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Inflation control around the world: Why are some countries more successful than others?

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Abstract

This paper focuses on two important questions concerning inflation performance in a country sample of forty-two of the most developed countries in the world. The first is why inflation tends to be more volatile in some countries than in others, in particular in very small, open economies and emerging market economies compared to the large and more developed ones. The empirical analysis suggests that the volatility of the risk premium in multilateral exchange rates, the degree of exchange rate pass-through to inflation, and monetary policy predictability play a key role in explaining the cross-country variation in inflation volatility. Other variables, related to economic development and size, international trade, output volatility, exposure to external shocks, and central bank independence are not found significant. The second question is what explains the general decline in inflation volatility over the sample period. Using a panel approach, the empirical analysis confirms that the adoption of inflation targeting has played a critical role in this improvement in addition to the three variables found important in the cross-country analysis. Inflation targeting therefore continues to play an important role in reducing inflation volatility even after adding the three controls to the panel analysis. The main conclusions are found to be robust to changes in the country sample and to different estimation methods.

JEL classification: E31; E42; E52; E58
Keywords: Inflation performance; Monetary policy; Inflation targeting

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1. Introduction

During the last two decades, the level and variability of inflation has fallen across the world, including many former high inflation countries in Latin America and Eastern Europe. This development has coincided with a general decline in overall economic instability and increased emphasis on price stability in the conduct of monetary policy, in many cases formalised with changes in the monetary policy framework towards an explicit inflation target.

This general trend towards increased price stability and monetary policy reform notwithstanding, it still remains the case that some countries have been more successful in controlling inflation than others, and the fact is that these countries are more or less the same countries that have been more successful over longer periods. Thus, relative inflation performance has remained stable over time, with the worst performers usually among emerging market economies and very small, open economies.

This paper focuses on these two issues. First, the paper tries to answer which factors explain this difference in inflation performance across countries. Second, the paper tries to answer what explains the improvement in inflation performance over time. To tackle these issues, a country sample of forty-two of the most developed countries in the world is used, with countries chosen on the criteria that their per capita income is at least as high as that of the poorest OECD member and their GDP level is at least as high as that of the smallest OECD member.

To try to explain relative inflation performance, a large menu of potential explanatory variables is used. These variables are related to economic structure (economic size and per capita income), trade openness and two indicators of trade patterns (trade diversification and the share of commodities in merchandise exports), output volatility, two different indicators of exposure to external shocks (correlation of domestic and world output, and the correlation of private consumption and exchange rate movements), two measures of the importance of exchange rate fluctuations (volatility of multilateral exchange rate risk premium – or the non-fundamental volatility of exchange rates – and the degree of exchange rate pass-through to inflation), and two indicators of monetary policy performance (predictability of monetary policy and central bank independence). By sequentially eliminating non-significant variables, I am left with three statistically significant explanatory variables accounting for the cross-country variation in inflation volatility: the two exchange rate indicators and the measure of monetary policy predictability. Further analysis suggests that these results are robust to a number of alterations of the empirical setup.

In the following section, I move on to the second question of the paper, namely what can explain the general improvement in inflation performance over time observed in the data. Using a panel setup, I start by replicating the common finding documented in many other papers, that the adoption of inflation targeting has played a significant role in reducing the level and volatility (using a two-year rolling standard deviation) of inflation and that this effect remains significant even after taking account of the overall improvement among the non-targeting countries in the sample.

The next step is to add the three significant explanatory variables from the previous section to the panel analysis. I use two-year rolling standard deviations to measure the time variation of the volatility of the exchange rate risk premium and predictability of monetary policy. To obtain some time variation in the degree of exchange rate pass-through, I estimate the pass-through coefficient before and after inflation targeting (or before and after 1997 – the average inflation targeting adoption date – for the non-targeting countries). The three variables are then added to the panel analysis, using an instrumental variable approach to allow for the possible endogeneity of the explanatory variables and the decision to adopt inflation targeting. The results show that all four variables are statistically significant with the expected sign: the contribution of inflation targeting to reducing inflation volatility remains significant and the three variables found important in explaining the cross-country variation in inflation volatility are also found important in explaining inflation volatility over time. Thus, inflation targeting is found to be statistically significant in a country sample that includes many countries that have not been used in similar analyses before and after allowing for additional controls that are found to be important in explaining the cross-country variation in inflation volatility.

The remainder of the paper is organised as follows. Section 2 discusses the country group and the sample period used, with Section 3 comparing inflation performance across country groups. Section 4 focuses on explaining the cross-country variation of inflation volatility from a large menu of possible structural variables and policy variables. Section 5 moves on to explain the declining inflation volatility observed in the country sample in a panel setup, while Section 6 concludes. Appendices explain the derivation of key explanatory variables, document the robustness of the cross-country results and detail the data sources and description.

2. The data

2.1. The country sample

This section describes the country sample analysed in this paper. The focus is on reasonably developed, market based economies. Thus, the aim is to include countries of similar income levels and size as OECD member countries. Hence, countries with PPP adjusted GDP per capita lower than the poorest OECD member country (Turkey, 8.9 thousand US dollars) and PPP adjusted GDP lower than the smallest OECD member country (Iceland, 11.4 billion US dollars) are excluded.[1] This gives a sample of sixty-five countries in total from the 226 countries recorded in the *CIA World Factbook*.

It turns out that quarterly data for a sufficient time span is not available for some key variables in some of these sixty-five countries. Furthermore, a number of these countries cannot reasonably be described as decentralised, market-based economies and others have experienced serious military conflicts within the sample period analysed here. Hence, twenty-three additional countries are excluded from the

[1] There is, however, one exception with Malta being included although its GDP is only 8.1 billion US dollars so as to add one observation of a very small, open economy.

sample. This gives a sample of forty-two countries, i.e. all the current thirty OECD member countries, plus Chile, Cyprus, Estonia, Hong Kong, Israel, Latvia, Lithuania, Malta, Slovenia, South Africa, Taiwan and Thailand, amounting to just below 60% of 2006 (PPP adjusted) world output and 20% of world population. This sample therefore contains more or less the forty-two richest and most developed countries in the world. The median per capita income is about 28 thousand US dollars, compared to just below 10 thousand US dollars for the whole world. Population ranges from 0.3 million in Iceland to 298 million in the US, with a median population of just above 10 million.

2.2. The sample period

The sample period includes quarterly data for the period 1985-2005. There are a few exceptions where quarterly data for all the period is not available or not used. In most cases this involves the former communist countries in Eastern Europe, where any meaningful economic analysis would usually use data starting in the early 1990s. There are also three former hyperinflation countries, where the analysis starts only after inflation has reached lower double digit rates, i.e. Israel (starts in 1986), Mexico (starts in 1989) and Poland (starts in 1992).

2.3. Different country groups

There are several interesting sub-groups in the country sample (see Table 1 below). The first is a group of seven very small, open economies with population levels below 2.5 million (VSOEs). A second group comprises the emerging and developing countries in the sample (EMEs). These are defined as the total country sample excluding countries that have been OECD members since 1961 in addition to Hong Kong, Israel, Korea and Taiwan, which are more naturally thought of as developed countries. Turkey is, however, treated as an EME country, as it most closely resembles an emerging market economy despite being an original OECD member. This gives a sample of fifteen countries. Compared to groups of large and more developed countries, such as the G6 countries or the original twelve euro countries (EURO12), these two country groups have experienced much more volatile inflation rates (see below).

The final group consists of the seventeen inflation targeting (IT) countries in the country sample. Of the countries that followed IT at the end of the sample period, this leaves out four countries: Brazil, Columbia, Peru and the Philippines, who are all excluded as they fall below the per capita income criteria described above. Furthermore, Finland and Spain, who temporarily adopted IT in the mid-1990s before joining EMU, are treated as non-targeting countries in the analysis.

For the timing of IT adoption, this paper uses the dates in Pétursson (2005), which again mainly follows the timing convention in Fracasso et al. (2003). The exceptions are Australia (where the adoption date comes from Schaechter et al., 2000), Chile (where the adoption date comes from Truman, 2003) and New Zealand (where the adoption date comes from Mishkin and Schmidt-Hebbel, 2002); see Pétursson (2005) for a further discussion of the targeting dates and the targeting group.

Table 1. Different country groups

Emerging market economies	Very small open economies	Euro 12 members	Inflation targeting countries (adoption dates)		Remaining countries
Chile	Cyprus	Austria	Australia	1993Q2	Denmark
Cyprus	Estonia	Belgium	Canada	1991Q1	Hong Kong
Czech Rep.	Iceland	Finland	Chile	1990Q3	Japan
Estonia	Latvia	France	Czech Rep.	1998Q1	Taiwan
Hungary	Luxembourg	Germany	Hungary	2001Q2	USA
Latvia	Malta	Greece	Iceland	2001Q1	
Lithuania	Slovenia	Ireland	Israel	1992Q1	
Malta		Italy	Korea	1998Q2	
Mexico		Luxembourg	Mexico	1999Q1	
Poland		Netherlands	New Zealand	1990Q1	
Slovakia		Portugal	Norway	2001Q1	
Slovenia		Spain	Poland	1998Q4	
South Africa			South Africa	2000Q1	
Thailand			Sweden	1993Q1	
Turkey			Switzerland	2000Q1	
			Thailand	2000Q2	
			UK	1992Q4	

3. Inflation performance

I start by looking at average inflation and inflation variability in the forty-two countries (with inflation measured as annualised quarterly changes in the seasonally adjusted headline consumer price index) for the period 1985-2005, or the available sample period. Table 2 reports average values for different country groups.

Average inflation for the whole country sample is 6.2% but is found to be significantly higher in the VSOEs and the EMEs than in the larger and more developed countries. The same applies to inflation volatility which is roughly 2% in the large, developed countries but roughly three times as high in the VSOEs and about four times higher in the EMEs.

