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How hard can it be? Inflation control around the world

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Abstract

During the last two decades, the level and variability of inflation has declined across the world. Some countries have, however, had more success in controlling inflation than others, and the fact is that these countries are usually the same countries that have been more successful over longer periods. The focus of this paper is to try to understand what factors explain this difference in inflation performance and, in particular, why inflation turns out to be more volatile in very small, open economies and in emerging and developing countries than in the large and more developed ones. Using a country sample of 42 of the most developed countries in the world spanning the period 1985-2005, the results suggest three main explanations: the volatility of currency risk premiums, the degree of exchange rate pass-through to inflation, and the size of monetary policy shocks. These three variables explain about three-quarters of the cross-country variation in inflation volatility. The results are found to be robust to changes in the country sample and to different estimation methods. In particular, they do not seem to arise because of reverse causality due to possible endogeneity of the explanatory variables.

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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 had more success in controlling inflation than others, and the fact is that these countries are usually the same countries that have been more successful over longer periods. For example, in the period 1985-1995 the standard deviation of inflation was on average 4.4% in the country sample studied in this paper, but had fallen to 3.4% in the period 1995-2005. But individual inflation performance remains highly correlated in the two periods, with a rank correlation equal to 0.81. Thus, the worst performers in the former period continued to rank among the lowest in the latter period.

The focus of this paper is to try to understand what factors explain this difference in the variability of inflation across countries, and in particular, why inflation turns out to be more volatile in very small, open economies (VSOEs) and emerging and developing countries (EMEs) than in the large and more developed countries. To try to answer this question, a sample of 42 of the most developed countries in the world is used. This sample includes countries with per capita income at least as high as the poorest OECD member and GDP levels at least as high as the smallest OECD member.

The paper starts by documenting a number of key economic features of the country sample that could help explain the cross-country variation in inflation volatility. It turns out that inflation is not only higher on average and more volatile in the VSOEs and EMEs, but is also less predictable. However, interestingly enough, inflation is equally or less persistent compared to the large, developed countries, which could reflect the fact that the real economy is more volatile in these two country groups which in turn could induce more forward-looking price and wage setting. The VSOEs and EMEs are also more open to international trade but their output is less correlated with world output. The fact that these country groups have both higher and more volatile inflation, although they are more open to trade, suggests that Romer's (1993) finding that more open economies tend to have lower inflation rates does not apply to this country sample.

It also turns out that the exchange rate in some small or less developed countries is more procyclical than in the large, developed countries, where they are more or less acyclical, which may generate a larger exchange rate risk premium that could translate into a more volatile inflation rate. Furthermore, exports in many countries which have experienced more volatile inflation rates tend to be less diversified and more commodity-based.

Perhaps surprisingly, effective exchange rates in the VSOEs and EMEs are not found to be more volatile than in the large, developed countries and, in some cases, are even more stable. This is, however, consistent with Krugman's (1989) conjecture that exchange rates in the large, developed countries are so volatile for the simple fact that this volatility has very little economic consequences. However, the exchange rate risk premium tends to be much more volatile in the VSOEs and EMEs than in the larger and more developed countries. This distinction between exchange rate volatility and the volatility of the exchange rate risk premium turns out to be of key importance in explaining the cross-country variation in inflation volatility. Finally, the degree of pass-through of exchange rate shocks to consumer price inflation tends to be higher in the two country groups, especially in the VSOEs, but monetary policy tends to be less predictable in the EMEs than in other country groups.

The paper moves on to try to determine which of the above factors are most important in explaining the cross-country variation in inflation volatility. The final results suggest three factors: volatility of currency risk premiums, the degree of exchange rate pass-through to inflation, and the size of monetary policy shocks. A more volatile currency risk premium plays a central role in explaining why inflation is more volatile in both the VSOEs and the EMEs. In addition, a larger exchange rate pass-through turns to be especially important for explaining volatile inflation in the VSOEs, while lack of monetary policy predictability is especially important in explaining inflation volatility in the EMEs. The results are found to be robust to variations in the country sample and to inclusion of different country group dummies. They are also robust to possible heteroscedasticity and outliers, using two different types of robust estimators. Finally, instrumental variables estimation indicates that the results do not arise because of reverse causality due to possible endogeneity of the explanatory variables.

The results suggest that a credible and transparent monetary policy could help the VSOEs and EMEs to reduce inflation volatility, by increasing monetary policy transparency and reducing exchange rate pass-through as many recent studies argue (cf. Taylor, 2000). It is, however, likely that the currency risk premium will remain more volatile in these countries, due to their more volatile business cycles and smaller co-movement with rest of the world (both probably reflecting more frequent idiosyncratic supply shocks), and less liquid and efficient foreign exchange markets. Inflation is therefore likely to remain more volatile in these countries than in the larger and more developed economies.

The remainder of the paper is organised as follows. Section 2 discusses the country sample and the sample period used. Section 3 compares inflation performance, whereas Section 4 discusses various structural features of the selected countries. Section 5 compares the variability of exchange rates, describes how exchange rate risk is measured and reports the degree to which exchange rate shocks are passed through to consumer price inflation. Section 6 discusses the role of monetary policy in explaining the different degree of inflation volatility and reports estimates of monetary policy shocks. Section 7 reports the results from the cross-section analysis explaining the cross-country variation in inflation volatility. Section 8 concludes.

2. The data

2.1. The country sample

This sub-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 development 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. 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 to the country sample analysed. Hence, of the 226 countries recorded in the *CIA World Factbook*, this gives a country sample of 65 in total.

It turned out that quarterly data for a sufficient time span was not available for some key variables in some of these 65 countries. Furthermore, a number of these countries cannot reasonably be described as decentralised market economies and others have experienced serious wars within the sample period analysed here. Hence, 23 additional countries were excluded from the sample. This gives a sample of 42 countries, i.e. all the current 30 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 42 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. See Table 2 below and Table A2 in Appendix A for further details.

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 was not available or not used. In most cases this involved 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 had reached lower double digit rates, i.e. Israel (starts in 1986), Mexico (starts in 1989) and Poland (starts in 1992). Sample periods available for each estimation result are reported in Table C1 in Appendix C and further detail on the data availability and sources can be found in Appendix D.

2.3. Different country groups

There are two country groups in the data set of particular interest as it turns out that they have experienced much more volatile inflation rates than most other countries in the sample (see below). The first consists of seven very small, open economies with population levels below 2.5 million (VSOEs). The second comprises the emerging and developing countries in the sample (EMEs). These are defined as the total country sample excluding the 24 countries that have been OECD members since 1961 plus Hong Kong, Israel, Korea and Taiwan, which are more naturally thought of as developed countries, but treating Turkey as a developing country, as it most closely resembles an emerging market economy despite being an original OECD member. This gives a sample of fifteen countries. For comparison, I also report results for two different combinations of large, advanced economies, i.e. the G6 countries and the original twelve euro countries (EURO12). Details on the country groups can be found in Table C2 in Appendix C.

3. Inflation performance

3.1. Average inflation and inflation variability

I start by looking at average inflation and inflation variability in the 42 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 1 reports median estimates for different country groups, with individual country results reported in Appendix A.

Table 1. Inflation performance and properties

Country group medians	Average inflation	Inflation persistence	Inflation volatility	Inflation forecast errors
All countries	3.9	0.50	3.1	2.5
EME	9.3	0.57	8.1	4.0
VSOE	6.4	0.28	3.6	2.7
EURO12	2.3	0.58	1.7	1.6
G6	2.6	0.51	1.7	1.3

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 persistence is obtained from an AR(k) model allowing for mean break of unknown date. Inflation forecast errors are standard deviations of one-quarter ahead forecast errors (in percentages) from a rolling-window VAR model. Individual country estimates are given in Table A1. Details of the country groups are given in Table C2. Details on sample periods are given in Table C1.

Median inflation for the whole country sample is 3.9% but is found to be significantly higher in the VSOEs and the EMEs than in the large, developed countries. The same applies to inflation volatility which is just under 2% in the large, developed countries but twice as high in the VSOEs and as high as 8% in the EMEs. Looking at individual countries in Table A1, shows that average inflation ranges from just above zero in Japan to 44% in Turkey. As is to be expected, inflation variability is highly correlated with average inflation (rank correlation equal to 0.87) and ranges from 1.2% in France to above 20% in Turkey.

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 4.7% on average to 3.4% in the 1995-2005 period.

However, the results from the analysis in this paper continue to hold whether the whole period or the more recent period is used; as previously discussed, countries that experience more volatile inflation rates over the whole sample period usually continue to do so for the latter half of the sample period as well.

An alternative measure of inflation volatility is to estimate the conditional variability of inflation by using a VAR model to generate out-of-sample, one-quarter ahead inflation forecasts. 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.[1] The resulting standard deviations of the forecast errors are reported in the fifth column of Table 1. The pattern is very similar to the one using unconditional standard deviations (rank correlation equal to 0.74): the forecast errors are higher in the VSOEs and the EMEs, although the difference is smaller than when using the unconditional standard deviations.

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 seems therefore to be robust. The focus of this paper is to try to understand what factors explain this difference. These include the properties of the inflation process itself, the properties of the variables influencing the inflation process and the sensitivity the inflation process to shocks to these forcing variables. Thus, one would expect inflation volatility to increase the more persistent the inflation process is and the more volatile and persistent the shocks hitting the economy are, including shocks to the real economy and the terms of trade, and the more sensitive inflation is to these shocks, as reflected in the slope of the Phillips curve and the size of the first-round effects of other types of shocks. Many of these factors may in turn be affected by structural features of the economy, such as trade openness and patterns of trade. Furthermore, monetary policy transparency and credibility will play a key role in determining all these factors. In the remainder of this paper I will present estimates of a number of these factors and analyse which of them can explain the cross-country variation in inflation volatility in the country sample used.

