Evolving International Inflation Dynamics: World and Country Specific Factors*

Haroon Mumtaz
Bank of England

Paolo Surico
Bank of England
University of Bari

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Abstract

Inflation in the most industrialized economies of the world has an important international common component that accounts for the historical decline in the national rates. Country specific conditions explain the rise in inflation volatility of the late 1970s and early 1980s, and the subsequent fall. During the last decade, the world contribution to the variance of inflation has become increasingly more important than national contributions. Monetary policy was a relevant source of country specific fluctuations. Our conclusions are based on a time-varying dynamic factor model applied to a large panel of inflation indicators.

JEL classification: E30, E52.

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1 Introduction

Many industrialized countries around the world have shared a similar inflation experience over the last thirty years. Inflation was typically high and volatile during the second half of the 1970s and the first half of the 1980s but low and stable in the most recent period. This pattern is apparent in Figure 1, which plots the inflation rates of 13 developed economies. Two features of the graph are worth emphasizing. First, national inflation rates move together for most of the sample. Second, the years that extend from 1975 to 1987 are fairly different from the rest of the sample. Figure 1 suggests a few questions. What are the common features of movements in national inflation rates? And, how have the contributions of the common features evolved over time?

These questions are important in that alternative interpretations of events carry different policy implications. If the rise and fall in the level and volatility of inflation is the result of a common world feature, then national policy makers would have an incentive to focus on global developments and the world economy might benefit from international policy coordination. On the other hand, if country specific economic policies are responsible for the large volatility of the 1970s and the beginning of the 1980s, then inspecting the policy decision process and the design of national institutions could reveal helpful insights to prevent repeating the mistakes of the past.

This paper decomposes movements in national inflation rates into world and country specific features. Using a dynamic factor model with time-varying coefficients and stochastic volatility, we find that an international common factor explains the historical decline in the level of inflation for the G7, Australia, New Zealand and Spain. Furthermore, the fraction of U.K. and U.S. inflation variability due to a world common factor is today as large as it was during the first oil price surge in 1974 despite the fact that the level of inflation is now about 4-5 times smaller. National conditions, on the other hand, account for the large volatility of the late 1970s and early 1980s.

To interpret further our results, we regress the factors and the fractions of inflation variance explained by world and country specific features on a number of macroeconomic variables including measures of globalization and domestic monetary policy activism. We find that trade openness and the response of the interest rate to inflation have strong negative correlations with the world factor.

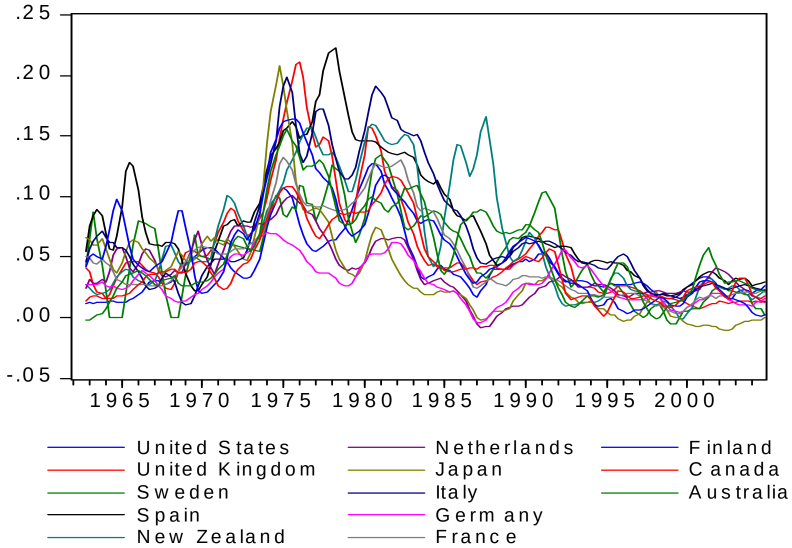

Figure 1: Figure 1: Inflation in 13 Developed Economies

Monetary policy also accounts for the contribution of the national factors to inflation volatility. International common features other than monetary policy explain the contribution of the world factor to the variance of inflation. International comovements are more important for explaining the variance when output growth is strong, whereas country specific characteristics are dominant when output growth is weak.