As previously discussed, inflation has fallen and become more stable worldwide during the last two decades (cf. Cecchetti et al., 2007), coinciding with a general decline in overall macroeconomic volatility (cf. McConnell and Perez-Quiros, 2000). This decline in the inflation level and volatility is also apparent in the country sample used here: average inflation is 4.4% during the period 1995-2005, compared to 6.2% for the whole sample period, while the standard deviation of inflation falls from 4.8% on average to 3.4% in the 1995-2005 period. Section 5 in this paper analysis this improvement in inflation performance with respect to the adoption of IT in many countries included in the sample.

An alternative measure of inflation volatility comes from estimating out-of-sample, one-quarter ahead inflation forecast errors from a VAR model. The VAR includes domestic and import price inflation, the output gap (measured as the deviation of output from its Hodrick-Prescott trend) and the short-term interest rate, and is estimated over a rolling window to capture learning behaviour of private agents. Hence, linear projections from a fourth-order VAR, re-estimated for a moving 40 quarters window, are used to approximate one-quarter ahead conditional inflation forecasts for the period 1995-2005.[2] The resulting standard deviations of the forecast errors are reported in the fourth column of Table 2. The pattern is very similar to the one using unconditional standard deviations (rank correlation equal to 0.74): conditional inflation volatility is higher in the VSOEs and the EMEs, although the difference is smaller than when using the unconditional standard deviations.

Table 2. Inflation performance and predictability

	Inflation	Inflation volatility	Inflation forecast errors
All countries	6.17	4.76	3.38
EME	11.62	8.08	5.52
VSOE	6.01	5.81	3.14
G6	2.50	1.64	1.29
EURO12	3.44	2.23	1.59
IT	6.78	5.66	3.59

The table reports average values for different country groups. Inflation is defined as annualised quarterly changes in seasonally adjusted headline consumer prices and inflation volatility as the standard deviation of inflation (both in percentages). Inflation forecast errors are standard deviations of one-quarter ahead forecast errors (in percentages) from a rolling-window VAR model.

The observation that very small, open economies and emerging and developing countries tend to experience more volatile and less predictable inflation rates than the large, developed countries therefore seems to be robust. The focus of the next section is to try to understand what factors explain this difference by analysing the cross-country differences in economic variables that can potentially affect inflation performance. These are variables related to the structure of the economy, trade factors, measures of economic volatility and exposure to external shocks, exchange rate developments and the predictability and independence of monetary policy.

4. Cross-country analysis of inflation performance

4.1. Variables used

This section describes the variables used to explain the cross-country variation in inflation volatility and the motivation for including them in the analysis. Where needed, Appendix A explains the technical issues involved in measuring the variables.

4.1.1. Economic structure

There are several channels through which the level of economic development can affect economic volatility and inflation volatility in particular. For example, Acemoglu and Zilibotti (1997) present a model where higher income countries are more able to

[2] There are a few countries were shorter sample periods are only available and a second order VAR with a 20 quarter horizon is used to preserve degrees of freedom.

undertake investment in indivisible forms of capital and therefore obtain a more balanced sectoral distribution of output than lower income countries. The overall level of economic development is also likely to coincide with financial market development which tends to smooth economic volatility through facilitating intertemporal smoothing of households and firms and adding liquidity to financial markets. Seignorage financing of government expenditure is also likely to be more important in low income countries, for example because there may be a fixed cost to building an effective tax-collection system, leading to higher and more volatile inflation (cf. Végh, 1988). Finally, per capita income can be thought of as a proxy for other economic and institutional developments which serve to reduce the time-inconsistency problem.

The relation between economic size and inflation volatility is perhaps less clear. It can, however, be argued that larger countries should experience lower inflation variability, other things being equal. Larger markets make financial risk diversification easier and help economies to absorb shocks. The economy will also be less dependent on relatively few industries that can have disproportionally large effects on overall economic performance. This effect may be further enhanced if there is a fixed cost to building institutions that are more effective in containing inflationary pressures, for example if there is a limited pool of skilled people to draw from.

To analyse the relationship between economic structure and inflation volatility, this paper includes economic size (SIZE), measured as PPP adjusted GDP and the level of economic development (INC), measured as PPP adjusted GDP per capita, as potential explanatory variables.[3]

4.1.2. Trade openness

Romer (1993) argues that economies more active in international trade should on average have less inflation (extended to inflation volatility by Bowdler and Malik, 2005). The reason is that an unanticipated monetary expansion will lead to a real exchange depreciation that directly raises import price inflation and the amount of domestic inflation for a given expansion of domestic output, for example if wages are partially indexed to inflation or if imported goods are used as intermediate inputs in domestic production. As both these effects are likely to be more pronounced in more open economies, the incentive to inflate should be smaller compared to less open economies. This suggests that countries more open to international trade should have lower and more stable inflation rates, with openness measured here as the sum of imports and exports of goods and services over GDP (constant prices, average for the period 2000-2005) (OPEN).

[3] Another aspect of economic structure not included here is the structure of the domestic labour market, for example measures of labour market frictions (such as employment protection and the replacement ratio) and real wage rigidities. For example, Abbritti and Weber (2008) find that greater labour market frictions tend to increase inflation volatility whereas greater real wage rigidities tend to be associated with more stable inflation. However, their analysis only covers a relatively small set of industrial countries used in this study and, to my knowledge, no such analysis of labour market institutions exists for the country sample used here. No indicator of labour market institutions is therefore included in this study.

4.1.3. Trade patterns

Different trade patterns can affect inflation performance to the extent that they reflect a different degree of exposure to external shocks. For example, a country that exports a narrow range of goods is bound to loose some diversification benefits and may experience more difficulties in stabilising the domestic economy and inflation than a country with a broad export product range. The same should apply to countries where primary commodities are a large share of the export product base. Many resource-based goods tend to experience large relative price swings in response to changes in international economic conditions, which can lead to large changes in domestic conditions in economies where these goods are relatively important.

Two measures of trade patterns are used in the paper. First, to measure the extent of trade diversification, an index constructed by the United Nations Conference on Trade and Development (UNCTAD) is used (DIVER). This index ranges from zero to one and measures to what extent a country's export structure differs from that of the average country. A country exporting only few goods will have a value closer to unity.[4] The second measure used is the share of commodities, defined as all food items, agricultural raw materials, fuels and ores and metals (including non-ferrous metals), in merchandise exports (COMM).

4.1.4. Output volatility and exposure to external shocks

One would expect countries with more volatile real economies to face an inferior trade-off between inflation volatility and output volatility and, thus, that greater output gap variability to be reflected in greater inflation variability. To measure the variability of real output, the standard deviation of the output gap, is used to measure economic volatility (REAL).

One would also expect a country's exposure to external shocks to have a significant effect on the performance of the domestic economy and its ability to control inflation. One indicator of this exposure is the co-movement of the domestic economy with the rest of the world, which is here proxied using the contemporaneous correlation between domestic and world output gaps (INTER).[5] The idea is that countries with little co-movement with the rest of the world face greater challenges in controlling inflation than countries that are more closely tied to the world economy. Frequent and large idiosyncratic shocks, often associated with large terms of

[4] UNCTAD also publishes an alternative index on trade concentration that is highly correlated with the one used here. The results are therefore not sensitive to which index is used. Gerlach (1999) finds a strong correlation between these two measures of trade concentration and the volatility of the terms of trade.

[5] Note that the simple correlation may overstate the co-movement for the large economies as they represent a significant part of the world output measure used here. To adjust for this, an alternative measure of world output excluding the largest economies individually was constructed (using constant US dollar price data obtained from Eurostat). Hence, to calculate the US correlation, US output was compared to world output excluding the US. A similar adjustment was made for the other five large economies (France, Germany, Italy, Japan, and the UK). With this adjustment, the correlation for Japan declines from 0.52 to 0.44, the correlation for the UK from 0.53 to 0.37, and from 0.79 to 0.29 for the US. For the other three countries, the correlation is basically unchanged.

trade fluctuations, are likely to make domestic monetary policy more challenging, especially in the modern world of freely flowing capital where asymmetric business cycles can generate huge capital flows in and out of countries. These procyclical capital flows could easily amplify economic volatility, making inflation control more difficult (cf. Aghion et al., 2004, and Kaminsky et al., 2004).

Another indicator of a country's exposure to external shocks is the contemporaneous correlation between the cyclical part of private consumption and the effective exchange rate (CONS) which, according to Lucas (1982), is the key determinant of the exchange rate risk premium. In his model, holding a particular currency is risky if it moves in the same direction as the consumption cycle, i.e. if the currency is weak in the low consumption state and strong in the high consumption state. In the standard sticky price model, a monetary policy tightening would generally lead to an exchange rate appreciation and a contraction in consumption, generating countercyclical exchange rate movements. However, procyclical exchange rate movements could reflect the importance of balance-sheet effects, for example in small countries where foreign-currency denominated borrowing is widespread, which can counteract the usual contractionary effects of monetary policy tightening on consumption. Procyclical exchange rate movements could also reflect the importance of terms of trade shocks for exchange rate developments. In both cases would this imply a relatively large exchange rate premium according to Lucas' (1982) model which might contribute to increased inflation variability if the risk premium is volatile (see the discussion below).

4.1.5. Exchange rate developments

This paper uses two measures of the importance of exchange rate fluctuations for inflation volatility. The first is the volatility of the risk premium in multilateral exchange rates (EXRISK).[6] To measure this, I use the standard monetary model of exchange rate determination, but allow for a time-varying exchange rate risk premium (represented as the rational expectations deviation from the simple interest rate parity condition). A signal extraction approach suggested by Durlauf and Hall (1988, 1989), described in Appendix A.1, gives an estimation of a lower-bound of the variance of the expected present value of the exchange rate risk premium. The argument is therefore that the more volatile the exchange rate risk premium (or the more noisy the exchange rate is), the more unpredictable the exchange rate will be and the more difficult inflation control becomes.