[1] There are a few countries were shorter sample periods are only available and a second order VAR with a 20 quarter horizon was used to preserve degrees of freedom. See Table C1 for further detail.

3.2. Inflation persistence

As argued above, one would expect inflation volatility to increase with the degree of inflation persistence. A less persistent rate of inflation would make inflation control easier as shocks to the price level would have a smaller and less protracted impact on the rate of inflation which would return to target without requiring strong responses from the monetary authority.

To estimate the persistence of inflation in the 42 countries it is assumed that the inflation process can be approximated by a kth-order AR process with a possible break in the mean of the process at an unknown date.[2] This is important as a failure to account for a possible break in mean inflation could lead to spuriously high estimates of inflation persistence

$$\pi_t = (\alpha_0 + \alpha_1 D_t) + \sum_{j=1}^{k} \psi_j \pi_{t-j} + u_t \tag{3.1}$$

where u_t is a white noise residual, D_t is a dummy variable equal to zero for $t < h$ and unity in all subsequent quarters, with the value of h determined by the Andrews and Ploeberger (1994) $ExpF$-test for structural breaks at unknown dates.

Equation (3.1) can be re-written as[3]

$$\pi_t = (\alpha_0 + \alpha_1 D_t) + \rho_\pi \pi_{t-1} + \sum_{j=1}^{k-1} \varphi_j \Delta\pi_{t-j} + u_t \tag{3.2}$$

with a direct measure of inflation persistence given by $\rho_\pi = \sum_{j=1}^{k} \psi_j$.

Table 1 reports the results. The median rate of persistence is 0.5 for all the countries, suggesting that a typical inflation fluctuation will only last for one to two quarters. These results are in line with the findings in Levin and Piger (2003), who obtain a median estimate of 0.7 in a sample of 12 industrial countries, and Cecchetti and Debelle (2006), who obtain a median estimate of 0.58 in a sample of 18 mainly developed countries. These findings suggest a substantially lower estimate of inflation persistence than previously had been thought (see for example Fuhrer and Moore, 1995) once a break in the mean is allowed for. Looking at individual countries in

[2] Levin and Piger (2003) find little evidence of structural breaks in the autoregressive coefficients. Furthermore, the results in Cecchetti and Debelle (2006) suggest that allowing for one break in the mean is usually sufficient. Note that this analysis does not make a distinction between "inherited" and "intrinsic" inflation persistince. Such a distinction would require estimating a structural model, such as in Fuhrer (2006).

[3] The lag order of the estimated inflation process is determined by the Akaike information criteria (with a maximum lag order of $k = 4$ considered). The possibility of a break is excluded for the first and last 15% of the sample period. A break is allowed for in the mean if the $ExpF$ test gives a p-value below 10% (p-values based on Hansen, 1997). Special dummy variables for changes in indirect taxes were included for Australia (2000Q3), Canada (1991Q1 and 1994Q1-Q2), Japan (1997Q2), Norway (2003Q1 and 2003Q2) and the UK (1990Q2). 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). Ignoring these outliers could induce a downward bias in the estimated degree of persistence.

Table A1, inflation persistence ranges from almost zero in Canada to almost unity in Poland. Persistence is in general found to be low to moderate: it is below 0.5 in half of the countries and below 0.8 in 38 of them, with persistence above 0.9 only in Poland.[4]

Finally, no obvious pattern is found by comparing the different country groups, except that the results suggest that persistence is lower on average in the VSOEs than in the other countries. The reason could be that these countries tend to have quite volatile economies (see Table 2 below), which could induce more forward-looking price and wage setting behaviour, contributing to reducing the persistency of inflation. As shown in Section 5.3 below, the VSOEs also tend to have a high exchange rate pass-through to inflation, which could also contribute to lower inflation persistence.

4. Economic structure

4.1. Size, development and output volatility

There are several channels through which 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 better able to undertake investment in indivisible forms of capital and therefore obtain a more balanced sectoral distribution of output than lower income countries. Overall 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, economic development can be thought of as a proxy for other economic and institutional developments correlated with per capita income.

The relation between economic size and inflation volatility is perhaps less clear. It can, however, be argued that larger countries may experience lower inflation variability, others thing 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 efficient institutions that are more effective in containing inflationary pressures, for example if there is a limited pool of skilled people to draw from.

This paper measures economic size with the level of GDP and economic devel-

[4] No significant break in the mean was found for 12 countries: Austria, Belgium, Cyprus, Germany, Ireland, Latvia, Luxembourg, Malta, the Netherlands, Poland, Slovakia and Thailand. The exact dates of the mean break in the other countries are usually found to be quite precisely estimated and indicate that mean inflation has fallen after the break. As in Levin and Piger (2003), the structural breaks are mainly found to occur in the late 1980s and the first half of the 1990s. Information on the breakdates and more detail on the estimation results are available from the author.

opment with GDP per capita (see Table 2). Median GDP per capita is 28 thousand dollars but is much lower in the EMEs and somewhat lower in the VSOEs, despite the latter group including two of the richest countries in the sample: Luxembourg and Iceland.

Table 2. Size, development and output volatility

Country group medians	Population	GDP	GDP per capita	Output volatility
All countries	10.3	253	27.9	1.4
EME	10.0	173	15.4	2.1
VSOE	0.8	26	22.7	1.9
EURO12	10.6	305	31.2	1.1
G6	72.6	2,244	31.4	1.0

GDP and per capita income are PPP adjusted. Population (in millions), GDP (in billion US dollars) and per capita income (in thousand US dollars) are 2006 data. Output volatility is the standard deviation (in percentages) of the output gap. Individual country estimates are given in Table A2. Details of the country groups are given in Table C2. Details on sample periods are given in Table C1.

Table 2 also reports the variability of real output, measured as the standard deviation of the output gap (with potential output measured by a Hodrick-Prescott trend). 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. This seems to be reflected in the data: output gap variability is about 2% in both the VSOEs and EMEs, about twice as high as in the large, developed countries. Looking at individual countries in Table A2, output gap variability ranges from 0.7% in Slovenia to almost 4% in Thailand and Turkey (both of which have experienced serious economic recessions within the sample period). Similar results are found using the variability of private consumption (rank correlation equal to 0.85).

4.2. Openness and exposure to external shocks

Using a standard open economy model with nominal rigidities and discretionary monetary policy, Romer (1993) argues that more open economies should on average have less inflation. 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. However, as Lane (1997) points out, Romer's story rests on the assumption that the domestic economy is large enough so that a domestic expansion will affect international relative prices – an unsatisfactory story for most countries. He therefore emphasises the role of monopolistic distortions and nominal rigidities in the non-traded sector. A monetary expansion increases consumption and production of non-tradables, therefore reducing these distortions. This incentive for monetary expansion will, however, be smaller in more open economies as the non-tradable sector is smaller. Therefore inflation will be lower in more open economies. Furthermore, a key ingredient induced by Romer's story is that the Phillips curve will be steeper in more open economies, for which Temple (2002) finds little evidence. He therefore argues that the negative correlation between inflation and openness rather stems from the fact that higher inflation is usually associated with greater exchange rate variability which is more costly in more open economies, therefore reducing the incentive to inflate in more open economies.

The negative relation between inflation and openness has also been extended to inflation volatility by Granato et al. (2006) and Bowdler and Malik (2005). Granato et al. (2006) relate this to Clarida's et al. (2001) result that the optimal monetary policy is under certain conditions more aggressive in more open economies, therefore leading to a more stable rate of inflation. Bowdler and Malik (2005), on the other hand, suggest that the negative correlation arises as inflation volatility undermines the competitiveness of the tradable sector, which is more costly the more open the economy is.

The second column of Table 3 reports openness to international trade, measured as the sum of imports and exports of goods and services over GDP (constant prices, average for the period 2000-2005). Openness ranges from the relatively closed economies of Japan and the US to extremely open economies such as Hong Kong and Luxembourg (see Table A3). The median level of openness is 86% but, not surprisingly, the VSOEs and EMEs tend to be much more open to trade than the large, developed countries, suggesting that greater openness to international trade coincides with higher and more volatile inflation rather than the opposite as the above papers argue. I will return to this result later.

Table 3. Openness, exposure to external shocks and trade patterns

Country group medians	Openness	Output correlation with the rest of the world	Consumption correlation with exchange rate	Trade diversification	Commodity share of exports
All countries	86.0	0.37	-0.09	0.44	17.5
EME	115.5	0.16	-0.16	0.47	21.8
VSOE	130.0	0.25	-0.01	0.56	22.5
EURO12	75.2	0.54	0.04	0.36	16.2
G6	53.4	0.40	0.07	0.28	13.3

The second column gives openness to international trade as the sum of exports and imports of goods and services as a percentage of GDP (average for 2000-2005). The third column reports the contemporaneous correlation between domestic and world output gaps. The fourth column gives the contemporaneous correlation between the cyclical components of private consumption and the effective exchange rate. The fifth column reports a measure of trade diversification (2005 data). A higher index indicates an export base of relatively few goods. The final column gives primary commodities as a percentage of merchandise exports (2005 data). Individual country estimates are given in Table A3. Details of the country groups are given in Table C2. Details on sample periods are given in Table C1.

A country's exposure to external shocks can also have a significant effect on the performance of the domestic economy and its ability to control inflation. Table 3 gives two different measures of exposure of the domestic economy to external shocks. The first measures the co-movement of the domestic economy with the rest of the world using the contemporaneous correlation between domestic and world output gaps.