A large empirical literature surveyed by Bernanke (2004) investigated the relative contributions of good luck and good policy to the fall in inflation volatility. According to the good luck interpretation, smaller macroeconomic shocks are behind the inflation stability observed since the end of the 1980s. Advocates of the good policy hypothesis interpret the reduction in the variance of inflation as the result of improved monetary policy management.

The good luck-good policy debate has been studied so far at national level. And, most of the international evidence is simply based on comparing the experiences of different countries (see Canova, Gambetti and Pappa, 2006, and Borio and Filardo, 2006). To the best of our knowledge, no paper has yet attempted to identify jointly the temporal evolution of world and country specific contributions to movements in national inflation rates.

Our work is related to two important strands of the empirical literature. The first strand builds upon the methods developed by Stock and Watson (1998) and Forni, Hallin, Lippi and Reichlin (2001), and employs *fixed coefficient* factor models to study the international comovements of macroeconomic variables (see Kose, Otrok and Whiteman, 2003, for real activity, and Ciccarelli and Mojon, 2005, for inflation).

The second strand uses small-scale VAR models to show that time-varying coefficients and stochastic volatility are important features of inflation dynamics in a number of industrialized countries (see Cogley and Sargent, 2005, Canova and Gambetti, 2005, and Benati and Mumtaz, 2006).

Our work links the literatures on fixed coefficient factor models and time-varying VARs by introducing time variation in a panel of 164 inflation indicators for the G7, Australia, New Zealand and Spain. In so doing, we characterize the temporal evolution of both international and national common features of inflation.

The paper is organized as follows. Section 2 presents the empirical model and the international panel of data. Section 3 describes the evolution of world and country contributions to movements in national inflation rates. A variance decomposition analysis allows us to assess the relative importance of the factors over time and across countries. Section 4 relates the factors and the patterns of variance decomposition to monetary policy, trade openness and other features of the national economies. The Appendix provides details on the estimation technique and further empirical results.

2 Modelling Global Inflation

This section describes the empirical model, the strategy for identifying world and country specific common features, and the estimation procedure. The idea is that *movements* in inflation are effectively described by a few factors and that these factors reflect national and international *comovements*. The geographic characteristics of the comovements are unobserved but they can be inferred via the factor loadings. In particular, an international feature is common to the inflation series of all countries while a national feature is only common to the inflation series of a single country. A number of recent contributions including

Cogley and Sargent (2005) and Canova and Gambetti (2005) suggest that the inflation process may have significantly changed over time: we are interested in assessing the relative contributions of international and national factors to any possible time variation.

2.1 The Empirical Model

Each national inflation series, $\pi_{i,t}$, is described by the following model:

$$\pi_{i,t} = \beta_i^c F_t^c + \beta_i^w F_t^w + \varepsilon_{i,t} \tag{1}$$

where F_t^c denotes a country specific factor, while F_t^w is a world factor with the associated factor loadings denoted by β_i^c and β_i^w.

The two factors are assumed to follow autoregressive processes of order (p):

$$F_t^j = \alpha_t^j + \sum_{k=1}^{P} \rho_{k,t}^j F_{t-k}^j + v_t^j \tag{2}$$

where $j = \{c, w\}$. The coefficients in the AR model, $\Phi_t^j = \left[\alpha_t^j, \rho_{k,t}^j\right]$, are time varying and evolve as random walks

$$\Phi_t^j = \Phi_{t-1}^j + \eta_t^j \tag{3}$$

In addition, we assume that $E\left(v_t^j\right)^2 = \Sigma_t^j$ evolve as geometric random walks

$$\ln\left(\Sigma_t^j\right) = \ln\left(\Sigma_{t-1}^j\right) + \mu_t^j \tag{4}$$

Finally, the vector $[\varepsilon_t^j, \eta_t^j, \mu_t^j]'$ is distributed as

$$\begin{bmatrix} \varepsilon_t^j \\ \eta_t^j \\ \mu_t^j \end{bmatrix} \sim N(0, V), \text{ with } V = \begin{bmatrix} R & 0 & 0 \\ 0 & Q & 0 \\ 0 & 0 & G \end{bmatrix} \tag{5}$$