The second exchange rate indicator is the degree of exchange rate pass-through to consumer price inflation (PASS). It seems reasonable to expect countries with high degree of pass-through to experience more difficulties in controlling inflation than countries with a low degree of pass-through, as exchange rates tend to be volatile and hard to predict. Furthermore, as shown by Betts and Devereux (2001), a high degree of pass-through should coincide with a negative co-movement of domestic and world output in the face of monetary policy shocks, thus creating an additional complication

[6] This variable can equivalently be interpreted as the variability of exchange rate noise, i.e. the non-fundamental part of exchange rate movements.

in conducting independent monetary policy as discussed above. To identify exchange rate shocks and estimate the degree of exchange rate pass-through, I use a VAR model that includes domestic and foreign inflation, exchange rate changes, the short-term interest rate and the output gap. Further details on the estimation approach are given in Appendix A.2.

4.1.6. Monetary policy

The final two variables measure the effects of monetary policy performance on inflation variability. The first measures monetary policy shocks or, alternatively, the predictability of monetary policy (POLICY). There is a large literature showing how a credible and transparent monetary policy can determine the level and variability of inflation directly through anchoring inflation expectations or indirectly through its effects on other determinants of the inflation process. See, for example, Taylor (2000) and for empirical evidence see, for example, Corbo et al. (2001), Roberts (2006) and Kuttner and Posen (1999), to name only few. To measure monetary policy shocks, a forward-looking Taylor rule similar to that of Clarida et al. (2000) is estimated.[7] Further details on the estimation approach are given in Appendix A.3.

The second monetary policy indicator is a measure of central bank independence, often found to be an important explanatory variable for inflation performance (e.g. Alesina and Summers, 1993). The basic idea is that central bank independence helps insulate monetary policy from political pressures and therefore reduces the time-inconsistency problem. This paper uses the independence index constructed by Mahadeva and Sterne (2000), which covers all the countries in the sample except Luxembourg which is given the same ranking as Belgium, as these two countries were in a monetary union up to euro adoption in 1999. The variable INDEP ranges between one and zero with a higher value indicating a more independent central bank.

4.2. Descriptive statistics for the cross-country analysis

This section reports some descriptive statistics for the explanatory variables used in the cross-country analysis below. Table 3 shows average values of each variable for the whole country sample and the five different country groups discussed above.[8] The table also reports rank correlations between each variable and inflation volatility (INFVOL).

When comparing the outcomes for the EMEs and VSOEs with the larger and more developed countries, a number of features are notable. First, as previously discussed, there is a strong negative correlation between SIZE and INC, on one hand, and INFVOL on the other, again suggesting that the larger and more developed

[7] A potentially important targeting variable for many emerging market and small, open economies could be the exchange rate. As a test for the robustness of the chosen measure of monetary policy shocks to omitted variables, the real exchange rate was therefore added to the policy rule and information set. The resulting variability of policy shocks was practically identical to the one used.

[8] Individual country estimates for each variable are available from the author. Most of them can also be found in Pétursson (2008).

countries have had greater success in controlling inflation than the smaller and less developed ones.

Table 3. Descriptive statistics (whole sample period)

	All countries	EME	VSOE	G6	EURO12	IT	RANK
SIZE	901	290	25	4,214	768	552	-0.35**
INC	27.3	16.1	29.6	33.1	33.4	24.8	-0.67***
OPEN	1.05	1.25	1.54	0.47	1.06	0.86	0.13
DIVER	0.46	0.50	0.57	0.30	0.41	0.50	0.39***
COMM	0.26	0.27	0.30	0.13	0.19	0.35	0.22*
REAL	1.68	2.06	1.76	1.03	1.35	1.86	0.60***
INTER	0.36	0.21	0.27	0.47	0.54	0.35	-0.47***
CONS	-0.11	-0.15	-0.11	0.00	-0.02	-0.22	-0.24*
EXRISK	13.69	20.86	17.74	10.53	8.04	14.96	0.68***
PASS	0.23	0.31	0.39	0.11	0.21	0.25	0.43***
POLICY	1.24	2.50	0.84	0.35	0.38	0.94	0.63***
INDEP	0.84	0.86	0.81	0.89	0.85	0.81	-0.10

The table reports average values for different country groups. SIZE: PPP adjusted GDP (billions of US dollars). INC: PPP adjusted GDP per capita (thousands of US dollars). OPEN: sum of exports and imports of goods and services as a share of GDP. DIVER: trade diversification; an index between 0 and 1; a higher index indicates a narrower export base. COMM: primary commodities as a share of merchandise exports. REAL: standard deviation of the output gap (in percentages). INTER: contemporaneous correlation between domestic and world output gaps. CONS: contemporaneous correlation between the cyclical part of private consumption and the effective exchange rate; a negative (positive) sign indicates a procyclical (countercyclical) exchange rate (the currency depreciates (appreciates) in the low consumption state). EXRISK: standard deviation of the exchange rate risk premium (in percentages). PASS: level of exchange rate pass-through. POLICY: standard deviation of monetary policy shocks (in percentages). INDEP: index of central bank independence; an index between 0 and 1; a higher index indicates greater central bank independence. RANK denotes the rank correlation of the given variable with inflation volatility. * [**] (***) denotes statistical significance at the 10% [5%] (1%) level.

Second, the VSOEs and EMEs tend to be much more open to trade than the larger and more developed countries, but unlike the results from Romer (1993) and Bowdler and Malik (2005), openness is not found to be significantly correlated with inflation performance. The results in both these papers, however, suggest that the negative relation is mainly confined to the poorer and less developed countries in their large country samples, most of which are not included in the country sample used here. Terra's (1998) results also suggest that the negative relationship is mainly due to the highly indebted countries during the debt crisis in the 1980s − of which only one country is included in the sample in this paper (Mexico). It is therefore perhaps not surprising that no significant link between openness and inflation performance can be found in the country sample used here.

Third, the two indicators of trade patterns suggest that the EMEs and, especially, the VSOEs seem to have less diversified export product range and are more resource-based than the larger counterparts. The rank correlation coefficients further imply that a narrower and more commodity dominated export base significantly coincides with higher inflation volatility.

Fourth, output in both the VSOEs and EMEs is much more volatile than in the larger and more developed ones, and this greater output volatility is strongly positively correlated with inflation volatility.

Fifth, the correlation between the domestic and world business cycles is found to be lower for the VSOEs and EMEs than for the larger and more developed countries, even though the former are much more open to international trade. The rank correlation suggests that countries with more stable inflation rates seem to have stronger links to the world economy even though they are relatively less open to international trade as discussed above.

Sixth, the correlation between consumption and exchange rate appreciation tends to be small and slightly negative in the case of the VSOEs and EMEs but more or less zero in the larger and more developed countries. Interestingly, the correlation is found to be much more negative in the IT countries. The sign of the rank correlation coefficient is consistent with the discussion above: a more procyclical exchange rate tends to coincide with higher inflation volatility.

Seventh, both exchange rate indicators suggest less favourable conditions for inflation control in the VSOEs and EMEs: both country groups have a more volatile exchange rate risk premium and a higher degree of exchange rate pass-through and both indicators are found to be significantly positively correlated with inflation volatility.[9]

Eighth, monetary policy shocks are found to be slightly greater in the VSOEs than in the larger and more developed countries, but the difference between the EMEs and other country groups is much larger, suggesting that monetary policy is much less predictable in the EMEs than in the other country groups.[10] This could imply that monetary policy is less systematic in the EMEs or that the inflation goal of the monetary authorities is more likely to be changed in the face of adverse inflationary developments. The reason could also be political distortions, weak monetary policy institutions, or capital market imperfections. But it can also reflect the simple fact that measuring the output gap is probably more difficult in the EMEs than in other countries; national accounts may be less reliable and timely, and estimation of potential output may be more difficult due to frequent structural changes. These structural changes may also lead to changes in the equilibrium real interest rate, which could also show up as large 'monetary policy shocks'. As expected, the size of these monetary policy shocks is found to be strongly positively correlated with inflation volatility.

Finally, the central banks of the VSOEs and EMEs are found to be slightly less independent than in their larger and more developed counterparts. The correlation with inflation volatility is negative, suggesting that greater central bank independence tends to coincide with less inflation volatility, but the correlation is found to be insignificant from zero.

[9] Higher degree of exchange rate pass-through in the EMEs than in the larger and more developed countries is consistent with the findings in the literature, see e.g. Calvo and Reinhart (2000).

[10] The results are consistent with Kaminsky et al. (2004) who find that monetary policy in emerging market countries tends to be procyclical instead of being countercyclical as in developed countries.

4.3. Basic cross-country results

This section attempts to explain the cross-country variation in INFVOL using the variables described above. In the empirical analysis below, SIZE and INC enter in logarithms, while other variables are measured in decimals (i.e. INFVOL of 1% enters as 0.01).[11]

The results are reported in Table 4. I start with all the potential explanatory variables, sequentially deleting the least significant one until left only with significant variables at the 5% critical level. Just as when looking at simple bilateral rank correlations in the previous section, no significant effects of OPEN and INDEP can be found. Furthermore, the results indicate that the cross-country variation in inflation volatility is not significantly explained by variations in SIZE, CONS, INTER, REAL and DIVER. The final two variables to be excluded are in fact not far from being significant from zero at the 10% critical level, COMM and INC, and both are correctly signed.

Having eliminated all the insignificant variables leaves three significant variables, all with t-values above 4: the volatility of the exchange rate risk premium and monetary policy shocks, and the extent of exchange rate pass-through to consumer price inflation. Thus, the more volatile the exchange rate risk premium, the greater the pass-through of exchange rate shocks, or less predictable monetary policy is, the more volatile inflation tends to be. These three variables turn out to account for a large and significant fraction of the cross-country variation in inflation volatility, with R^2 equal to 0.75.

The impact of these three variables on inflation volatility is also quantitatively large. The point estimates in column (10) in Table 4 suggest, for example, that a one standard deviation decline in EXRISK from its sample mean decreases INFVOL by 0.3 standard deviations from its mean, or by 1.4 percentage points (from 4.8% in Table 2 to 3.4%). A one standard deviation decline in POLICY decreases INFVOL by 0.5 standard deviations, or by 2.3 percentage points, while a one standard deviation decrease in PASS decreases INFVOL by 0.4 standard deviations, or by 1.8 percentage points. These three explanatory variables are therefore not only statistically significant but also economically important.