One could argue 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-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 (cf. Aghion et al., 2004, and Kaminsky et al., 2004).

Furthermore, as Betts and Devereux (2001) show, a low or negative co-movement of output across countries will tend to coincide with a high degree of pass-through of exchange rate shocks to inflation in the face of monetary policy shocks. The intuition is that a contractionary monetary policy shock will tend to induce an appreciation of the domestic currency and therefore generate an expenditure-switching effect away from domestic goods as import prices decline, leading to a negative correlation between the domestic and world business cycle the higher the pass-through. For countries with a small pass-through, this expenditure-switching effect is small or neglectable, with monetary policy shocks thus inducing a positive cross-country correlation. As shown below, a high exchange rate pass-through tends to coincide with more volatile inflation rates.

As Table 3 reports, the correlation between the domestic and world business cycles is lower for the VSOEs and EMEs than for for the larger, more developed countries.[5] The latter, which have 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.

The second measure of exposure to external shocks presented in Table 3 gives the contemporaneous correlation between the cyclical part of private consumption and the effective exchange rate 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 opposite direction to the consumption cycle, i.e. if the currency is weak in the low consumption state. As shown in the fourth column of Table 3, this correlation tends to be quite small and, as suggested by Table A3, is usually slightly positive, implying a negative correlation between consumption and exchange rate appreciations, consistent with standard exchange-rate models based on sticky prices where a monetary policy tightening would simultaneously lead to an economic contraction and an exchange rate appreciation which lowers import prices and leads to consumption switching from domestic to imported goods as described above. Overall consumption expenditure would, however, tend to decline as households face tighter

[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.

financial conditions and deteriorating labour market prospects, thus leading to the above-mentioned small or negative correlation between consumption and exchange rate appreciations.

There may, however, be important offsetting effects if, for example, imported durable goods are important in total consumption expenditure or through favourable balance-sheet effects if foreign currency denominated loans are a significant share of household liabilities. This may be the case in countries like Finland, Iceland, Korea, Mexico, New Zealand and Turkey where an appreciation of the currency tends to coincide with consumption above trend. Lucas' (1982) model would suggest that these currencies should have a relatively large exchange rate risk premium which might contribute to increased inflation variability if the risk premium is volatile (see the discussion below on the exchange rate risk premium). This positive correlation between consumption and exchange rate appreciation could also suggest that terms-of-trade shocks are an important source of exchange rate movements in these countries as they tend to move the exchange rate and consumption in the same direction. Comparing the inflation performance in Table 1 and this correlation does not, however, suggest any obvious pattern of relationship between the size and sign of this correlation and inflation performance or country size.

4.3. Trade patterns

Different trade patterns can also 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 important.

To measure the extent of trade diversification, an index constructed by the United Nations Conference on Trade and Development (UNCTAD) is used. 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.[6] The results are reported in the fifth column of Table 3, with individual country results in Table A3. The EMEs and, especially, the VSOEs seem to have less diversified export product range than the larger counterparts, with Chile and Iceland having the most concentrated export base, while Taiwan has the most diverse one. Not surprisingly, trade diversification is found to be highly negatively correlated with country size (rank correlation equal to -0.66).

[6] 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.

The final column gives the share of commodities, defined as all food items, agricultural raw materials, fuels and ores and metals (including non-ferrous metals), in merchandise exports. The result show that the EMEs and VSOEs are more resource-based, although looking at the individual country results in Table A3 suggests that most of the commodity based economies in the sample tend to be medium sized developed countries; only Iceland, among the VSOEs, and Chile, among the EMEs respectively, can be described as significant commodity exporters. The share of commodities in merchandise exports in those two countries, along with Norway, is by far the highest or about 80%, while the share of commodities is lowest in Hong Kong and Japan (just over 3%).

5. Exchange rate developments

5.1. Exchange rate variability

As previously discussed, inflation and inflation variability has declined globally during the last two decades, even though the world economy has experienced a lengthy economic expansion during most of the period. Many have attributed this to the disinflationary effects of exchange rate appreciation and declining import prices (see e.g. Taylor, 2000), suggesting that there maybe some, albeit incomplete, pass-through of exchange rate shocks to consumer price inflation, implying that exchange rate development is an important concern for monetary policy and inflation control. In fact, given the unpredictability of exchange rate developments and its apparent disconnect to economic fundamentals (cf. Obstfeld and Rogoff, 2000), it seems clear that inflation control becomes more complicated the more important exchange rate developments are for domestic inflation and the transmission of monetary policy to the real economy and inflation. In this section I go beyond simply comparing exchange rate variability across the country sample to trying to estimate the volatility of the underlying exchange rate shocks (here attributed to the exchange rate risk premium) and the degree to which exchange rate shocks affect consumer price inflation, a key factor in the above mentioned disinflation process according to the literature as mentioned above.

I start by reporting a simple measure of exchange rate volatility given as the standard deviation of annualised quarterly changes of the nominal effective exchange rate, expressed as the price of domestic currency in terms of a trade weighted currency basket (second column of Table 4). The median standard deviation is 9.1%, with similarly volatile exchange rates in the EMEs and the G6 countries but lower in the VSOEs, with Iceland, and Latvia to a lesser extent, being the only VSOEs with exchange rate variability similar to the EME and G6 medians (see Table A4). The most volatile exchange rate is found to be in Turkey, with a standard deviation of over 42%. Thus, interestingly enough, exchange rates seem more volatile in the larger, more developed countries than in the very small, open economies. This suggests a relationship between exchange rate volatility and the importance of exchange rate developments for the economy, consistent with Krugman's (1989) conjecture that exchange rates are so volatile in the large, developed economies for the simple fact that the volatility has limited economic effect. As the results suggest no obvious connection between the volatility of exchange rates and the volatility of inflation for different country groups, they also imply the need to look beyond the volatility of exchange rates in trying to explain the role of exchange rates for accounting for different inflation performance.

Table 4. Exchange rate volatility and pass-through

Country group medians	Exchange rate volatility	Volatility of exchange rate risk	Exchange rate pass-through
All countries	9.1	11.6	0.20
EME	10.2	18.5	0.26
VSOE	3.6	15.7	0.34
EURO12	5.5	7.2	0.22
G6	10.4	10.7	0.06

Exchange rate volatility is the standard deviation (in percentages) of annualised quarterly changes of effective exchange rates. Volatility of exchange rate risk (in percentages) is obtained from a signal extraction approach. Exchange rate pass-through is estimated as the cumulative effect of a 1% exchange rate shock after 8 quarters in a VAR model using the generalised impulse response approach. Individual country estimates are given in Table A4. Details of the country groups are given in Table C2. Details on sample periods are given in Table C1.

5.2. Exchange rate risk

Exchange rate movements can reflect changes in economic fundamentals (i.e. changes in current and expected returns on currency holdings) or changes in the perceived risk of holding these currencies. Although the results do not suggest an obvious pattern between exchange rate volatility and inflation performance, it could be argued that a more volatile exchange risk premium, that is less related to movements in economic fundamentals (i.e. greater exchange rate noise), can make inflation control more difficult and therefore lead to more volatile inflation rates.

To test this hypothesis, the standard monetary model of exchange rate determination is employed. The model includes a money demand relation

$$m_t - p_t = \varphi y_t - \lambda i_t \tag{5.1}$$

a PPP condition

$$p_t = s_t + p_t^* \tag{5.2}$$

and a UIP condition adjusted for a time-varying risk premium

$$i_t = i_t^* + \mathrm{E}(s_{t+1} | \Theta_t) - s_t + \xi_t \tag{5.3}$$

where m_t is domestic money supply, 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 spot exchange rate (the domestic currency price of one unit of a basket of foreign currencies), ξ_t is the deviation from the simple UIP condition, and can be interpreted as a time-varying exchange rate risk premium that investors require to compensate for investing in domestic assets, and $\mathrm{E}(s_{t+1}\,|\Theta_t)$ denotes rational expectations of the one period ahead spot rate, conditional on the public information set Θ_t available at time t.

From (5.1)-(5.3), using the law of iterative expectations and imposing a no-bubble condition, the spot exchange rate can be written as

$$s_t = \sum_{j=0}^{\infty} \left(\frac{\lambda}{1+\lambda}\right)^j \mathrm{E}(f_{t+j}\,|\Theta_t) + \kappa_t \tag{5.4}$$

where f_t denotes the economic fundamentals

$$f_t = \left(\frac{1}{1+\lambda}\right)(m_t - \varphi y_t - p_t^* + \lambda i_t^*) \tag{5.5}$$

and κ_t, defined as *exchange rate risk*, is given as the expected present value of the risk premium ξ_t[7]

$$\kappa_t = \sum_{j=0}^{\infty} \left(\frac{\lambda}{1+\lambda}\right)^{j+1} \mathrm{E}(\xi_{t+j}\,|\Theta_t) \tag{5.6}$$

By defining

$$s_t^* = \sum_{j=0}^{\infty} \left(\frac{\lambda}{1+\lambda}\right)^j f_{t+j} \tag{5.7}$$

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

$$s_t = \mathrm{E}(s_t^*\,|\Theta_t) + \kappa_t \tag{5.8}$$

The assumption of rational expectations implies that

$$\mathrm{E}(s_t^*\,|\Theta_t) = s_t^* - v_t \tag{5.9}$$

where v_t is the rational expectations forecast error, which satisfies $\mathrm{E}(v_t\,|\Theta_t) = 0$. Inserting this into (5.8) gives

$$s_t - s_t^* = \kappa_t - v_t \tag{5.10}$$

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

$$\mathrm{proj}(s_t - s_t^*\,|\Upsilon_t) = \mathrm{proj}(\kappa_t\,|\Upsilon_t) = \widehat{\kappa}_t \tag{5.11}$$

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

[7] This definition of exchange rate risk is closely related to the definition of the "level" exchange rate risk premium in Obstfeld and Rogoff (2003).

$$\zeta_t = \text{proj}(\kappa_t \,|\Theta_t) - \text{proj}(\kappa_t \,|\Upsilon_t) = \kappa_t - \widehat{\kappa}_t \tag{5.12}$$

the following is obtained

$$\kappa_t = \widehat{\kappa}_t + \zeta_t \tag{5.13}$$

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

$$\sigma^2_\kappa = \sigma^2_{\widehat{\kappa}} + \sigma^2_\zeta \tag{5.14}$$

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

$$\sigma^2_{\widehat{\kappa}} \leq \sigma^2_\kappa \tag{5.15}$$

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 demand equation (5.1) for the period 1990-2005 (or 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 was 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 a median estimate of 0.12, which is 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. It is interesting, however, that the interest rate elasticities are about twice as high in the VSOEs and the EMEs (around 0.2) compared to the larger, developed countries.