2.2 Identification

For notational convenience, we rewrite equation (1) as:

$$\pi_{i,t} = \beta F_t + \varepsilon_{i,t} \tag{6}$$

where $F_t = [F_t^c; F_t^w]$. The country and the world factors are identified by the structure of the factor loading matrix. We label 'world factor' the unobserved component that is loaded by all variables in the panel. We label 'country specific factors' the unobserved components that are exclusively loaded by the variables of each individual countries. This implies that, in addition to the world factor, we estimate as many factors as the number of nations. The matrix of factor loading has the following structure:

$$\beta = \begin{pmatrix} \beta_1^{country1} & 0 & 0 & 0 & \beta_1^{world} \\ . & 0 & 0 & 0 & . \\ \beta_{g1}^{country1} & 0 & 0 & 0 & \beta_{g1}^{world} \\ 0 & \beta_1^{country2} & 0 & 0 & \beta_{g1+1}^{world} \\ 0 & . & 0 & 0 & . \\ 0 & \beta_{g2}^{country2} & 0 & 0 & . \\ 0 & 0 & \beta_i^{countryJ} & 0 & . \\ 0 & 0 & 0 & \beta_1^{countryN} & . \\ 0 & 0 & 0 & . & . \\ 0 & 0 & 0 & \beta_{gN}^{countryN} & \beta_{g1+..+gN}^{world} \end{pmatrix}$$

This model is subject to the rotational indeterminacy problem. For any $k \times k$ orthogonal matrix P, there is an equivalent specification such that the rotations $F_t^* = PF_t$ and $\beta^* = \beta P'$ produce the same distribution for $\pi_{i,t}$ as in the original factor model (6). The implication is that the sign of the factor loadings and the sign of the factors are not separately identified. Following, Geweke and Zhou (1996) and Bernanke, Boivin, Eliasz (2005), we impose further restrictions on the factor loadings. In particular, for each country we require the first $k \times k$ block of the factor loadings to be an identity matrix, where k denotes the number of factors per country.

2.3 Sources of Time Variation

The autoregressive process of the factors is modelled as time-varying. The factor loadings, in contrast, are fixed. Allowing for time variation in the factor autoregressive coefficients, the factor variances, the factor loadings and the variance of the idiosyncratic component simultaneously would greatly inflate the number of parameters in the model and thus substantially increase the computational burden. A feasible alternative to the specification used in this paper is a fixed model for the factors but time-varying factor loadings (see Otrok and Del Negro, 2005).

In the current application, we do not consider such an alternative model for two reasons. Firstly, a fixed coefficient factor model implies time-invariant inflation dynamics for each country in the panel. Recent empirical evidence, however, questions this assumption (see, for instance, Cogley and Sargent, 2005, and Canova and Gambetti, 2005). Second, even with a time invariant AR process for the factors, the model with time-varying factor loadings involves substantially more computation, with N passes through the Kalman filter and smoother at each iteration of the Gibbs sampler.

2.4 Estimation

The model in equations (1) to (5) is estimated using the Bayesian methods described by Kim and Nelson (2000). In particular, we employ a Gibbs sampling algorithm that approximates the posterior distribution. As the number of parameters to be estimated in the model is large, we use fairly tight priors on some elements of the parameter vector. A detailed description of the prior distributions and the sampling method is given in Appendix A. Here we summarise the basic algorithm in four steps:

1. Conditional on a draw for the factors, we simulate the AR parameters and hyperparameters

    - The AR coefficients Φ_t^j are simulated by using the methods described in Carter and Kohn (2000). Note that we only retain draws with roots inside the unit circle.
    - The volatilities of the shocks to the factor equations, Σ_t^j, are drawn using the date by date blocking scheme introduced by Jacquier, Polson and Rossi (2004).
    - The hyperparameters Q are drawn from an inverse Wishart distribution while the elements of G are simulated from an inverse gamma distribution.

2. Conditional on a draw of the factors, we draw the factor loadings (β) and the covariance matrix R.

    - Given data on F_t^j and $\pi_{i,t}$, standard results for regression models can be used, and the coefficients and the variances are simulated from a normal and inverse gamma distribution.

3. Simulate the factors conditional on all the other parameters

    - This step is carried out in a straightforward way by employing the procedures described by Bernanke, Boivin and Eliasz (2005), and Kim and Nelson (2000).

4. Go to step 1.

We use 24000 Gibbs sampling replications and discard the first 20000 as burn-in. We assess convergence by examining the variation of the posterior moments across the retained draws. In particular, we compare the posterior estimates calculated over subsets of the 4000 draws. The results from this exercise, available upon request, show that the estimates are virtually identical across the subsamples indicating convergence to the ergodic distribution.