Finally, as the results in Appendix B show, these results are found to be robust to various alterations in model specification and estimation methods, such as adding country-group dummy variables or changes in the country sample, possible effects of large outliers using robust estimators, or possible endogeneity of the explanatory variables using instrumental variables (IV) estimation.

[11] A common practice in the literature is to use logarithm transformations of the dependent variable (whether inflation or inflation volatility) to reduce the effects of large outliers on the regressions results, although a drawback is that very low observations would get undue weights. The level is used in this study as there are no extremely large observations in this sample, but using logarithm transformations gives very similar results, both in the cross-country analysis described here and the panel analysis discussed in the next section.

Table 4. Cross-country results for INFVOL

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
log(SIZE)	0.000									
	(0.99)									
CONS	0.001	0.001								
	(0.91)	(0.91)								
OPEN	0.002	0.002	0.003							
	(0.81)	(0.77)	(0.73)							
INTER	0.009	0.009	0.009	0.007						
	(0.64)	(0.63)	(0.63)	(0.69)						
INDEP	0.000	0.000	0.000	0.000	0.000					
	(0.57)	(0.56)	(0.55)	(0.52)	(0.50)					
REAL	0.636	0.640	0.594	0.666	0.583	0.492				
	(0.48)	(0.45)	(0.41)	(0.33)	(0.37)	(0.43)				
DIVER	-0.032	-0.032	-0.032	-0.030	-0.029	-0.032	-0.021			
	(0.49)	(0.40)	(0.39)	(0.41)	(0.41)	(0.36)	(0.51)			
COMM	0.046	0.046	0.046	0.043	0.041	0.038	0.032	0.024		
	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)	(0.08)	(0.10)	(0.11)		
log(INC)	-0.012	-0.012	-0.012	-0.011	-0.011	-0.012	-0.014	-0.016	-0.016	
	(0.33)	(0.33)	(0.32)	(0.34)	(0.34)	(0.26)	(0.18)	(0.11)	(0.12)	
EXRISK	0.113	0.113	0.114	0.114	0.107	0.115	0.121	0.111	0.125	0.174
	(0.12)	(0.09)	(0.08)	(0.07)	(0.07)	(0.05)	(0.04)	(0.04)	(0.02)	(0.00)
POLICY	0.725	0.725	0.725	0.719	0.719	0.696	0.728	0.709	0.701	0.774
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
PASS	0.089	0.088	0.088	0.090	0.090	0.088	0.090	0.086	0.082	0.087
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.007	0.008	0.008	0.005	0.009	0.039	0.048	0.050	0.054	-0.006
	(0.92)	(0.91)	(0.91)	(0.94)	(0.88)	(0.34)	(0.22)	(0.20)	(0.17)	(0.41)
R^2 (adj.)	0.728	0.737	0.746	0.753	0.760	0.764	0.766	0.770	0.760	0.750
SE	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.020	0.020	0.021
Excl. test	-	0.990	0.994	0.988	0.991	0.980	0.969	0.972	0.855	0.849

The exclusion test is a F-test that tests for the exclusion of all the variables eliminated up to the given stage. The numbers in parenthesis and values reported for the exclusion test are p-values.

5. Inflation control and inflation targeting

This section focuses on explaining the decline in inflation volatility over the sample period and the potential role of the three factors found important in explaining the cross-country variation in inflation volatility in accounting for this development. Furthermore, a large and growing literature suggests that the adoption of inflation targeting has played a critical role in this improvement by reducing inflation levels, volatility and persistence, and that it has, by providing a better anchor for long-term inflation expectations, made inflation more predictable. Many of these studies have also found that these effects are especially important for IT emerging market economies.[12] The possible role of IT in the declining inflation volatility is therefore

[12]See Batini and Laxton (2007), Bernanke et al. (1999), Corbo et al. (2001), Mishkin and Schmidt-Hebbel (2007), Pétursson (2005), Truman (2003) and Vega and Winkelried (2005), to name

also analysed.

5.1. Descriptive statistics for the pre and post-targeting periods

Table 5 reports descriptive statistics for the pre and post-targeting periods for inflation volatility and the three potential explanatory variables. As is standard in this literature (cf. Mishkin and Schmidt-Hebbel, 2007), I use the average IT adoption date as the break-date for the non-targeting countries. In this sample, this date is 1996Q4: the pre-targeting period for the non-targeters is therefore 1985-1996, while the post-targeting period is 1997-2005.

Table 5. Descriptive statistics (pre- and post-targeting)

	Pre-targeting	Post-targeting
INFVOL		
All countries	4.47	2.65
EME	7.59	4.47
VSOE	5.86	2.72
G6	1.56	0.94
EURO12	2.11	1.19
IT	5.46	2.39
Non-IT	3.80	2.83
EXRISK		
All countries	9.44	11.00
EME	10.39	15.60
VSOE	6.54	15.19
G6	11.02	10.04
EURO12	8.61	7.27
IT	11.58	11.13
Non-IT	7.98	10.91
POLICY		
All countries	2.28	1.29
EME	3.84	2.62
VSOE	1.06	0.85
G6	0.67	0.32
EURO12	0.91	0.40
IT	1.84	0.99
Non-IT	2.40	1.49
PASS		
All countries	0.36	0.11
EME	0.72	0.20
VSOE	0.74	0.23
G6	0.09	0.03
EURO12	0.13	0.07
IT	0.36	0.15
Non-IT	0.36	0.08

The table reports average values for different country groups before and after inflation targeting or before and after 1997 for the non-targeting countries. INFVOL, EXRISK and POLICY are reported in percentages.

only few studies providing empirical support for the important role of IT in these developments, while Ball and Sheridan (2005) provide a more sceptical view. Many studies have also analysed the effects of inflation targeting on other key macroeconomic variables. See, for example, Mishkin and Schmidt-Hebbel (2007) for a recent overview of the main results.

To capture the time variation in the volatility of inflation, the exchange rate risk premium and monetary policy shocks, I use rolling two-year standard deviations.[13] To obtain some time variation in the degree of exchange rate pass-through, I follow Edwards (2007) in using a simple regression approach to obtain estimates of the pass-through coefficient before and after IT (or before and after 1997 for the non-targeting countries); Appendix A.2 gives a more detailed description of the approach.

Inflation volatility is found to decline in all country groups, with average volatility declining from 4.5% to 2.7% for the whole country sample. The biggest improvement is found in the VSOEs, EMEs and the IT countries. This improvement in inflation performance has occurred despite the fact that the volatility of the exchange rate risk premium seems to have increased. This increase seems however to be restricted to the VSOEs and EMEs, with declining volatility of the exchange rate risk premium observed in other country groups.[14] Predictability of monetary policy seems, however, to have improved in all country groups although monetary policy shocks continue to be much larger in the EMEs than in the other country groups. Finally, the table shows that the rate of exchange rate pass-through has declined in all country groups, with the largest decline observed in the VSOEs and EMEs, although pass-through continues to be higher than in the larger and more developed countries.

The declining volatility of inflation reported in Table 5, and the role of the three other variables from the table in this improvement, is studied more systematically in the next section, adding the potential impact of IT adoption to the analysis.

5.2. Panel analysis of inflation performance

To estimate the role of IT and the three explanatory variables from the cross-country analysis above in the declining volatility of inflation, I use a panel approach which allows for utilising both the country and time dimensions of the data. The panel approach also allows for analysing the importance of the composition of the treatment (the IT countries) and control (the non-targeting countries) groups, which Mishkin and Schmidt-Hebbel (2007) show plays a key role in the final analysis of the importance of IT for comparative inflation performance.

The treatment group in this paper includes the seventeen IT countries, while the control group consists of the remaining twenty-five countries of the forty-two country sample. The control group therefore includes countries ranging from very small emerging market countries, such as Cyprus and Malta, to very large developed countries, such as Japan and the US, in addition to the twelve highly developed EMU countries. This should give a control group that is suitably heterogeneous to offer an interesting comparison to the treatment group that also contains a similarly

[13] Changes in indirect taxes create jumps in measured volatility of headline inflation which can lead to a bias in the analysis. To avoid this I have removed the effects of known indirect tax changes in the rolling window standard deviations. These tax changes are for Australia (2000Q3), Canada (1991Q1 and 1994Q1-Q2), Japan (1997Q2), Norway (2003Q1 and 2003Q2) and the UK (1990Q2).

[14] Pétursson (2009) finds that IT adoption has not led to increased volatility of the exchange rate risk premium, whereas EMU-membership has significantly contributed to a declining volatility of the exchange rate risk premium

heterogeneous group of countries ranging from small to large countries, and emerging market to highly developed countries. The control group also offers a country set with a wide array of monetary policy frameworks, ranging from exchange rate pegs, currency boards, and monetary unions, to floating exchange rates with monetary targets or other hybrid frameworks.[15] Results for a narrower control group of the seventeen non-targeting industrial countries are also reported as a robustness check (the EURO12 countries plus the five remaining countries from Table 1).

The panel model estimated is specified as[16]

$$\mathrm{INFVOL}_{i,t} = \mu + \gamma_1 \mathrm{INFVOL}_{i,t-1} + \gamma_2 \mathrm{INFVOL}_{i,t-2} + \beta D_{i,t} + \boldsymbol{\phi}' \mathbf{Z}_{i,t-1} + \alpha_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

where μ is the overall constant in the model, α_i denotes the country-specific fixed effects, δ_t the time-specific fixed effects and $\varepsilon_{i,t}$ is the error term. $\mathrm{INFVOL}_{i,t}$ is the volatility of inflation in country i at time t and $D_{i,t}$ is the IT dummy variable that equals unity from the first quarter after IT adoption if country i is a targeter but zero throughout for non-targeters. Two lags of $\mathrm{INFVOL}_{i,t}$ are found to be sufficient to capture the persistence in inflation volatility (which can either be intrinsic or reflect other omitted determinants of volatility). Finally, $\mathbf{Z}_{i,t}$ is a set of the three additional control variables: $\mathrm{EXRISK}_{i,t}$, $\mathrm{POLICY}_{i,t}$ and $\mathrm{PASS}_{i,t}$. These three control variables are included lagged by one quarter to reduce any potential bias that may stem from including them contemporaneously.