Having obtained estimates of φ and λ, data for the fundamentals from equation (5.5) can be generated using the end-point approximation suggested by Shiller (1981)[8]

$$s^*_t = \sum_{j=0}^{T-t} \left(\frac{\lambda}{1+\lambda}\right)^j f_{t+j} + \left(\frac{\lambda}{1+\lambda}\right)^{T-t} s_T \tag{5.16}$$

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

[8] In some cases the terminal value of (5.16) tends to jump for the last few observations. To avoid this problem, data for 2006 and observations for what was available for 2007, plus artificial data was used to generate three further years of data. The artificial data was 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.

of s_t and f_t, using a Newey-West adjusted covariance matrix. This gives the lower bound estimate of σ_κ reported in the third column of Table 4. The median estimate is just under 12%, but is found to be higher in the VSOEs and the EMEs than in the larger developed countries, especially the EURO12 countries. Thus, even though no clear relation between exchange rate volatility and inflation performance of the different country groups is apparent, a clear pattern between inflation volatility and the variability of exchange rate risk emerges.

Finally, it is worth noting that the standard deviation of exchange rate risk in Table 4 is not 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 than σ_ξ as $\lambda > 1$ and as ξ_t tends to be very persistent (cf. Backus et al., 1993). To see this, assume that ξ_t follows a simple AR(1) process. In this case it is easy to show that (where ρ_ξ is the autoregressive coefficient)

$$\sigma_\kappa = \left(\frac{\lambda}{1+\lambda(1-\rho_\xi)}\right)\sigma_\xi \tag{5.17}$$

Backus et al. (1993), obtain a median estimate for the annualised standard deviation of the risk premium equal to 9.4% for the US dollar. Using the US estimate of λ equal to 1.7 and assuming that ρ_ξ equals 0.8 (a typical finding in Backus et al., 1993) gives σ_κ equal to 11.6%, identical to that found in Table A4. The more persistent the risk premium is or higher the interest rate semi-elasticity, the greater the difference between these two standard deviations. For example, Lithuania has the highest σ_κ according to Table A4. The estimate for λ for Lithuania is 4.2 which, again assuming $\rho_\xi = 0.8$, implies that σ_κ will be more than twice as large as σ_ξ. 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.

5.3. Exchange rate pass-through

Having estimated the variability of exchange rate risk, this sub-section analysis how exchange rate shocks are transmitted through to consumer price inflation, i.e. the degree of exchange rate pass-through. It seems reasonable to expect that countries with high degree of pass-through will 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 discussed in Section 4.2, 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 in conducting independent monetary policy.

The extent of this pass-through to inflation depends on the degree of pass-through from exchange rates to import prices. A number of recent studies suggest that the pass-through to import prices is incomplete, at least in the short to medium run (cf.

Campa and Goldberg, 2002). Several explanations for this imperfect pass-through to import prices have been suggested in the literature. Most focus on microeconomic explanations related to imperfect competition and the pricing strategies of firms, e.g. that firms price to market, in particular that they set prices in the currency of the importing country (local currency pricing), see Goldberg and Knutter (1997) for a survey of this literature.

These results also suggest that small, open economies tend to have a higher degree of import price pass-through as international producers are likely to pay less attention to pricing strategies in smaller markets and therefore simply price their exports in their own currency (producer currency pricing), therefore increasing exchange rate pass-through. This is supported by the findings in Campa and Goldberg (2002), who find a much lower pass-through to import prices in the US, consistent with a widespread use of local currency pricing for exporting goods to the US. Furthermore, small countries are more likely to have a more concentrated industrial composition and to produce more homogenous goods, therefore lowering the elasticity of substitution between domestic and foreign goods and, in turn, increasing the degree of import price pass-through. Finally, one would expect that in smaller countries, domestic financial markets offer fewer possibilities for financial hedging against currency movements which could otherwise reduce the effect of exchange rate movements on domestic prices.

The consumption basket includes domestically produced goods and imported goods. Consumer prices will therefore rise directly through the import share. Furthermore, rising import prices, following a currency depreciation, tend to shift demand towards domestic goods causing upward pressures on domestic resources and general inflation. An incomplete pass-through to import prices is therefore likely to translate into incomplete pass-through to consumer prices.[9]

The degree of pass-through to consumer prices may also depend on the monetary policy regime. In an influential paper, Taylor (2000) uses a model with staggered price setting and monopolistic competition to show how the degree of pass-through will increase if cost changes (e.g. due to exchange rate depreciation) are perceived to be more persistent, which usually coincides with higher and more volatile inflation. Devereux and Yetman (2002), in a model of endogenous frequency of price changes, and Devereux et al. (2004), in a model where firms endogenously decide which currency to list their export price in, reach similar conclusions: higher inflation leads to more frequent price changes and producer currency pricing, thus increasing the pass-through of exchange rate movements to consumer price inflation. Thus, exchange rate movements are less likely to affect the price of domestically produced goods and wages and, from there, consumer price inflation if inflation is low and stable. I will return to this issue in the next section, when discussing the role of monetary policy explaining the cross-country variation in inflation volatility.

To estimate the exchange rate pass-through, I use a VAR model that includes do-

[9] But even with a perfect import price pass-through, local distribution costs and different pricing strategies of foreign wholesalers and domestic retailers can lead to an imperfect pass-through to consumer prices (cf. Bacchetta and van Wincoop, 2003).

mestic and foreign inflation, exchange rate changes (annualised quarterly changes), the short-term interest rate and the output gap (deviations of output from its Hodrick-Prescott trend). The VAR is estimated for each country for the period 1985-2005 (or the sample period available) with the lag order chosen using the Akaike information criteria.[10] 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 are very similar). The fourth column of Table 4 reports the accumulated impulse responses of inflation after two years to a 1% shock to the exchange rate.[11] 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.[12] As can be seen from Table A4, the degree of pass-through ranges from almost zero in the US to as high as 0.8 and higher in Israel and Estonia. The median estimate is 0.2, suggesting that a 1% exchange rate depreciation causes consumer price inflation to rise approximately by 0.2% after two years, with about three-quarters of the shock appearing in the first year.

These results are consistent with the findings of other papers. For example, the median pass-through estimates for a sample of 20 OECD countries in Gagnon and Ihrig (2004) and a sample of 71 countries in Choudhri and Hakura (2006) equals 0.21 (taking a weighted average of the reported effect after one and five years to obtain a comparable two year effect), whereas Devereux and Yetman (2002) find a median estimate of 0.26 in a sample of 122 countries.

The estimated pass-through is found to be significantly higher in the VSOEs (0.34) than in the other country groups. Furthermore, pass-through seems to be much lower in the G6 countries (0.06), consistent with evidence from Calvo and Reinhart (2000), who obtain larger pass-through estimates for emerging countries compared to developed countries, and Choudhri et al. (2005) who obtain relatively low estimates for the G7 countries (excluding the US). Pass-through is therefore found to be significantly negatively correlated with GDP (rank correlation equal to -0.43) and positively correlated with openness (rank correlation equal to 0.44). It is also found to be positively correlated with inflation volatility (rank correlation equal to 0.43). Thus, small, open economy seem much more exposed to exchange rate fluctuations than the larger, closed ones.

[10] The VAR includes the indirect tax dummies used in estimation inflation persistence in equation (3.2) in addition to special 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).

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

[12] There are three exceptions where the impulse responses peak at shorter lags: They peak at impact in Korea and after one year in Lithuania and New Zealand. The peak effect is under 0.1 in all cases.

6. Interest rates and monetary policy

In the final analysis it will be the performance of monetary policy that determines the level and variability of inflation, although different country specific factors and shocks will influence how easy monetary policy attains its goal. Monetary policy can directly influence inflation variability by credibly anchoring inflation expectations and, doing that, reduce inflation volatility and persistence. See the discussion in Taylor (2000) and for empirical evidence see, for example, Corbo et al. (2001), Siklos (1989) and Kuttner and Posen (1999).

