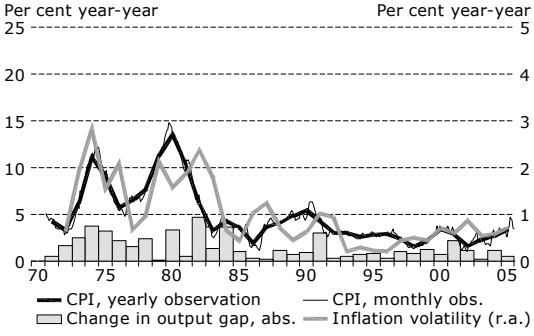
Switzerland



UK



USA



Robustness of estimations to the classification of monetary-policy regime

TABLE A.2. SIGNIFICANCE OF THE MONETARY-POLICY REGIME TO THE LEVEL OF INFLATION. DIFFERENCE-IN-DIFFERENCE ESTIMATION. 1972-2005

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
REGIME_FER	-3.13	-4.51	-3.06	-4.45	-3.09	-4.31	-3.12	-4.36	-3.19	-4.28
	(-7.16)	(-9.54)	(-6.45)	(-8.90)	(-7.04)	(-9.14)	(-7.07)	(-9.20)	(-7.21)	(-9.04)
	[-3.11]	[-3.50]	[-3.14]	[-3.72]	[-3.33]	[-3.48]	[-3.34]	[-3.53]	[-3.45]	[-3.46]
REGIME_IT	-1.86	-2.31	-2.04	-2.73	-2.02	-2.45	-2.03	-2.51	-2.10	-2.32
	(-3.87)	(-4.53)	(-4.08)	(-5.11)	(-4.12)	(-4.69)	(-4.15)	(-4.82)	(-4.42)	(-4.64)
	[-2.11]	[-2.94]	[-2.26]	[-3.52]	[-2.22]	[-3.08]	[-2.25]	[-3.21]	[-2.40]	[-3.03]
FER _5y_before		-3.70		-3.83		-3.52		-3.49		-3.30
		(-7.09)		(-7.18)		(-6.81)		(-6.73)		(-6.45)
		[-3.48]		[-4.31]		[-3.42]		[-3.40]		[-3.15]
IT_5y_before		0.80		0.59		0.80		0.45		0.50
		(1.33)		(0.97)		(1.32)		(0.76)		(0.87)
		[0.81]		[0.56]		[0.84]		[0.49]		[0.51]
R2	.76	.78	.76	.78	.76	.78	.76	.78	.76	.78

Note: (1) and (2): Belgium, Denmark and France change to a fixed-exchange-rate policy in 1983 instead of 1987. (3) and (4): Belgium, Denmark and France change to a fixed-exchange-rate policy in 1993 instead of 1987. (5) and (6): Norway changes to inflation targeting in 2001 instead of 1999. (7) and (8): Sweden changes to inflation targeting in 1995 instead of 1993. (9) and (10): Finland is considered as an inflation targeter in 1993-96. Conventional t values in round brackets. The equivalent adjusted for heteroscedasticity and autocorrelation in square brackets. FER_5y_before and IT_5y_before are indicators of 5 years up to the change of regime. The same number of countries and observations as in columns (1) and (2) in Table 5.1.

TABLE A.3. SIGNIFICANCE OF THE MONETARY-POLICY REGIME TO INFLATION VOLATILITY. DIFFERENCE-IN-DIFFERENCE ESTIMATION. 1972-2005