As discussed in Mishkin and Schmidt-Hebbel (2007), the adoption of IT may be an endogenous decision that is based, inter alia, on past inflation performance. Thus, estimating (1) can give biased results if this potential endogeneity is not accounted for. As shown by Mishkin and Schmidt-Hebbel (2002), initial inflation plays an important role in the decision to adopt IT. Countries with high inflation in the past therefore seem more likely to adopt inflation targeting than countries with better inflation records. I therefore follow Mishkin and Schmidt-Hebbel (2007) in estimating the panel model applying IV panel estimation techniques, using pre-targeting average inflation (or pre-1997 average inflation for the non-targeting countries) in addition to the lagged IT dummy and lags of $\mathrm{INFVOL}_{i,t}$ and $\mathbf{Z}_{i,t}$ as instruments.

The estimation period uses all the available data, which is 1987Q2-2005Q4, generating a large panel with the number of observations ranging from 2,374 to 2,941. Table 6 reports the results, allowing for country-specific fixed effects or country and time-specific fixed effects. The table reports the results with and without the three additional controls in $\mathbf{Z}_{i,t}$ for the two control groups.

[15] It should be kept in mind that some of these countries do not pursue a truly independent monetary policy for some part of the sample period (e.g. the EMU countries), or a monetary policy that is similar to that of the IT countries (e.g. the European countries, Japan and the US). This may reduce the number of truly independent observations in the control group and make the identification of the treatment effect more difficult. Including the emerging market countries is therefore important to help reducing this potential identification problem.

[16] Allowing for interactive terms between $D_{i,t}$ and $\mathbf{Z}_{i,t-1}$ does not give any additional significant non-linear effects.

As the table shows, the IT effect is found to be statistically significant at the 5% critical level, except when the panel model is estimated without the three controls in $\mathbf{Z}_{i,t}$ using the fixed cross-country effects, in which case the IT dummy is found to be statistically significant at the 10% critical level. The impact effect of the dummy variable ranges from -0.11% to -0.21%. Taking account of the lagged dynamics of $\text{INFVOL}_{i,t}$, this implies that IT adoption reduces inflation volatility by 0.6-1.6 percentage points in the long run, depending on control group and model specification.[17]

Including the three additional controls in $\mathbf{Z}_{i,t}$ tends to reduce the size of the IT effect, but it remains statistically significant and, in fact, is found to be more significant when allowing for $\mathbf{Z}_{i,t}$ in some specifications. Furthermore, all the additional controls are found to be statistically significant when using the whole country sample (country group 1): $\text{EXRISK}_{i,t}$ and $\text{POLICY}_{i,t}$ at the 5% critical level or lower and $\text{PASS}_{i,t}$ at the 10% critical level. Taking account of the lagged dynamics of $\text{INFVOL}_{i,t}$ gives a long-run coefficient on $\text{EXRISK}_{i,t}$ just below 0.1, which implies that a one standard deviation decline in $\text{EXRISK}_{i,t}$ reduces $\text{INFVOL}_{i,t}$ by 1.4 percentage points in the long-run, which is the same as in the cross-country analysis. Similarly, the long-run coefficient on $\text{POLICY}_{i,t}$ is close to 0.3 which implies that a one standard deviation decline in $\text{POLICY}_{i,t}$ reduces $\text{INFVOL}_{i,t}$ by 0.5 percentage points in the long-run, compared to 2.3 percentage points in the cross-country analysis. Finally, the long-run coefficient on $\text{PASS}_{i,t}$ is just below 0.01, which implies that a one standard deviation decline in $\text{PASS}_{i,t}$ leads to a 0.2 percentage points long-run reduction in $\text{INFVOL}_{i,t}$, compared to 1.8 percentage points in the cross-country analysis.

Comparing the results for the two control groups shows that while the effects of $\text{EXRISK}_{i,t}$ and $\text{POLICY}_{i,t}$ remain statistically significant and similar in size when using the second, more narrower control group (country group 2), the effects of $\text{PASS}_{i,t}$ are now found to be insignificant from zero. This is perhaps not surprising considering what countries are left out of this control group. Of the eight countries left out, three belong to the EME group (Lithuania, Slovakia and Turkey), while the other five also belong to the VSOE group (Cyprus, Estonia, Latvia, Malta and Slovenia), therefore leaving only two VSOE countries in the analysis: Iceland in the treatment group and Luxembourg in the control group. Most of the eight countries excluded are therefore either very small or rather small open economies and all are less developed than most of the remaining countries, which the previous analysis has shown to have the highest degree of exchange rate pass-through (see Table 3) and have experienced the biggest reduction in the pass-through coefficient (see Table 5). It is interesting to note that the cross-country results from the previous section are robust to excluding these eight countries from the sample. This highlights how the

[17] Estimating the panel model for the inflation level, for comparison with previous studies (without the additional controls), gives a highly significant IT effect (p-values of 1% or lower). The long-run effect equals 3.3 percentage points for the first control group and 4.3 percentage points for the second control group. This can be compared to roughly 5 percentage points found in Mishkin and Schmidt-Hebbel (2007), for a similar treatment group. Pétursson (2005), also using a panel setup but with a relatively narrow set of industrial countries as a control group, finds a smaller effect of 1-2 percentage point long-run reduction in inflation.

cross-country and panel analysis capture different aspects of the data. The cross-country analysis shows that a higher degree of pass-through tends to coincide with higher inflation volatility, while the panel analysis shows how the declining degree of pass-through has contributed to declining inflation volatility. The panel results suggest, however, that the small and less developed countries are needed in the control group to capture this latter feature of the data.

Table 6. Panel results for INFVOL

	Country group 1				Country group 2			
	Fixed cross section effects		Fixed cross section and time effects		Fixed cross section effects		Fixed cross section and time effects	
Constant	0.0034	0.0025	0.0033	0.0025	0.0026	0.0018	0.0025	0.0018
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
$\text{INFVOL}_{i,t-1}$	0.9729	0.9390	0.9722	0.9407	1.0779	1.0618	1.0780	1.0665
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\text{INFVOL}_{i,t-2}$	-0.1069	-0.1581	-0.1085	-0.1595	-0.1969	-0.2298	-0.1972	-0.2343
	(0.040)	(0.008)	(0.040)	(0.008)	(0.001)	(0.000)	(0.001)	(0.000)
IT dummy	-0.0021	-0.0013	-0.0013	-0.0012	-0.0019	-0.0011	-0.0013	-0.0011
	(0.003)	(0.015)	(0.094)	(0.026)	(0.004)	(0.018)	(0.061)	(0.033)
$\text{EXRISK}_{i,t-1}$		0.0207		0.0212		0.0148		0.0152
		(0.005)		(0.007)		(0.012)		(0.014)
$\text{POLICY}_{i,t-1}$		0.0628		0.0621		0.0586		0.0610
		(0.017)		(0.020)		(0.000)		(0.000)
$\text{PASS}_{i,t-1}$		0.0018		0.0020		0.0004		0.0004
		(0.097)		(0.090)		(0.677)		(0.709)
R^2	0.90	0.91	0.90	0.91	0.90	0.89	0.90	0.90
SE	0.0093	0.0072	0.0092	0.0072	0.0068	0.0054	0.0068	0.0053
Countries	42	42	42	42	34	34	34	34
Observations	2,941	2,680	2,941	2,680	2,507	2,374	2,507	2,374

Country group 1 includes all the 42 countries. Country group 2 includes the 17 IT countries and the 17 non-targeting industrial countries in the sample. The panels are estimated with the instrumental variables method, using average pre-targeting (or pre-1997 for the non-targeting countries) inflation, two lags of INFVOL and one quarter lags of the inflation-targeting dummy, and the three additional explanatory variables (where applicable) as instruments. The numbers in parenthesis are p-values using robust cross-section panel corrected standard errors.

Comparison of the cross-sectional and panel estimation results also suggests that the part of the estimated effects of $\mathbf{Z}_{i,t}$ on $\text{INFVOL}_{i,t}$ found in the cross-country analysis are now captured by the IT dummy variable. This is also seen when the IT dummy variable is excluded from the panel analysis, thus using the same three explanatory variables as in the cross-section analysis. In this case, the p-values on the $\text{PASS}_{i,t}$ coefficient are well below 5% in the first control group and, although still insignificant, decline substantially in the second group. Hence, it seems that the IT dummy captures some of the improvement observed in inflation performance which previous studies, such as Gagnon and Ihrig (2004), have attributed to declining pass-through. For the other two variables, the parameter estimates and p-values however remain unchanged.

The panel results therefore confirm the general consensus from the literature that IT has played a significant role in the observed improvement in inflation performance over the last two decades. In addition, the results show that the three controls found to play a significant role in explaining the cross-country variation in inflation volatility are also important in explaining the time variation in inflation volatility. Thus, the general decline in inflation volatility can in part be explained by the general increase in monetary policy predictability and the decline in exchange rate pass-through, while the fact that the volatility of the exchange rate risk premium seems to have risen in the EMEs and VSOEs, at the same time it has fallen in the larger and more advanced countries, can at least partially explain why the former two country groups continue to be relatively less successful in stabilising inflation. Finally, the panel results show that the IT effect continues to be significant even after allowing for these three additional controls in the analysis. The results are found to be robust to different specifications of the panel and to variations in the composition of the control group, except that exchange rate pass-through is not found significant when the control group only includes industrial countries.