But there are other potential channels through which a more transparent and credible monetary policy can reduce inflation volatility. For example, empirical studies suggest that a more credible and transparent monetary policy has contributed to reducing economic instability, including output volatility (Corbo et al., 2001, Neumann and von Hagen, 2002, and Roberts, 2006) and exchange rate variability (Kuttner and Posen, 2000). There is also evidence that a firmer commitment to price stability has contributed to flattening the Phillips curve, therefore making inflation less responsive to output volatility (cf. Roberts, 2006, and Williams, 2006), and to relative price shocks, such as energy prices (cf. Hooker, 2002, and Neumann and von Hagen, 2002). As discussed in the previous section, there are also a number of studies suggesting that monetary policy plays a key role in determining the degree of exchange rate pass-through to consumer prices and that the decline in pass-through in the 1990s can mainly be contributed to a more transparent and credible monetary policy (cf. Choudhri and Hakura, 2006, Devereux and Yetman, 2002, Gagnon and Ihrig, 2004, and Taylor, 2000). Finally, monetary policy may contribute to reducing the inflation risk premium and, through that, other asset price risk premium, including the exchange rate risk premium (cf. Buraschi and Jiltsov, 2005), although an extensive literature surveyed by Froot and Thaler (1990) suggests that the exchange rate risk premium is in fact largely exogenous.

It is therefore clear that monetary policy shocks should play a key role in any comparison of inflation variability across country samples. To obtain an estimate of monetary policy predictability, a simple forward-looking monetary policy rule similar to that of Clarida et al. (2000) is estimated for each country

$$i_t = \gamma i_{t-1} + (1-\gamma)\left[(r^* + \pi^*) + \beta(\mathrm{E}(\pi_{t+1}\,|\Omega_t) - \pi^*) + \eta x_t\right] + \varepsilon_t \qquad (6.1)$$

where i_t is the short-term nominal interest rate, r^* is the equilibrium real interest rate, π_t is the inflation rate, π^* is the targeted inflation rate, x_t is the output gap (deviation of output from its Hodrick-Prescott trend), $\Omega_t \subseteq \Theta_t$ denotes the monetary policy maker's information set, and ε_t is a random shock to the interest rate. Woodford (2003) shows that a rule of this form represents an optimal monetary policy under plausible assumptions and a number of studies, such as Clarida et al. (2000), have found that such a rule characterises actual monetary policy in a number of countries quite well.

The random shock ε_t can be thought of as representing uncertainty in the monetary policy rule. It can be interpreted as capturing uncertainty about the type or preferences of the monetary authority but can also be thought of as a temporary shock to the monetary authority's inflation target. Similarly, it can also be interpreted as representing random shocks to the equilibrium real interest rate. A third interpretation, suggested by Orphanides et al. (2000), is that ε_t reflects measurement error in the output gap. Finally, ε_t could reflect mis-specification of the policy rule itself, for example if some variables are omitted from the policy rule. A potentially important targeting variable for many emerging market and small countries 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 (with rank correlation between the two measures very close to unity).

Equation (6.1) is estimated by instrumental variables, 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). The policy rule is estimated for the period 1995-2005, or the sample period available, with the standard deviation of the monetary policy shocks, ε_t, reported in the fourth column of Table 5. The median policy shock for the whole country sample is 0.5%, but the range is very large: from as low as 0.2% in countries such as Austria and Japan to more than 19% in Turkey (see Table A5). It is found to be similarly low in the large, developed countries and the VSOEs but is more than three times higher for the EMEs (three times higher excluding Turkey).

Table 5. Interest rates and monetary policy

Country group medians	Interest rate volatility	Interest rate forecast errors	Monetary policy shocks
All countries	1.3	0.9	0.5
EME	2.5	1.7	1.4
VSOE	1.2	1.0	0.6
EURO12	1.0	0.6	0.3
G6	1.0	0.5	0.4

Interest rate volatility is the standard deviation (in percentages) of the cyclical component of short-term interest rates. Interest rate forecast errors are standard deviations of one-quarter ahead forecast errors (in percentages) from a rolling-window VAR model. Monetary policy shocks are measured as the standard deviation (in percentages) of the residual from a forward-looking Taylor rule. Individual country estimates are given in Table A5. Details of the country groups are given in Table C2. Details on sample periods are given in Table C1.

Monetary policy therefore seems much less predictable in the EMEs than in the other country groups.[13] 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

[13]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.

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 discussed above.

Similar results are obtained when looking at the variability of the interest rate itself (second column of Table 5) or monetary policy predictability using the rolling-window VAR model described in Section 3.1 to obtain conditional one-quarter ahead forecast errors for the short-term interest rate (third column of Table 5).

7. Cross-country analysis

7.1. Basic results

In this section I try to explain the cross-country variation in inflation volatility (INFVOL) using a large menu of potential explanatory variables taken from previous sections. The explanatory variables are inflation persistence (PERS) from Table 1; GDP (SIZE), real per capita income (INC) and real output volatility (REAL) from Table 2; openness (OPEN), the correlation between domestic and world output (INTER), the correlation between private consumption and the exchange rate (CONS), trade diversification (DIVER) and the share of commodities in merchandise exports (COMM) from Table 3; the standard deviation of exchange rate risk (EXRISK) and exchange rate pass-through (PASS) from Table 4; and monetary policy shocks (POLICY) from Table 5. SIZE and INC enter in logarithms, while other variables are measured in decimals (i.e. INFVOL of 1% enters as 0.01).[14]

The results are reported in Table 6. I start with all the potential explanatory variables, deleting the least significant one in each step until left only with significant variables at the 5% level. The results indicate that the cross-country variation in inflation volatility is not significantly explained by variations in CONS, SIZE, INTER, PERS, REAL and DIVER, although, the effects of SIZE (lower INFVOL the larger the economy), PERS (lower INFVOL the lower is inflation persistence), REAL (lower INFVOL the less volatile the real economy is) and DIVER (lower INFVOL the greater trade diversification) are correctly signed. Interestingly, no significant effects of OPEN can be found, even though papers such as Romer (1993) and Bowdler and Malik (2005) find a significant negative relationship between inflation and inflation variability one the one hand and openness on the other. 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

[14] 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 log transformations gives very similar results.

that the negative relationship is mainly due to the highly indebted countries during the debt crisis of 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 effects of openness can be found in the country sample used here.

Table 6. Cross-country regression results for INFVOL

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	0.026	0.026	0.021	0.022	0.020	0.039	0.048	0.050	0.054	-0.006
	(0.4)	(0.4)	(0.4)	(0.5)	(0.4)	(1.0)	(1.3)	(1.3)	(1.4)	(0.8)
CONS	0.000									
	(0.0)									
log(SIZE)	-0.001	-0.001								
	(0.2)	(0.2)								
INTER	0.006	0.006	0.006							
	(0.3)	(0.3)	(0.3)							
OPEN	0.002	0.002	0.003	0.002						
	(0.2)	(0.2)	(0.4)	(0.3)						
PERS	0.011	0.011	0.010	0.012	0.011					
	(0.6)	(0.6)	(0.7)	(0.8)	(0.8)					
REAL	0.554	0.536	0.506	0.465	0.531	0.492				
	(0.6)	(0.7)	(0.7)	(0.7)	(0.9)	(0.8)				
DIVER	-0.041	-0.040	-0.036	-0.036	-0.035	-0.032	-0.021			
	(0.9)	(0.9)	(1.0)	(1.0)	(1.0)	(0.9)	(0.7)			
COMM	0.043	0.042	0.043	0.040	0.039	0.038	0.032	0.024		
	(1.7)	(1.8)	(1.8)	(1.8)	(1.9)	(1.8)	(1.7)	(1.6)		
log(INC)	-0.010	-0.010	-0.010	-0.010	-0.009	-0.012	-0.014	-0.016	-0.016	
	(0.7)	(0.8)	(0.8)	(0.8)	(0.8)	(1.2)	(1.4)	(1.7)	(1.6)	
EXRISK	0.129	0.130	0.132	0.129	0.130	0.115	0.121	0.111	0.125	0.174
	(1.9)	(2.0)	(2.1)	(2.1)	(2.2)	(2.1)	(2.2)	(2.1)	(2.4)	(4.0)
POLICY	0.712	0.712	0.708	0.706	0.701	0.696	0.728	0.709	0.701	0.774
	(4.9)	(5.0)	(5.1)	(5.2)	(5.3)	(5.3)	(5.8)	(5.9)	(5.7)	(6.6)
PASS	0.085	0.085	0.086	0.086	0.087	0.088	0.090	0.086	0.082	0.087
	(4.2)	(4.3)	(4.5)	(4.6)	(4.9)	(5.0)	(5.2)	(5.3)	(5.0)	(5.3)
R^2 (adj.)	0.729	0.738	0.746	0.754	0.761	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	-	0.968	0.989	0.990	0.996	0.980	0.969	0.972	0.855	0.849

Absolute t-values are in parentheses. The exclusion test is a F-test that tests for the exclusion of all the variables eliminated up to the given stage.

COMM is the next variable to be excluded, although its coefficient is not far from being significant from zero. In addition, the sign of the effect of COMM is as expected: the more commodity-based the economy is, the more volatile inflation tends to be. The final insignificant variable is INC, although again only marginally rejected. The coefficient sign is also as expected: the more developed the country is, the more stable inflation tends to be.

Having eliminated all the insignificant variables leaves me with three significant variables, all with t-values above 4: the volatility of exchange rate risk and monetary policy shocks and the extent of exchange rate pass-through to consumer price inflation. 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 0.75.

The impact of these three variables on inflation volatility is also quantitatively large. The point estimates in column (10) in Table 6 suggest, for example, that a one standard deviation decline in EXRISK from its sample mean (from 13.7% to 5.8%) decreases INFVOL by 0.3 standard deviations from its mean (from 4.8% to 3.4%). A similar decline in POLICY (from 1.2% to 0.5%) decreases INFVOL by 0.1 standard deviations (from 4.8% to 4.2%).[15] Finally, a one standard deviation decrease in PASS from its sample mean (from 0.23 to 0.03) decreases INFVOL by 0.4 standard deviations from its mean (from 4.8% to 3%).