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
REGIME_FER	-0.47	-0.76	-0.48	-0.70	-0.49	-0.65	-0.51	-0.67	-0.49	-0.63
	(-3.15)	(-4.61)	(-3.00)	(-4.03)	(-3.25)	(-3.97)	(-3.35)	(-4.04)	(-3.23)	(-3.82)
	[-1.94]	[-2.41]	[-2.06]	[-2.25]	[-2.31]	[-2.11]	[-2.38]	[-2.13]	[-2.29]	[-2.01]
REGIME_IT	0.01	0.07	-0.03	0.02	-0.00	0.09	-0.06	0.06	-0.01	0.12
	(0.04)	(0.38)	(-0.18)	(0.13)	(-0.02)	(0.51)	(-0.37)	(0.34)	(-0.08)	(0.67)
	[0.02]	[0.25]	[-0.11]	[0.09]	[-0.01]	[0.33]	[-0.21]	[0.23]	[-0.04]	[0.44]
FER _5y_before		-0.85		-0.66		-0.62		-0.61		-0.62
		(-4.72)		(-3.56)		(-3.48)		(-3.39)		(-3.49)
		[-3.22]		[-2.73]		[-2.10]		[-2.06]		[-2.10]
IT_5y_before		0.70		0.67		0.67		0.72		0.61
		(3.38)		(3.17)		(3.20)		(3.46)		(3.09)
		[1.70]		[1.57]		[1.62]		[1.74]		[1.62]
R2	.51	.54	.51	.53	.51	.53	.51	.53	.51	.53

Note: Same as for Table A.2.

TABLE A.4. SIGNIFICANCE OF THE MONETARY-POLICY REGIME TO VARIABILITY IN THE OUTPUT GAP. DIFFERENCE-IN-DIFFERENCE ESTIMATION. 1972-2005

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
REGIME_FER	-0.28	-0.28	-0.07	-0.13	-0.26	-0.30	-0.30	-0.31	-0.28	-0.24
	(-1.72)	(-1.48)	(-0.42)	(-0.66)	(-1.62)	(-1.66)	(-1.82)	(-1.69)	(-1.68)	(-1.30)
	[-2.88]	[-1.76]	[-0.64]	[-0.85]	[-2.25]	[-2.02]	[-2.51]	[-2.11]	[-2.34]	[-1.48]
REGIME_IT	-0.11	-0.14	-0.04	-0.10	-0.06	-0.15	-0.17	-0.15	-0.10	0.02
	(-0.60)	(-0.70)	(-0.24)	(-0.49)	(-0.34)	(-0.73)	(-0.96)	(-0.75)	(-0.55)	(0.12)
	[-0.50]	[-0.63]	[-0.20]	[-0.46]	[-0.27]	[-0.64]	[-0.85]	[-0.65]	[-0.48]	[0.10]
FER _5y_before		-0.03		-0.12		-0.05		-0.05		-0.02
		(-0.14)		(-0.61)		(-0.25)		(-0.26)		(-0.11)
		[-0.12]		[-0.53]		[-0.20]		[-0.22]		[-0.09]
IT_5y_before		-0.11		-0.10		-0.22		0.08		0.35
		(-0.47)		(-0.41)		(-0.93)		(0.36)		(1.58)
		[-0.48]		[-0.42]		[-1.20]		[0.28]		[0.90]
R2	.26	.26	.26	.26	.26	.26	.26	.26	.26	.27

Note: Same as for Table A.2.

Robustness of the estimations to omission of the countries one by one

TABLE A.5. SIGNIFICANCE OF THE MONETARY-POLICY REGIME TO THE LEVEL OF INFLATION. DIFFERENCE-IN-DIFFERENCE ESTIMATION. 1972-2005

Fixed-exchange-rate countries

Excl. …	Belgium	Denmark	Finland	France	Greece	Ireland	Italy	Portugal	Spain
REGIME_	-3.70	-3.43	-3.28	-3.32	-2.69	-3.41	-3.10	-2.75	-3.14
FER	(-7.84)	(-7.20)	(-7.10)	(-6.93)	(-6.42)	(-7.57)	(-6.78)	(-6.58)	(-6.92)
	[-3.84]	[-3.22]	[-3.24]	[-3.06]	[-3.13]	[-3.60]	[-3.14]	[-3.33]	[-3.19]
REGIME_IT	-1.96	-1.98	-2.04	-1.97	-2.07	-2.11	-2.07	-2.28	-2.08
	(-3.97)	(-3.96)	(-4.11)	(-3.93)	(-4.58)	(-4.36)	(-4.19)	(-5.07)	(-4.25)
	[-2.17]	[-2.17]	[-2.21]	[-2.16]	[-2.29]	[-2.30]	[-2.25]	[-2.66]	[-2.26]
R2	.77	.76	.76	.76	.77	.76	.76	.77	.76