6. Conclusions

The focus of this paper is twofold. First, to try to identify what factors explain why some countries have more success in stabilising inflation than others and, in particular, why inflation seems more volatile in very small, open economies and in emerging and developing countries than in the large and more developed ones. Second, to try to answer what explains the general decline in inflation volatility observed over the last two decades. To do this, I use a country sample of forty-two of the most developed countries in the world. The results imply that three factors can to a large extent explain the cross-country variation in inflation volatility: volatility of currency risk premiums, the degree of exchange rate pass-through to inflation, and the predictability of monetary policy. Other variables, related to economic development and size, international trade, output volatility, exposure to external shocks, and central bank independence are not found significant. The three significant variables, in addition to the adoption of inflation targeting, are also found to play a critical role in explaining the developments of inflation volatility over the last two decades.

Thus, the results confirm the general findings from the empirical inflation targeting literature, that inflation targeting does matter for inflation performance. The paper also shows that this result continues to hold even after allowing for controls that are found critical in explaining the cross-country variation of inflation volatility. The importance of inflation targeting is also found robust to using a heterogeneous country group that includes many small, open economies that have not been included in previous studies. Finally, the results are found to be robust to variations in the country sample and to allowing for the possible endogeneity of inflation targeting adoption.

There are several policy implications that can be drawn from the analysis. For example, the results suggest that very small, open economies and emerging market economies may have to live with more volatile inflation rates than the larger and more developed countries as greater exposure to idiosyncratic supply shocks and their small and relatively inefficient foreign exchange markets are likely to continue to contribute to larger and more volatile exchange rate risk premiums. Small and less efficiently traded currencies therefore seem to come at a cost of more volatile inflation rates. This excessive exchange rate volatility and the relatively high degree of pass-through of exchange rate shocks to domestic inflation seem to make inflation control particularly difficult in these countries. However, not withstanding this drawback of being small and less developed, the results suggest that a more predictable monetary policy backed by a formal adoption of inflation targeting can significantly contribute to stabilising inflation.

Appendix A: Derivation of explanatory variables

A.1. Measuring exchange rate risk premium

Durlauf and Hall (1988, 1989) suggest a general signal extracting approach for rational expectations present-value models under the presumption that the underlying model is false. In this case, the model is assumed to be a sum of two unobserved components: a combination of the data implied by the specific model under the null, and an unobserved component that is model noise. The idea is then to perform a signal extraction exercise on the data to estimate a lower bound for the variance of the noise component.

This approach is adopted here using the standard monetary model of exchange rate determination as the null model. The three standard building blocks of the model are given by a money market relation, a purchasing power parity condition and an interest rate parity condition

$$
\begin{aligned}
m_t - p_t &= \varphi y_t - \lambda i_t & \text{(A.1)} \\
p_t &= s_t + p_t^* & \text{(A.2)} \\
i_t &= i_t^* + \mathrm{E}(s_{t+1} | \Theta_t) - s_t + \xi_t & \text{(A.3)}
\end{aligned}
$$

where m_t is domestic money, p_t and p_t^* are the domestic and foreign price levels, respectively, y_t is real domestic output, i_t and i_t^* are the short-term domestic and foreign nominal interest rates, respectively, s_t is the multilateral spot exchange rate (the domestic currency price of one unit of a basket of foreign currencies) and $\mathrm{E}(s_{t+1} | \Theta_t)$ denotes rational expectations of the one quarter ahead spot rate, conditional on the public information set Θ_t available at time t.

The variable ξ_t denotes deviations from the rational expectations interest rate parity condition, and can be interpreted as a time-varying exchange rate risk premium that investors require to compensate for investing in domestic assets or, alternatively, as capturing deviations from the standard monetary model − i.e. the non-fundamental part of exchange rate behaviour, or exchange rate noise.

From (A.1)-(A.3), using the law of iterative expectations and imposing a no-bubble condition, the spot exchange rate can be written as

$$s_t = \sum_{j=0}^{\infty} \left(\frac{\lambda}{1+\lambda}\right)^j \mathrm{E}(f_{t+j} \,|\Theta_t) + \kappa_t \tag{A.4}$$

where f_t denotes the economic fundamentals

$$f_t = \left(\frac{1}{1+\lambda}\right)(m_t - \varphi y_t - p_t^* + \lambda i_t^*) \tag{A.5}$$

and κ_t is the expected present value of the risk premium ξ_t

$$\kappa_t = \sum_{j=0}^{\infty} \left(\frac{\lambda}{1+\lambda}\right)^{j+1} \mathrm{E}(\xi_{t+j} \,|\Theta_t) \tag{A.6}$$

By defining

$$s_t^* = \sum_{j=0}^{\infty} \left(\frac{\lambda}{1+\lambda}\right)^j f_{t+j} \tag{A.7}$$

as the perfect foresight (risk-neutral) exchange rate, the following relation between the actual spot rate and s_t^* is obtained

$$s_t = \mathrm{E}(s_t^* \,|\Theta_t) + \kappa_t \tag{A.8}$$

The assumption of rational expectations implies that

$$\mathrm{E}(s_t^* \,|\Theta_t) = s_t^* - v_t \tag{A.9}$$

where v_t is the rational expectations forecast error, which satisfies $\mathrm{E}(v_t \,|\Theta_t) = 0$. Inserting this into (A.8) gives

$$s_t - s_t^* = \kappa_t - v_t \tag{A.10}$$

Hence, a linear projection of $(s_t - s_t^*)$ on the econometrician's information set $\Upsilon_t \subseteq \Theta_t$ gives

$$\mathrm{proj}(s_t - s_t^* \,|\Upsilon_t) = \mathrm{proj}(\kappa_t \,|\Upsilon_t) = \widehat{\kappa}_t \tag{A.11}$$

where $\mathrm{proj}(x_t \,|\Upsilon_t)$ denotes an operator which linearly projects x_t onto the information set Υ_t. A linear projection of $(s_t - s_t^*)$ on Υ_t is therefore the same as a linear projection of κ_t on Υ_t. Finally, by defining

$$\zeta_t = \mathrm{proj}(\kappa_t \,|\Theta_t) - \mathrm{proj}(\kappa_t \,|\Upsilon_t) = \kappa_t - \widehat{\kappa}_t \tag{A.12}$$

the following is obtained

$$\kappa_t = \widehat{\kappa}_t + \zeta_t \tag{A.13}$$

and the variance of κ_t can therefore be decomposed into two components, one which is orthogonal to Υ_t and another which is not

$$\sigma_{\kappa}^2 = \sigma_{\widehat{\kappa}}^2 + \sigma_{\zeta}^2 \tag{A.14}$$

Hence, following Durlauf and Hall (1988, 1989), a lower bound on the variance of κ_t is obtained as

$$\sigma_{\widehat{\kappa}}^2 \leq \sigma_{\kappa}^2 \tag{A.15}$$

Durlauf and Hall (1989) show that if the information set Υ_t includes current values of s_t and f_t, this signal extraction approach corresponds to an optimal Kalman filter smoothing estimate of κ_t (or model noise more generally).

The first step to obtaining this lower bound is to estimate the money market equation (A.1) for the sample period available to get values of φ and λ, using the dynamic OLS (DOLS) approach of Stock and Watson (1993) with one lead and lag of the data. For those countries where $\varphi > 1$, a unit income elasticity is imposed. The interest rate semi-elasticity was always correctly signed and significant from zero in almost all cases. The resulting interest rate elasticities (available from the author) are usually small, ranging from 0.01 to 0.57 with an average estimate of 0.16. It is interesting, however, that the interest rate elasticities are more than twice as high in the VSOEs and the EMEs (with an average value of around 0.25) compared to the larger, developed countries (with an average value of around 0.10). These findings are consistent with the findings in Driscoll and Lahiri (1983), for developing countries, and Fair (1987), for developed countries, who find that the elasticity is small, usually around 0.10.

Having obtained estimates of φ and λ, data for the fundamentals from equation (A.5) can be generated using the end-point approximation suggested by Shiller (1981)[18]

$$s_t^* = \sum_{j=0}^{T-t} \left(\frac{\lambda}{1+\lambda}\right)^j f_{t+j} + \left(\frac{\lambda}{1+\lambda}\right)^{T-t} s_T \tag{A.16}$$

The final step is to generate $\widehat{\kappa}_t$. This is done by projecting $(s_t - s_t^*)$ on the information set Υ_t, which is assumed to include a constant and current and four lags of s_t and f_t, using a Newey-West adjusted covariance matrix. This gives the lower bound estimate of σ_κ.

Finally, it is worth noting that σ_κ is not the same as the standard deviation of the exchange rate risk premium itself, but of the present value of the current and expected future risk premium. These are obviously related but σ_κ will be larger

[18] In some cases the terminal value of (A.16) tends to jump for the last few observations. To avoid this problem, data for 2006 and observations for what is available for 2007, plus artificial data is used to generate three further years of data. The artificial data is constructed by assuming an 2% annual steady state rate of inflation, a 3% steady state rate of growth, a 5% (the sum of inflation and output growth) steady state growth rate of money and an unchanged interest rate and exchange rate from the last observation. The results are not sensitive to these assumptions.

than σ_ξ as $\lambda > 1$ and as ξ_t tends to be very persistent (cf. Backus et al., 1993). For example, if ξ_t follows a simple AR(1) process, the relationship between the two will be given as $\sigma_\kappa = [\lambda/(1+\lambda(1-\rho_\xi))]\sigma_\xi$, where ρ_ξ is the autoregressive coefficient. Thus, the more persistent the risk premium is or higher the interest rate semi-elasticity, the greater the difference between the two. This is also consistent with the findings from a sticky-price general equilibrium model in Obstfeld and Rogoff (2003), who show that the 'level' exchange rate risk premium, which is closely related to κ_t, can be substantially larger than the standard forward exchange rate risk premium and that the scaling factor equals the interest rate semi-elasticity of money demand.