2.5 Data

The panel includes 164 quarterly series of prices for 13 countries: United Kingdom, United States, Sweden, Spain, Netherlands, New Zealand, Japan, Italy, Germany, France, Finland, Canada and Australia. The full sample is 1961:1-2004:3 and we use the first twelve years of data to calibrate the priors. Data are seasonally adjusted and standardized. CPI inflation, which is available for each country, is the variable that we choose to explain. Appendix B provides a detailed description of the series. For the sake of exposition, we report results for selected countries. In particular, we do not present results for Sweden where only two series are available over the full-sample. The findings for France and Netherlands are similar to those for Germany and for Italy to Spain. We hence report results for Germany and Spain, and make those for Finland, France, Netherlands and Italy available upon request.

3 Results

This section presents the results of the empirical model and disentangles geographically the sources of movements in inflation. In particular, we construct world and country 'indicators' for measuring the goodness of fit, and we decompose the variance of inflation into national and international contributions.

Appendix C reports the world and country factors, and the world indicators for each country.[1]

3.1 World and Country Indicators

The country indicators are constructed as the product of the country factor and the corresponding factor loading for CPI inflation. Similarly, the world indicators are constructed as the product of the world factor and the corresponding factor loading for each national CPI inflation. In particular, we compute 8 country indicators, which are reported in figure 1, and 8 world indicators, which are reported in Appendix C. The bottom-right chart of Figure 1 summarizes the information contained in the international factor by plotting, at each point in time, the average value of the world indicators across all countries. The dark lines are median values and red lines represent the central 68th posterior bands.

The indicators represent a measure of fit that can be used to assess the explanatory power of the world and country factors for national inflation. A number of interesting results emerge from this analysis. The loadings of the international factor for CPI inflation are very similar across countries (see Appendix C). An interpretation of this result is that the world factor drives the *level* of the national rates: when the world factor increases by $x\%$, inflation increases by the same amount in all countries.[2] The decline in the international factor is consistent with the notion of *global disinflation* put forward by Rogoff (2003).

Figure 1 reveals that the world indicator is more persistent than the country indicators. Indeed, the panel in the bottom right corner shows that the world factor is statistically significant over the full sample, having a positive contribution to national inflation rates before 1985 and a negative contribution after.

[1] A few countries including U.K., U.S., New Zealand, Japan and Canada are more represented than others in terms of number of series. To make sure that the over-representation does not affect our results, we also estimate a *balanced* panel made up of 7 series per country. The results using the smaller panel are similar to those obtained with the full panel, though the world and country factors are less precisely estimated. Our analysis will hence be based on the full panel.

[2] In the macrofinance literature, analogously, the factor that is loaded with similar weights by yields of different maturities is referred to as 'the level of the yield curve'.