It is also of interest to compare what the results imply for different country groups. The point estimates in column (10) imply a median value for INFVOL for the VSOEs equal to 5.5%, consistent with the actual value (excluding the missing country observation on Slovenia due to the lack of a PASS estimate as discussed before). The fitted value for the EMEs, however, underestimates inflation volatility: the point estimates imply a value of 5.9% but the actual median is 8.4% (excluding Slovenia). The opposite occurs for the large, developed countries: the fitted values for EURO12 and G6 are 2.8% and 2.1%, respectively, whereas the actual values are 1.7% in both cases. This could suggest that there are other additional factors explaining inflation volatility in the EMEs that are missing from this analysis and, by the same token, that there are some institutional features in the large, developed countries that have enabled them to stabilise inflation over and above what could be expected from the regression results reported in Table 6. One possible omitted variable that could explain this result is central bank independence, often found to be an important variable for explaining cross-country inflation performance. For example, according to the comprehensive analysis on central bank independence reported in Mahadeva and Sterne (2000), larger countries tend to have more independent central banks than smaller and less developed countries. For example, the G6 countries obtain a median score of 91 (out of 100) compared to 86 for the EMEs and 83 for the VSOEs. However, this variable is found to be statistically insignificant when added to the final estimates in column (10), with a p-value of 0.70 (with the other three variables still highly significant). Central bank independence does therefore not seem to contain any additional information on the cross-country variability of inflation volatility over and above the three final explanatory variables. Another possible omitted variable could be some measure 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 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.

[15] This excludes Turkey from the standard deviation of POLICY. If Turkey is included, the standard deviation of POLICY increases from 0.7% to 2.9%.

Finally, it is of interest to analyse what the high inflation volatility country groups, the VSOEs and the EMEs, are to gain by reducing the explanatory variables down to the values experienced by the large, developed countries. For example, by reducing the variability of exchange rate risk towards the median value for the EURO12 countries, the VSOEs could reduce INFVOL down from 5.5% to 4% and the EMEs from 5.9% to 4%. There is little to gain for the VSOEs in reducing the variability of monetary shocks to the EURO12 level (from 5.5% to 5.3%), but the EMEs could reduce it from 5.9% to 5.1%. Finally, if the VSOEs could reduce the pass-through of exchange rate shocks to consumer price inflation towards the median value for the EURO12 countries, they could reduce INFVOL from 5.5% to 4.5% but the reduction for the EMEs is minor (from 5.9% to 5.6%). Hence, both country groups can reduce the volatility of their inflation rate by reducing the variability of the exchange rate risk premium on their currency. There are additional gains for the VSOEs in reducing the exchange rate pass-through, while the EMEs have relatively more to gain in reducing to variability of their monetary policy shocks.

7.2. Robustness

As previously discussed, the results in Table 6 seem to overestimate inflation volatility in the larger, developed countries but underestimate inflation volatility in the EMEs. It is therefore of interest to analyse whether the results are sensitive to the inclusion of different country group dummies. Table B1 in Appendix B reports the results of adding different country group dummies to the regression of column (10) in Table 6. The results imply that the differences across these country groups are not statistically significant: the coefficients on the dummy variables are not significant from zero and the estimated relationship between inflation volatility and the three key explanatory variables basically remains unchanged.

Table B2 reports further robustness tests of the basic results. First, I find that the statistical inference of the OLS estimates in Table 6 is not sensitive to the possible existence of heteroscedasticity. Second, the results are not found to be sensitive to systematically excluding every country in the sample, each one at a time. The explanatory variables remain highly significant, except in the case of excluding Turkey (reported in the table), in which case the POLICY coefficient becomes less precisely estimated. As a further analysis of sensitivity of the results to the exact country sample and to possible outliers, Table B2 also includes estimation results from two robust estimators. Both estimates give essentially similar results to the OLS estimates, indicating that the results are not driven by few outliers in the country sample.

Finally, as discussed in Section 6, monetary policy should be the primary underlying factor explaining inflation variability through its effects on inflation expectations and its potential effects on some of the factors used here to explain inflation volatility. There is therefore a possibility that a reverse causality is explaining the regression results reported in Table 6. To address this possibility, the basic regression is re-estimated using instrumental variables (IV). Natural candidates for instruments are always hard to come by, but the variables included in Table 6 and different country group dummies from Table B1 that were found to have no significant effect on inflation volatility but are correlated with any of the three explanatory variables could be candidates. As described in Appendix B, the instruments chosen are OPEN, log(SIZE), DIVER, INTER and CONS, plus a EME country group dummy and a country group dummy for hard exchange rate peg countries (PEG). Using the approach suggested by Shea (1997) indicates that these 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. Tests for overall validity of the over-identifying restrictions on the model indicate that the instrument list is valid and the OLS and IV parameter estimates are very similar and an insignificant Durbin-Wu-Hausman test statistic suggests that there are no potential endogeneity problems affecting the consistency of the OLS estimates. Thus, there is no evidence of possible endogeneity of the explanatory variables with respect to inflation volatility being the source of the association reported in Table 6.

8. Conclusions

The economic and social costs of high and variable inflation are now almost universally accepted among the economic profession and the general public. High and variable inflation makes it difficult for households and firms to discern between changes in relative prices and general inflation and makes forecasting the future price level less precise, thus leading to inefficient investment decisions and allocation of funds with detrimental effects on the long-term growth potential of the economy. Furthermore, high and variable inflation also exaggerates social inequality and creates social tension between different income groups. These detrimental economic and social effects of inflation explain the overriding emphasis of modern central banking on maintaining a low and stable rate of inflation. It also shows why understanding the determinants of inflation volatility is so important.

Although inflation is in the long run a monetary phenomenon, there are many potential factors that can affect the ability of the monetary authorities in controlling inflation. Central banks are always faced with information and control problems and a fully credible precommitment to low and stable inflation remains difficult. The focus of this paper is to try to understand 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. Using a country sample of 42 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 size of monetary policy shocks. Exchange rate pass-through turns out to be especially important for explaining inflation volatility in very small, open economies, while the size of monetary policy shocks turns out to be especially important for explaining inflation volatility in emerging and developing countries. The volatility of currency risk premiums is an important explanatory variable for inflation volatility in both these country groups.

The results are found to be robust to inclusion of different country group dummies and to changes in the country sample. They are also robust to different estimation methods and, in particular, do not seem to arise because of reverse causality due to possible endogeneity of the explanatory variables.

There are several policy implications that can be drawn from the analysis. First, as a more transparent monetary policy reduces monetary policy shocks, it can reduce inflation variability directly by providing a firmer anchor for inflation expectations. Furthermore, there is growing evidence that a more credible and transparent monetary policy can reduce inflation volatility through indirect channels by reducing exchange rate volatility and the pass-through of exchange rate shocks to inflation. It is, however, likely that idiosyncratic supply shocks and small and relatively inefficient foreign exchange markets will continue to contribute to a larger and more volatile exchange rate risk premium in the small, open economies and the emerging and developing countries compared to the large and more developed ones. Inflation is therefore likely to remain somewhat more volatile in the former country groups, especially in those countries who maintain their own currency. Finally, the results may suggest that efforts in improving the functioning of the foreign exchange market, in an attempt to reduce the volatility of the exchange rate risk premium, may be more fruitful for stabilising inflation than direct attempts to reduce exchange rate volatility.

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Appendix A: Individual country estimates

Table A1. Inflation performance and properties

	Average inflation	Inflation persistence	Inflation volatility	Inflation forecast errors
Australia	3.8	0.37	3.2	2.7
Austria	2.2	0.70	1.5	1.4
Belgium	2.1	0.46	1.3	1.7
Canada	2.7	0.01	2.0	2.3
Chile	9.9	0.81	8.1	5.6
Cyprus	3.3	0.04	2.8	4.0
Czech Republic	9.1	0.39	11.6	3.4
Denmark	2.5	0.18	1.5	1.1
Estonia	10.8	0.13	12.0	5.7
Finland	2.4	0.60	2.1	1.6
France	2.1	0.21	1.2	1.2
Germany	1.9	0.73	1.7	1.3
Greece	9.3	0.61	6.5	2.7
Hong Kong	4.0	0.67	5.3	3.7
Hungary	13.7	0.80	8.6	3.3
Iceland	7.7	0.36	8.3	2.5
Ireland	3.0	0.51	1.6	1.7
Israel	8.9	0.31	7.6	5.7
Italy	3.9	0.57	1.8	1.0
Japan	0.6	0.45	1.8	1.6
Korea	4.5	0.36	3.1	5.4
Latvia	9.3	0.82	10.0	2.7
Lithuania	4.0	0.14	7.8	8.7
Luxembourg	2.1	0.58	1.6	2.1
Malta	2.8	0.02	2.2	2.7
Mexico	13.4	0.74	10.4	12.0
Netherlands	2.0	0.80	1.4	1.2
New Zealand	3.9	0.40	4.9	1.9
Norway	3.1	0.44	2.8	2.9
Poland	13.8	0.96	11.6	2.5
Portugal	5.9	0.58	3.9	1.5
Slovakia	7.7	0.48	5.0	9.7
Slovenia	6.4	0.28	3.6	2.3
South Africa	9.3	0.89	4.3	1.4
Spain	4.3	0.52	2.2	1.7
Sweden	2.4	0.47	3.2	2.9
Switzerland	1.8	0.66	1.8	1.3
Taiwan	1.9	0.12	3.0	3.3
Thailand	3.8	0.62	2.8	4.0
Turkey	44.2	0.57	20.4	14.7
United Kingdom	3.4	0.63	1.9	1.2
United States	3.0	0.34	1.4	1.4

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 persistence is obtained from an AR(k) model allowing for mean break of unknown date. Inflation forecast errors are standard deviations of one-quarter ahead forecast errors (in percentages) from a rolling-window VAR model.