A.2. Measuring exchange rate pass-through

To obtain values of the degree of exchange rate pass-through, a VAR model that includes domestic and foreign inflation, exchange rate changes (annualised quarterly changes), the short-term interest rate and the output gap is estimated for each country for the sample period available with the lag order chosen using the Akaike information criteria.[19]

For identifying the exchange rate shocks, the generalised impulse response approach suggested by Pesaran and Shin (1998) is used. This identification approach is based on the historical covariance structure of idiosyncratic shocks and is not sensitive to the exact ordering of the variables in the VAR as when using a Cholesky ordering (although the results turned out to be very similar). The degree of exchange rate pass-through is measured as the accumulated impulse responses of inflation after two years to a 1% shock to the exchange rate.[20] The reason for using the accumulated shock after two years is that the impulse responses typically peak at around that time and are less sensitive to the exact identification of the contemporaneous shocks than impulse responses at shorter lags.

This VAR approach is, however, not suitable to obtain the degree of exchange rate pass-through before and after IT used in the panel analysis since the sample period in either sub-samples turns out to be too short for many countries. Instead, I follow Edwards (2007) in using a simple regression approach to obtain estimates of the pass-through coefficient before and after IT. Hence the following equation is estimated (the regressions also include the tax-dummies from the VAR analysis)

$$\pi_t = \alpha + [\gamma(L) + \eta D_t]\,\pi_{t-1} + [\beta(L) + \delta D_t]\,\Delta s_t + \phi(L)\pi_t^* + \theta x_{t-1} + u_t \qquad \text{(A.17)}$$

where π_t is domestic inflation, π_t^* is foreign inflation, Δs_t denotes nominal exchange rate changes (all three measured as annualised quarterly changes), x_t is the output

[19] The VAR includes the special dummy variables for changes in indirect taxes discussed in the main text. The dummy variables are unity in the given quarter and zero elsewhere, except the Canadian 1994Q1-Q2 dummy (0.75 in 1994Q1 and 0.25 in 1994Q2). In addition there are dummy variables to account for large outliers in the case of Chile (1991Q1 and 1991Q2), Korea (1997Q4 and 1998Q1), Malta (2001Q3), New Zealand (1998Q4) and Thailand (1997Q3 and 1998Q2).

[20] Results for Slovenia are missing as it turns out that a stable VAR model over the short sample period available is not obtainable (interest rate data is only available since 1998) and the estimated impulse responses turn out to be implausibly high and very sensitive to slight changes in model specification and the sample period used.

gap and u_t an error term. D_t is a dummy variable, equal to unity from the first quarter after IT adoption for the IT countries and from 1997Q1 for the non-targeting countries. Finally, $\gamma(L)$, $\beta(L)$ and $\phi(L)$ are lag polynomials to be determined by the data for each individual country. Thus, the pass-through coefficient changes from $\beta(1)/(1-\gamma(1))$ to $(\beta(1)+\delta)/(1-\gamma(1)-\eta)$ after IT adoption (or from 1997Q1 for the non-targeting countries).

Overall, the resulting pass-through estimates are quite similar to the ones obtained using the VAR approach from above. Estimating (A.17) for the whole sample without the regime dummy variable gives an average pass-through coefficient of 0.20, compared to 0.23 from the VAR approach.[21] Furthermore, the results from the cross-country analysis are found to be robust to using this estimate of the pass-through coefficient in the cross-country analysis instead of the VAR estimate: all the three explanatory variables, including the pass-through coefficient, continue to be highly significant.

A.3. Measuring monetary policy shocks

To obtain a measure of monetary policy predictability, the following monetary policy rule is estimated for each country

$$i_t = \gamma i_{t-1} + (1-\gamma)\left[(r+\pi^T) + \beta(\mathrm{E}(\pi_{t+1}\,|\Omega_t) - \pi^T) + \eta x_t\right] + \varepsilon_t \tag{A.18}$$

where i_t is the short-term nominal interest rate, r is the equilibrium real interest rate, π_t is the inflation rate, π^T is the targeted inflation rate, x_t is the output gap, $\Omega_t \subseteq \Theta_t$ denotes the monetary policy maker's information set, and ε_t is a random shock to the interest rate, i.e. the monetary policy shock. Many studies, such as Clarida et al. (2000), have found that the above rule characterises actual monetary policy in a number of countries quite well.

The policy rule is estimated by IV for the sample period available, assuming that the information set, Ω_t, includes four lags of i_t, π_t and x_t, using a Newey-West adjusted covariance matrix (the results are more or less the same if current values of π_t and x_t are also included in the information set).

An alternative measure of monetary policy predictability tried is obtained using a rolling-window VAR model that includes domestic and import price inflation, the output gap and the short-term interest rate. This gives conditional out-of-sample one-quarter ahead forecast errors for the short-term interest rate. The empirical results using this measure of monetary policy predictability are practically identical to the ones reported in the paper.

[21] The pass-through estimates are also found to be similar to typical findings in the literature. For example, Gagnon and Ihrig (2004) find that the pass-through coefficient in a sample of industrial countries declines on average from 0.23, in a relatively high inflation regime, to 0.05, in the relatively low inflation regime. This can be compared to the decline from 0.11 in the pre-targeting period to 0.03 in the post-targeting period for the same country group as they use (from 0.36 to 0.11 for the total country group).

Appendix B: Robustness of cross-country results

Table B1 reports robustness tests of the basic results reported in Table 4.[22] The second column of the table checks whether the inference using OLS is sensitive to possible heteroscetasticity problems, using White's heteroscedastic-consistent standard errors. The standard error of the EXRISK coefficient increases slightly, although its t-value remains above 3. Standard errors of the two other coefficients actually decline.

Table B1. Robustness tests

	Hetero-scedasticty consistent estimates	Excluding Turkey	LAD estimates	LTS estimates	IV estimates
EXRISK	0.174	0.171	0.225	0.317	0.180
	(0.000)	(0.001)	(0.000)	(0.000)	(0.021)
POLICY	0.774	0.857	0.717	0.804	0.989
	(0.000)	(0.126)	(0.000)	(0.029)	(0.003)
PASS	0.087	0.087	0.088	0.061	0.097
	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)
Constant	-0.006	-0.006	-0.013	-0.020	-0.012
	(0.312)	(0.409)	(0.098)	(0.000)	(0.246)
SE	0.021	0.021	0.022	0.011	0.022
Sargan test					0.885
J test					0.916
Durbin-Wu-Hausman test					0.396

The parentheses report p-values. The second column adjusts for possible heteroscedasticity using White's heteroscedasticity adjustment for the standard errors of the final estimate. The third column excludes Turkey from the country sample. The fourth and fifth columns report two robust estimates: the least absolute deviations (LAD) estimates and the least trimmed squares (LTS) estimates. The sixth column gives the instrumental variables (IV) estimates using OPEN, log(SIZE), DIVER, INTER, CONS, EME, and a dummy variable for the three countries that have followed a hard currency peg throughout the sample period, as instruments. The table also reports p-values for the Sargan and J tests for instrumental validity and the Durbin-Wu-Hausman test for any potential endogeneity problems affecting the consistency of the OLS estimates.

As a simple test of whether the results are sensitive to any particular country in the sample, I also re-estimated the final regression excluding every country in the sample, one at a time. The estimation results (available from the author) were found to be insensitive to this country exclusion (with t-values always exceeding 3), except in the case of Turkey, reported in the third column of Table B1. In this case the

[22] As an additional robustness check, dummy variables for different country groups were also added to the final cross-country regression. The country-group dummies tried were for the original fifteen EU countries, the countries that have de facto followed more or less a free floating exchange rate regime throughout the sample period, the hard currency peg countries in the sample, the very high inflation countries in the sample, plus the EME, VSOE, IT95, EURO12 and G6 countries previously discussed. In no case were these dummy variables found to be statistically significant from zero or to alter the main results in any way (these results are available from the author).

coefficient on POLICY becomes less precisely estimated but the results are otherwise not affected.

As a further analysis of the robustness of the estimation results, I next use two types of robust estimators to check whether the results are sensitive to possible outliers. The first estimator is the least absolute deviations (LAD) estimator. This estimator is less sensitive to outliers as it is based on minimising the absolute rather than the squared residuals. This estimator is therefore consistent and asymptotically normal under a broader set of conditions than the OLS estimator. The second estimator is the least trimmed squares (LTS) estimator. In this case a re-sampling algorithm that draws from 3,000 subsamples is used to locate 'contaminated' observations that are excluded from the final estimation procedure, i.e. observations with standardised residuals exceeding 2.5. OLS is then applied using the remainder of the observations. The re-sampling algorithm excludes the Czech Republic, Greece, Hong Kong, Hungary, Lithuania, Malta, Mexico, Thailand and Turkey, leaving thirty-two observations to estimate the model. As can be seen in the fourth and fifth columns of Table B1, the results are essentially the same as the OLS estimates, indicating that the results are not driven by few outliers in the country sample. The parameter estimates are similar to the OLS estimates, although the coefficient on EXRISK in the LTS case is somewhat larger. The residual standard error is also only about half as large as when using OLS.

Finally, to test for a possible endogeneity problem, I re-estimate the model using instrumental variables, reported in the sixth column of Table B1. Simple regression results suggest that OPEN and INTER can serve as instruments for EXRISK, i.e. that the more open the economy is to international trade and the more closely tied to the world economy it is, the less volatile the exchange rate risk premium tends to be, consistent with predictions from the standard optimal currency literature. A dummy variable for the EME countries is also found to be a significant explanatory variable for EXRISK, suggesting that the EMEs have an unusually volatile exchange rate risk premium compared to other country groups. A F-test for the joint significance of these explanatory variables for EXRISK gives a p-value of 0.00. Similar analysis suggests that CONS and the EME dummy can serve as instruments for POLICY, i.e. that countries with a negative correlation between consumption and exchange rate appreciations tend to experience smaller monetary policy shocks and that the EMEs tend to have unusually large monetary policy shocks as previously discussed. A F-test for the joint significance of these explanatory variables gives a p-value of 0.04. Finally, a dummy variable for the three countries that have followed a hard currency peg throughout the sample period (Estonia, Hong Kong and Luxembourg) seems a valid instrument for PASS. The three hard peg countries are all extremely open economies (with an openness ratio ranging from 200-300%) and the hard peg dummy therefore seems to pick up the positive effect of trade openness on exchange rate pass-through rather than the OPEN variable itself. The EME dummy is also significant, suggesting that the EMEs have greater pass-through for a given degree of openness. A F-test for the joint significance of these explanatory variables gives a p-value of 0.01. Finally, SIZE and DIVER are added as instruments for all three variables as they are found to increase the efficiency of the IV estimates without affecting the coefficient estimates.