Inflation targeting countries

Excl. …	Australia	Canada	New Z.	Norway	Sweden	UK
REGIME_FER	-3.10	-3.09	-3.06	-3.09	-3.10	-3.12
	(-6.90)	(-6.84)	(-6.97)	(-6.86)	(-6.88)	(-7.05)
	[-3.31]	[-3.29]	[-3.29]	[-3.31]	[-3.27]	[-3.34]
REGIME_IT	-2.10	-2.39	-1.26	-2.14	-1.98	-1.88
	(-3.99)	(-4.47)	(-2.43)	(-4.12)	(-3.76)	(-3.63)
	[-2.10]	[-2.65]	[-1.79]	[-2.15]	[-1.97]	[-1.86]
R2	.76	.76	.77	.76	.76	.76

Control countries

Excl.. …	Austria	Germany	Japan	Netherl.	Switzerl.	USA
REGIME_FER	-2.91	-2.83	-3.17	-2.88	-2.91	-2.96
	(-6.36)	(-6.23)	(-7.10)	(-6.32)	(-6.44)	(-6.45)
	[-3.07]	[-3.03]	[-3.37]	[-3.08]	[-3.05]	[-3.10]
REGIME_IT	-1.75	-1.67	-2.03	-1.72	-1.76	-1.82
	(-3.48)	(-3.34)	(-4.11)	(-3.42)	(-3.54)	(-3.60)
	[-1.86]	[-1.81]	[-2.15]	[-1.83]	[-1.87]	[-1.91]
R2	.76	.77	.77	.76	.77	.76

Note: Conventional t values in round brackets. The equivalent adjusted for heteroscedasticity and autocorrelation in square brackets.

TABLE A.6. SIGNIFICANCE OF THE MONETARY-POLICY REGIME TO INFLATION VOLATILITY. DIFFERENCE-IN-DIFFERENCE ESTIMATION. 1972-2005

Fixed-exchange-rate countries

Excl. …	Belgium	Denmark	Finland	France	Greece	Ireland	Italy	Portugal	Spain
REGIME_	-0.60	-0.51	-0.53	-0.59	-0.43	-0.55	-0.51	-0.40	-0.54
FER	(-3.67)	(-3.10)	(-3.38)	(-3.64)	(-3.04)	(-3.49)	(-3.22)	(-2.77)	(-3.44)
	[-2.53]	[-2.03]	[-2.29]	[-2.49]	[-2.09]	[-2.47]	[-2.26]	[-2.38]	[-2.32]
REGIME_IT	-0.02	-0.02	-0.01	-0.02	-0.06	-0.04	-0.05	-0.12	-0.03
	(-0.12)	(-0.10)	(-0.06)	(-0.11)	(-0.36)	(-0.27)	(-0.28)	(-0.82)	(-0.16)
	[-0.07]	[-0.06]	[-0.04]	[-0.06]	[-0.19]	[-0.15]	[-0.16]	[-0.46]	[-0.09]
R2	.51	.50	.51	.51	.53	.51	.50	.48	.52

Inflation targeting countries

Excl. …	Australia	Canada	New Z.	Norway	Sweden	UK
REGIME_FER	-0.49	-0.50	-0.48	-0.47	-0.48	-0.50
	(-3.19)	(-3.27)	(-3.24)	(-3.08)	(-3.18)	(-3.33)
	[-2.29]	[-2.35]	[-2.20]	[-2.21]	[-2.22]	[-2.39]
REGIME_IT	-0.07	-0.19	0.14	-0.08	-0.03	0.15
	(-0.40)	(-1.07)	(0.78)	(-0.43)	(-0.17)	(0.85)
	[-0.22]	[-0.70]	[0.45]	[-0.24]	[-0.09]	[0.52]
R2	.52	.52	.54	.52	.52	.51