Table A2. Size, development and output volatility

	Population	GDP	GDP per capita	Output volatility
Australia	20.3	666	32.9	1.1
Austria	8.2	280	34.1	0.9
Belgium	10.4	330	31.8	1.0
Canada	33.1	1,165	35.2	1.3
Chile	16.1	203	12.6	2.0
Cyprus	0.8	18	22.7	1.0
Czech Republic	10.2	221	21.6	2.4
Denmark	5.5	199	36.4	1.2
Estonia	1.3	26	19.6	2.3
Finland	5.2	172	32.8	2.2
France	62.8	1,871	29.8	0.8
Germany	82.4	2,585	31.4	1.2
Greece	10.7	252	23.5	1.9
Hong Kong	7.0	253	36.3	2.8
Hungary	10.0	173	17.3	2.4
Iceland	0.3	11	38.1	2.7
Ireland	4.1	177	43.6	2.3
Israel	6.4	166	26.2	2.2
Italy	58.1	1,727	29.7	0.9
Japan	127.5	4,220	33.1	1.2
Korea	49.0	1,180	24.1	2.4
Latvia	2.3	35	15.4	1.4
Lithuania	3.6	54	15.1	2.1
Luxembourg	0.5	33	67.9	1.9
Malta	0.4	8	20.3	2.4
Mexico	108.7	1,134	10.4	2.3
Netherlands	16.5	512	31.0	1.1
New Zealand	4.1	106	26.0	1.4
Norway	4.6	207	45.0	1.0
Poland	38.5	543	14.1	1.6
Portugal	10.6	203	19.1	0.9
Slovakia	5.4	96	17.7	1.6
Slovenia	2.0	46	22.9	0.7
South Africa	44.0	576	13.1	1.4
Spain	40.4	1,070	26.5	1.1
Sweden	9.0	285	31.6	1.3
Switzerland	7.5	253	33.6	1.1
Taiwan	22.9	668	29.2	1.5
Thailand	65.1	586	9.0	3.9
Turkey	70.4	627	8.9	3.6
United Kingdom	60.6	1,903	31.4	1.1
United States	298.4	12,980	43.5	0.9

GDP and per capita income are PPP adjusted. Population (in millions), GDP (in billion US dollars) and per capita income (in thousand US dollars) are 2006 data. Output volatility is the standard deviation (in percentages) of the output gap.

Table A3. Openness, exposure to external shocks and trade patterns

	Openness	Output correlation with the rest of the world	Consumption correlation with exchange rate	Trade diversi-fication	Commodity share of exports
Australia	37.8	0.50	-0.27	0.59	68.5
Austria	96.0	0.77	0.51	0.35	15.7
Belgium	153.5	0.43	0.06	0.35	18.8
Canada	80.5	0.64	-0.15	0.38	37.1
Chile	67.3	0.03	0.50	0.77	83.6
Cyprus	105.3	0.31	0.08	0.56	36.3
Czech Republic	179.3	0.31	-0.16	0.38	10.0
Denmark	94.0	0.36	-0.30	0.40	30.9
Estonia	200.9	0.00	-0.01	0.47	22.5
Finland	77.9	0.72	-0.71	0.52	14.9
France	57.3	0.75	0.15	0.28	17.9
Germany	72.4	0.35	0.13	0.28	9.5
Greece	56.2	0.25	-0.18	0.50	42.1
Hong Kong	302.6	0.17	0.11	0.52	3.1
Hungary	179.7	0.37	-0.34	0.38	11.2
Iceland	75.8	0.25	-0.61	0.79	79.8
Ireland	153.6	0.45	0.19	0.64	10.4
Israel	88.3	0.30	-0.23	0.61	4.4
Italy	51.7	0.64	-0.47	0.36	12.0
Japan	21.7	0.44	0.33	0.40	3.5
Korea	85.5	0.03	-0.71	0.43	9.1
Latvia	107.8	0.05	0.17	0.52	40.8
Lithuania	151.3	-0.25	0.22	0.53	43.8
Luxembourg	270.6	0.49	0.03	0.56	13.8
Malta	188.9	0.16	-0.23	0.64	4.1
Mexico	74.1	0.55	-0.75	0.40	22.6
Netherlands	148.9	0.65	0.02	0.37	31.7
New Zealand	65.1	0.08	-0.65	0.63	65.5
Norway	70.8	0.16	0.11	0.68	79.4
Poland	65.0	0.53	0.18	0.43	19.7
Portugal	71.8	0.43	0.51	0.39	16.7
Slovakia	171.0	-0.06	-0.38	0.45	15.8
Slovenia	130.0	0.62	-0.20	0.47	11.9
South Africa	53.3	0.49	-0.05	0.56	43.8
Spain	64.4	0.59	-0.52	0.34	22.1
Sweden	86.6	0.69	-0.22	0.37	15.5
Switzerland	87.3	0.77	0.28	0.55	6.3
Taiwan	106.4	0.39	0.51	0.16	8.8
Thailand	115.5	-0.04	-0.54	0.38	21.8
Turkey	82.7	0.16	-0.72	0.52	17.1
United Kingdom	55.0	0.37	-0.13	0.24	18.1
United States	25.8	0.29	0.00	0.25	14.7

The second column gives openness to international trade as the sum of exports and imports of goods and services as a percentage of GDP (average for 2000-2005). The third column reports the contemporaneous correlation between the domestic and world output gaps. The fourth column gives the contemporaneous correlation between the cyclical components of private consumption and the exchange rate. The fifth column reports a measure of trade diversification (2005 data). A higher index indicates an export base of relatively few goods. The final column gives primary commodities as a percentage of merchandise exports (2005 data).

Table A4. Exchange rate volatility and pass-through

	Exchange rate volatility	Volatility of exchange rate risk	Exchange rate pass-through
Australia	14.5	11.1	0.08
Austria	3.7	5.7	0.14
Belgium	4.7	5.5	0.20
Canada	9.2	13.4	0.03
Chile	17.5	22.0	0.18
Cyprus	2.4	13.9	0.05
Czech Republic	8.9	18.5	0.28
Denmark	5.6	7.7	0.16
Estonia	3.5	15.7	0.93
Finland	9.7	12.4	0.15
France	5.2	7.4	0.06
Germany	5.9	8.7	0.29
Greece	6.7	8.5	0.23
Hong Kong	9.1	6.0	0.23
Hungary	11.2	15.3	0.33
Iceland	11.0	18.5	0.43
Ireland	7.4	7.0	0.23
Israel	11.5	14.6	0.79
Italy	10.3	14.0	0.18
Japan	18.6	9.8	0.07
Korea	17.7	9.4	0.04
Latvia	7.8	30.5	0.31
Lithuania	10.2	41.5	0.06
Luxembourg	3.6	6.3	0.37
Malta	3.6	30.4	0.22
Mexico	28.1	14.8	0.67
Netherlands	4.2	5.7	0.41
New Zealand	12.3	11.2	0.02
Norway	7.5	7.8	0.18
Poland	15.7	27.4	0.45
Portugal	3.4	8.8	0.26
Slovakia	8.5	11.3	0.41
Slovenia	4.6	8.8	-
South Africa	20.4	14.9	0.11
Spain	7.0	6.4	0.03
Sweden	11.6	11.6	0.21
Switzerland	8.3	8.5	0.23
Taiwan	9.2	12.8	0.08
Thailand	20.2	23.7	0.18
Turkey	42.3	24.1	0.24
United Kingdom	10.4	11.5	0.04
United States	11.0	11.7	0.02

Exchange rate volatility is the standard deviation (in percentages) of annualised quarterly changes of effective exchange rates. Volatility of exchange rate risk (in percentages) is obtained from a signal extraction approach. Exchange rate pass-through is estimated as the cumulative effect of a 1% exchange rate shock after 8 quarters in a VAR model using the generalised impulse response approach.

Table A5. Interest rates and monetary policy

	Interest rate volatility	Interest rate forecast errors	Monetary policy shocks
Australia	1.6	0.7	0.3
Austria	0.8	0.2	0.2
Belgium	0.9	1.7	0.3
Canada	1.3	0.8	0.5
Chile	6.0	9.1	3.2
Cyprus	0.5	0.4	0.3
Czech Republic	1.7	0.5	0.5
Denmark	1.1	0.9	0.4
Estonia	2.2	1.7	1.9
Finland	1.4	0.8	0.3
France	0.9	0.6	0.5
Germany	0.8	0.3	0.3
Greece	1.2	1.3	1.0
Hong Kong	1.5	1.9	1.1
Hungary	2.9	0.6	0.6
Iceland	3.8	1.9	0.6
Ireland	2.1	1.7	0.5
Israel	3.3	1.7	1.6
Italy	1.2	0.8	0.4
Japan	0.8	0.3	0.2
Korea	2.0	3.0	2.0
Latvia	3.2	2.0	1.7
Lithuania	4.0	5.4	2.6
Luxembourg	0.9	0.5	0.3
Malta	0.3	0.2	0.2
Mexico	0.8	0.4	0.2
Netherlands	0.9	0.5	0.3
New Zealand	1.6	0.7	0.6
Norway	1.2	0.9	0.7
Poland	2.5	2.8	1.4
Portugal	1.5	0.4	0.3
Slovakia	3.9	4.1	2.2
Slovenia	1.2	1.0	0.9
South Africa	2.4	1.2	1.0
Spain	1.3	0.6	0.4
Sweden	1.3	1.0	0.4
Switzerland	1.1	0.5	0.3
Taiwan	1.3	1.1	0.5
Thailand	2.7	3.1	1.6
Turkey	29.3	46.3	19.2
United Kingdom	1.4	0.5	0.4
United States	1.1	0.5	0.4

Interest rate volatility is the standard deviation (in percentages) of the cyclical component of short-term interest rates. Interest rate forecast errors are standard deviations of one-quarter ahead forecast errors (in percentages) from a rolling-window VAR model. Monetary policy shocks are measured as the standard deviation (in percentages) of the residual from a forward-looking Taylor rule.