The relevance of the instrument list can be investigated following the approach suggested by Shea (1997) for testing for instrument relevance in a setup where there are potentially multiple endogenous regressors. Using his approach, gives a partial R^2 for EXRISK equal to 0.38 (with a p-value from a F-test for joint significance equal to 0.00), a partial R^2 for PASS equal to 0.27 (with a p-value from a F-test for joint significance equal to 0.01), and a partial R^2 for POLICY equal to 0.16 (with a p-value from a F-test for joint significance equal to 0.08). These results suggest that the instruments are highly relevant for EXRISK and PASS, but are weaker for POLICY, suggesting that better instruments for that variable might be needed to improve the identification of the IV estimate for the POLICY coefficient.

The seven instruments impose four over-identifying restrictions on the model that can be tested. The Sargan and J statistics for the overall validity of these over-identifying restrictions are insignificant, suggesting that the instrument set is valid. Furthermore, the parameter estimates are very similar to the OLS estimates and a Durbin-Wu-Hausman test fails to reject the null hypothesis that the IV and OLS estimates are equal, suggesting that there are no potential endogeneity problems affecting the consistency of the OLS estimates.

Appendix C: Data sources and description

Structural data

PPP adjusted GDP and *PPP adjusted GDP per capita:* 2006 country data from the *CIA World Factbook*: www.cia.gov/cia/publications/factbook.

Trade diversification: A modified Finger-Kreinin index of trade similarities that ranges from 0 and 1. It measures to what extent a country's exports structure differs from that of the average country. A country exporting only few goods will have a value closer to 1, indicating a bigger difference from the world average. The data is for 2005 and is obtained from the United Nations Conference on Trade and Development (UNCTAD): www.unctad.org/Handbook.

Commodity share of exports: Share of primary commodities, including all food items, agricultural raw materials, fuels and ores and metals (including non-ferrous metals) in total merchandise exports (SITC codes 0, 1, 2, 3, 4 and 68). The data is for 2005 and is obtained from the United Nations Conference on Trade and Development (UNCTAD): www.unctad.org/Handbook.

Price level data

Consumer prices: Quarterly data on the headline consumer price index for the period 1985-2005, except for the Czech Republic (from 1989Q1), Estonia (the implicit private consumption price deflator from 1993Q1), Latvia (from 1993Q1), Lithuania (the implicit private consumption price deflator from 1995Q1), Malta (from 1990Q1), Slovakia (from 1993Q1) and Slovenia (the implicit private consumption price deflator from 1995Q1).

All the data are seasonally adjusted from source or by the author using X-12. The data source is Reuters/EcoWin, except for Estonia, Lithuania and Slovenia (data from Eurostat); and Iceland, Israel, Malta and Slovakia (data from national central banks or statistical offices).

Import prices: Quarterly data on the implicit price deflator of imports of goods and services for the period 1985-2005, except for Austria (from 1988Q1), Chile (from 1990Q1), Cyprus (from 1995Q1), the Czech Republic (from 1995Q1), Estonia (from 1993Q1), Hungary (from 1995Q1), Latvia (from 1995Q1), Lithuania (from 1995Q1), Malta (from 1990Q1), New Zealand (from 1987Q2), Poland (from 1990Q1), Portugal (from 1995Q1), Slovakia (from 1993Q1), Slovenia (from 1995Q1), Thailand (from 1993Q1) and Turkey (from 1987Q1).

All the data are seasonally adjusted from source or by the author using X-12. The data source is Eurostat, except for Australia, Canada, Germany (all data prior to 1991 for West Germany), Korea, Luxembourg, Mexico, New Zealand, Poland, South Africa and Taiwan (data from Reuters/EcoWin); Finland, France, Italy, Norway, Portugal, Sweden, Switzerland and the UK (data from Eurostat and Reuters/EcoWin); Ireland, Thailand and Turkey (data from Reuters/EcoWin and national central banks); and Hong Kong, Iceland, Israel, Chile and Malta (data from national monetary authorities, central banks or statistical offices).

Exchange rate data

Quarterly data on the *effective exchange rate index* for the period 1985-2005, except for Cyprus (from 1994Q1), the Czech Republic (from 1991Q1), Estonia (from 1994Q1), Israel (from 1986Q4), Latvia (from 1994Q1), Lithuania (from 1994Q1), Malta (from 1990Q1), Slovakia (from 1994Q1) and Slovenia (from 1994Q1). Defined as the value of the domestic currency per one unit of foreign currencies.

The data source is Eurostat, except for Chile, Korea, Luxembourg, Mexico, Poland, South Africa, Taiwan and Thailand (data from Reuters/EcoWin and IFS); the Czech Republic and Hungary (data from Eurostat and IFS); and Hong Kong, Iceland, Israel and Malta (data from national monetary authorities and central banks).

Interest rate data

Quarterly data on the *short-term interest rate* for the period 1985-2005, except for Cyprus (from 1993Q1), the Czech Republic (from 1993Q1), Estonia (from 1996Q1), Hungary (from 1987Q1), Iceland (from 1988Q4), Israel (from 1986Q1), Latvia (from 1993Q4), Lithuania (from 1994Q3), Malta (from 1993Q1), Slovakia (from 1994Q1), Slovenia (from 1998Q2) and Turkey (from 1993Q1).

The interest rate is a short-term money market rate, except for Chile (commercial bank deposit rate for 1985-1995 and money market rate from 1996), Cyprus (t-bill rate for 1993-1998 and money market rate from 1999), Iceland (Central Bank of Iceland policy rate), Israel (discount rate for 1985-1987 and Bank of Israel policy rate from 1988), Lithuania (t-bill rate for 1994-1998 and money market rate from 1999), Malta (t-bill rate for 1993-1994 and money market rate from 1995), Poland (short-term interest rate from 1991Q3), Taiwan (31-90 days CP rates) and Thailand (money market rate (weighted average of all maturities) for 1985-1996, 3 month repo rate for 1997-2002 (up to May), 3 month SWAP rate for 2002 (from June)-2004, 3 month BIBOR rate for 2005).

The data source is Reuters/EcoWin, except for Cyprus, Estonia, Latvia, Lithuania, Malta, Slovakia, Slovenia and Turkey (data from Eurostat); Hong Kong, Iceland, Taiwan and Thailand (data from national monetary authority or central bank); Chile and Israel (data from national central banks and IFS); and Germany, Hungary and Korea (data from Reuters/EcoWin and IFS).

Money supply data

Quarterly data on *broad money* (M2 or M3 depending on availability) for the period 1985-2005, except for Chile (from 1986Q1), Cyprus (from 1990Q1), the Czech Republic (from 1992Q1), Estonia (from 1993Q1), Hungary (from 1990Q4), Latvia (from 1993Q1), Lithuania (from 1993Q2), Malta (from 1992Q1), New Zealand (from 1988Q1), Poland (from 1989Q4), Slovakia (from 1993Q1) and Slovenia (from 1993Q1).

All the data are seasonally adjusted from source or by the author using X-12. The data source is Reuters/EcoWin, except for Cyprus, Denmark, Estonia, Latvia, Lithuania, Malta, Slovakia and Slovenia (data from Eurostat); Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain (data from Reuters/EcoWin up to 1998 linked with Euroarea money supply from 1999 from Eurostat); and Iceland, Israel and Sweden (data from national central banks).

National account data

Quarterly data on *private consumption*, *exports of goods and services*, *imports of goods and services* and *GDP* for the period 1985-2005, except for Austria (from 1988Q1), Chile (from 1986Q1, except for consumption from 1996Q1), Cyprus (from 1995Q1), the Czech Republic (from 1994Q1, except for GDP from 1990Q1), Estonia (from 1993Q1), Hungary (from 1995Q1 for consumption, exports and imports), Latvia (from 1995Q1), Lithuania (from 1995Q1), Luxembourg (from 1995Q1 for consumption), Malta (from 1990Q1), New Zealand (from 1987Q2), Poland (from 1990Q1, except for consumption from 1995Q1), Portugal (from 1995Q1), Slovakia (from 1993Q1), Slovenia (from 1995Q1), Thailand (from 1993Q1) and Turkey (from 1987Q1).

All the data are constant price and seasonally adjusted from source or by the author using X-12. The data source is Reuters/EcoWin, except for Austria, Belgium, Cyprus, Denmark, Estonia, Greece, Latvia, Lithuania, the Netherlands, Slovakia, Slovenia and Spain (data from Eurostat); the Czech Republic (data for consumption, exports, imports and GDP from Reuters/EcoWin and Eurostat); Hungary (data from Eurostat, except GDP data from Reuters/EcoWin and Eurostat); Chile, Hong Kong (imports data), Iceland, Israel, Malta (data from national monetary authorities or central banks); and Ireland, Sweden and Thailand (exports data) (data from

Reuters/EcoWin and national central banks or statistical offices).

International data

Consumer prices: Quarterly data on OECD countries excluding high inflation countries (Hungary, Mexico, Poland and Turkey) from Reuters/EcoWin. Seasonally adjusted using X-12.

GDP: Quarterly data on OECD former total 25 countries for the period 1985-2005 from Reuters/EcoWin. Seasonally adjusted from source.

Interest rate: Quarterly data on OECD countries excluding high inflation countries (Hungary, Mexico, Poland and Turkey) using interest rate data on individual member countries from above for those countries included in this study and OECD Main Economic Indicators for the remaining member countries, with truncated current OECD country weights.

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