Control countries

Excl.. …	Austria	Germany	Japan	Netherl.	Switzerl.	USA
REGIME_FER	-0.43	-0.42	-0.55	-0.43	-0.46	-0.47
	(-2.76)	(-2.70)	(-3.60)	(-2.75)	(-2.95)	(-3.00)
	[-2.06]	[-2.02]	[-2.69]	[-2.04]	[-2.13]	[-2.19]
REGIME_IT	0.04	0.05	-0.07	0.04	0.02	-0.00
	(0.24)	(0.30)	(-0.42)	(0.25)	(0.10)	(-0.00)
	[0.14]	[0.17]	[-0.24]	[0.14]	[0.06]	[-0.00]
R2	.51	.52	.51	.51	.51	.51

Note: Conventional t values in round brackets. The equivalent adjusted for heteroscedasticity and autocorrelation in square brackets.

TABLE A.7. SIGNIFICANCE OF THE MONETARY-POLICY REGIME TO VARIABILITY IN THE OUTPUT GAP. DIFFERENCE-IN-DIFFERENCE ESTIMATION. 1972-2005

Fixed-exchange-rate countries

Excl. …	Belgium	Denmark	Finland	France	Greece	Ireland	Italy	Portugal	Spain
REGIME_	-0.28	-0.20	-0.23	-0.34	-0.27	-0.29	-0.29	-0.25	-0.29
FER	(-1.59)	(-1.18)	(-1.44)	(-1.92)	(-1.60)	(-1.72)	(-1.73)	(-1.53)	(-1.72)
	[-2.17]	[-2.05]	[-1.97]	[-3.15]	[-2.07]	[-2.31]	[-2.35]	[-2.06]	[-2.35]
REGIME_IT	-0.10	-0.10	-0.08	-0.11	-0.16	-0.13	-0.12	-0.12	-0.10
	(-0.56)	(-0.55)	(-0.45)	(-0.61)	(-0.90)	(-0.69)	(-0.66)	(-0.64)	(-0.56)
	[-0.47]	[-0.46]	[-0.35]	[-0.52]	[-0.75]	[-0.56]	[-0.55]	[-0.53]	[-0.46]
R2	.26	.27	.27	.25	.26	.26	.26	.26	.26

Inflation targeting countries

Excl. …	Australia	Canada	New Z.	Norway	Sweden	UK
REGIME_FER	-0.29	-0.28	-0.31	-0.27	-0.28	-0.28
	(-1.77)	(-1.77)	(-1.90)	(-1.64)	(-1.74)	(-1.71)
	[-2.42]	[-2.38]	[-2.66]	[-2.26]	[-2.34]	[-2.33]
REGIME_IT	-0.06	-0.18	-0.21	-0.10	-0.24	0.06
	(-0.30)	(-0.93)	(-1.09)	(-0.51)	(-1.24)	(0.30)
	[-0.23]	[-0.70]	[-0.89]	[-0.40]	[-1.06]	[0.32]
R2	.28	.27	.27	.27	.28	.27

Control countries

Excl.. …	Austria	Germany	Japan	Netherl.	Switzerl.	USA
REGIME_FER	-0.27	-0.30	-0.28	-0.24	-0.29	-0.33
	(-1.60)	(-1.75)	(-1.69)	(-1.42)	(-1.76)	(-1.99)
	[-2.16]	[-2.38]	[-2.25]	[-2.07]	[-2.41]	[-2.91]
REGIME_IT	-0.11	-0.13	-0.13	-0.08	-0.14	-0.17
	(-0.57)	(-0.68)	(-0.69)	(-0.44)	(-0.74)	(-0.90)
	[-0.47]	[-0.56]	[-0.56]	[-0.38]	[-0.61]	[-0.75]
R2	.27	.25	.28	.26	.26	.27

Note: Conventional t values in round brackets. The equivalent adjusted for heteroscedasticity and autocorrelation in square brackets.