Appendix B: Robustness of cross-country results

Table B1 reports the results of adding country group dummies to the basic regression of column (10) in Table 6. The dummies included are for the original fifteen EU countries (EU15), the seven countries that had adopted inflation targeting by 1995 (IT95), the six countries, which according to the Reinhart and Rogoff (2004) de facto classification have followed a more or less free floating exchange rate regime throughout the sample period used here (FLOAT), the three countries who have had hard currency pegs (i.e. a currency board, have adopted another country's currency or are participants in a monetary union) for the whole of the sample period and therefore have no independent monetary policy (PEG), and the three countries which have experienced very high inflation rates within the sample period (HIGH), plus dummy variables for the EMEs, VSOEs, and the large, developed countries (EURO12 and G6). As discussed in the main text, none of the dummy variables are found to be statistically significant.

Table B1. Robustness to different country group dummies

Dummy variable added	Constant	EXRISK	POLICY	PASS	DUMMY	SE
EU15	-0.006	0.132	0.759	0.084	-0.014	0.020
	(0.8)	(2.7)	(6.7)	(5.3)	(1.9)	
EURO12	0.003	0.140	0.765	0.087	-0.013	0.020
	(0.3)	(2.9)	(6.6)	(5.4)	(1.6)	
IT95	-0.007	0.174	0.775	0.088	0.003	0.021
	(0.9)	(3.9)	(6.5)	(5.3)	(0.3)	
FLOAT	-0.008	0.176	0.777	0.089	0.004	0.021
	(0.9)	(4.0)	(6.5)	(5.1)	(0.4)	
EME	0.000	0.105	0.744	0.078	0.017	0.020
	(0.0)	(1.8)	(6.4)	(4.6)	(1.7)	
VSOE	-0.007	0.186	0.756	0.091	-0.008	0.021
	(1.0)	(4.0)	(6.3)	(5.3)	(0.8)	
G6	-0.003	0.169	0.764	0.083	-0.010	0.021
	(0.3)	(3.8)	(6.5)	(4.9)	(1.1)	
PEG	-0.006	0.175	0.773	0.087	0.000	0.021
	(0.8)	(3.8)	(6.5)	(4.8)	(0.0)	
HIGH	-0.003	0.164	0.649	0.077	0.028	0.020
	(0.4)	(3.8)	(4.9)	(4.6)	(1.8)	

Absolute t-values are in parentheses. Information on the different country groups can be found in Table C2 in Appendix C.

Table B2 reports further robustness tests of the basic results. The third 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.

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, each 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 fourth column of Table B2. In this case the coefficient on POLICY becomes less precisely estimated but the results are otherwise not affected.

Table B2. Further analysis of robustness

	Hetero-scedasticty consistent estimates	Excluding Turkey	LAD estimates	LTS estimates	IV estimates
Constant	-0.006	-0.006	-0.013	-0.020	-0.012
	(1.0)	(0.8)	(1.7)	(4.3)	(1.2)
EXRISK	0.174	0.171	0.225	0.317	0.180
	(3.3)	(3.3)	(5.4)	(7.8)	(2.4)
POLICY	0.774	0.857	0.717	0.804	0.989
	(12.6)	(1.6)	(5.9)	(2.3)	(3.2)
PASS	0.087	0.087	0.088	0.061	0.097
	(6.1)	(5.1)	(5.2)	(6.0)	(2.9)
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

Absolute t-values are in parentheses. The third column adjusts for possible heteroscedasticity using White's heteroscedasticity adjustment for the standard errors of the final estimate. The fourth column excludes Turkey from the country sample. The fifth and sixth columns report two robust estimates: the least absolute deviations (LAD) estimates and the least trimmed squares (LTS) estimates. The seventh column gives the instrumental variables (IV) estimates using OPEN, log(SIZE), DIVER, INTER, CONS, EME and PEG 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 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 32 observations to estimate the model. As can be seen in the fifth and sixth columns of Table B2, the results are essentially similar to 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 (IV). 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 exchange rate risk tends to be, consistent with predictions from the standard optimal currency literature. The EME dummy variable 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, the PEG and EME dummies seem valid instruments for PASS. The three countries included in the PEG dummy (Estonia, Hong Kong and Luxembourg) are all extremely open economies and the 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. In addition, SIZE and DIVER are added as instruments 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 a 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: Different sample periods and country groups

Table C1. Different sample periods

Inflation performance and properties
Sample period: 1985-2005, except:
Czech Republic (1989), Estonia (1993), Israel (1986), Lativa (1993), Lithuania (1995), Mexico (1989), Poland, (1992), Slovakia (1993) and Slovenia (1995)

Rolling-window VAR model
Estimation period: whole sample period, except:
Cyprus (1995), Czech Republic (1995), Estonia (1996), Hungary (1995), Lativa (1995), Lithuania (1995), Malta (1993), Poland, (1995), Portugal (1995), Slovakia (1994), Slovenia (1998), Thailand (1993) and Turkey (1993)

Forecast period: 1995-2005, except:
Cyprus (1998), Czech Republic (1998), Estonia (1999), Hungary (1998), Lativa (1998), Lithuania (1998), Malta (1996), Poland, (1998), Portugal (1998), Slovakia (1997), Slovenia (2001), Thailand (1996) and Turkey (1996)

Real output volatility and output correlation with rest of the world
Sample period: 1985-2005, except:
Austria (1988), Chile (1986), Cyprus (1995), Czech Republic (1990), Estonia (1993), Latvia (1995), Lithuania (1995), Malta (1990), New Zealand (1987), Poland (1990), Portugal (1995), Slovakia (1993), Slovenia (1995), Thailand (1993) and Turkey (1987)

Consumption correlation with exchange rate
Sample period: 1985-2005, except:
Austria (1988), Chile (1996), Cyprus (1995), Czech Republic (1994), Estonia (1994), Hungary (1995), Israel (1986), Latvia (1995), Lithuania (1995), Luxembourg (1995), Malta (1990), New Zealand (1987), Poland (1995), Portugal (1995), Slovakia (1994), Slovenia (1995), Thailand (1993) and Turkey (1987)

Interest rate volatility
Sample period: 1985-2005, except:
Cyprus (1993), Czech Republic (1993), Estonia (1996), Hungary (1987), Iceland (1988), Israel (1986), Latvia (1993), Lithuania (1994), Malta (1993), Poland (1992), Slovakia (1994), Slovenia (1998) and Turkey (1993)

Monetary policy shocks
Estimation period: 1995-2005, except:
Cyprus (1996), Estonia (1997), Latvia (1996), Lithuania (1996), Portugal (1996) and Slovenia (1999)

Exchange rate volatility
Sample period: 1985-2005, except:
Cyprus (1994), Czech Republic (1991), Estonia (1994), Israel (1986), Latvia (1994), Lithuania (1994), Malta (1990), Slovakia (1994) and Slovenia (1994)

Money demand equation/exchange rate risk premium (if different)
Estimation period: 1990-2005, except:
Cyprus (1995/1996), Czech Republic (1993), Estonia (1996/1995), Greece (1994/1990), Latvia (1995/1996), Lithuania (1995/1996), Malta (1993), Poland (1992), Portugal (1995/1996), Slovakia (2001/1995), Slovenia (1998/1996) and Thailand (1994)

Exchange rate pass-through
Estimation period: 1985-2005, except:
Austria (1988), Cyprus (1995), Czech Republic (1993), Estonia (1996), Hungary (1987), Iceland (1988), Israel (1987), Latvia (1995), Lithuania (1998), Malta (1994), Mexico (1989), Poland (1992), Portugal (1997), Slovakia (1994), Thailand (1993) and Turkey (1995)

Table C2. Different country groups

Country dummies	Description	Countries
EU15	15 original EU members	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom
EURO12	12 original euro members	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain
IT95	7 countries which had adopted inflation targeting by 1995	Australia, Canada, Chile, Israel, New Zealand, Sweden, United Kingdom
FLOAT	6 countries which have followed a more or less free floating regime throughout the sample period	Australia, Canada, Japan, New Zealand, Switzerland, United Sates
EME	Emerging and developing countries	Chile, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Mexico, Poland, Slovakia, Slovenia, South Africa, Thailand, Turkey
VSOE	Very small open economies	Cyprus, Estonia, Iceland, Latvia, Luxembourg, Malta, Slovenia
G6	6 largest countries	France, Germany, Italy, Japan, United Kingdom, United States
PEG	Countries which have had a hard peg throughout the sample	Estonia, Hong Kong, Luxembourg
HIGH	Countries with very high inflation for a significant period in the sample	Mexico, Poland, Turkey

Appendix D: Data sources and description

Structural data

Population, 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.