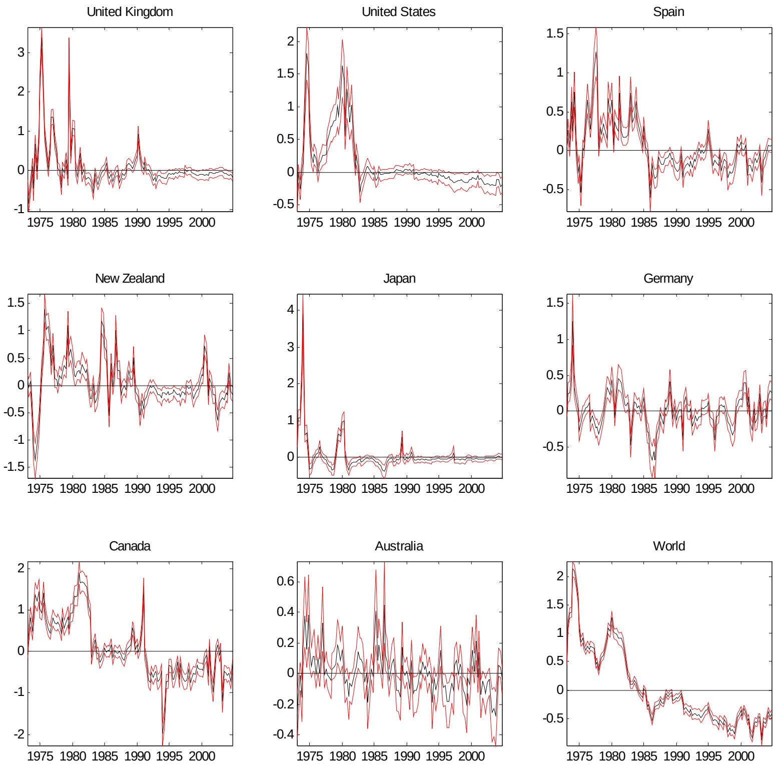

Figure 2: World and Country Indicators

The first peak in the world factor coincides with the oil price increase in 1974 and appears to be statistically and economically more important than the second peak at the end of 1979. The correlation between the oil price change and the world factor one year later is 0.43. Excluding the oil price shock in 1973 and the subsequent inflation rise in 1974, however, reduces the correlation to only 0.04.[3] This implies that the world factor captures other international common features beyond oil price.[4] We assessed the robustness of our results to alternative specifications of the model and found no significant evidence for a second world factor.

Turning to the country indicators, we identify differences and similarities across nations. Domestic factors were more volatile during the 1970s and the beginning of the 1980s and had explanatory power for national inflation in a few historical periods typically concentrated at the beginning of the sample.

For the U.K., the first two peaks corresponded to the breakdown of income policies over the years 1975-1977. Various national factors contributed to the rise in UK inflation in 1979-1980: another breakdown of income policies, high pay awards in the public sector including those coming from the Clegg Commission and the increase in V.A.T. from 8% to 15%. Subsequently, a strong exchange rate, a sharp slowdown in economic activity, and the macroeconomic discipline implied by the Medium-Term Financial Strategy helped to reverse the rise. The last significant peak occurred in 1990, and was followed by a sizable decline in inflation and economic activity during the UK membership of the ERM. Since the introduction of the inflation targeting framework at the end of 1992, country specific conditions have no longer fed into higher inflation.

The relevant episodes for the U.S. occurred in 1974 and during the period 1978-1982 which includes the experiment of non-borrowed reserve targeting of the newly appointed Fed Chairman Paul Volcker. Country specific conditions appear important for Spain until 1985 and for New Zealand until 1989 when explicit targets for inflation were agreed in the Reserve Bank Act. National factors contributed to movements in inflation during 1973 and around 1980 in Japan and Germany. Lastly, while the country indicator for Canada was important over most of the sample with the exception of the second half of the 1980s, for Australia domestic conditions had little influence on inflation.

[3] The measure of oil price is the IMF synthetic Brent crude oil series.

[4] A similar result for output can be found in Kose, Otrok and Whiteman (2003).

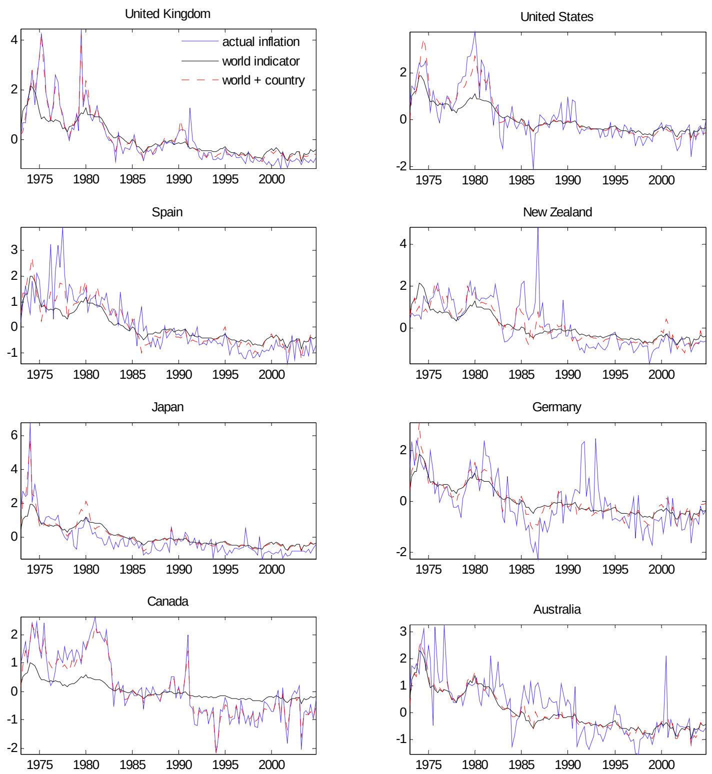

Figure 3: Actual Inflation and Indicators

A simple way to evaluate the contribution of country indicators is presented in Figure 2. Following Canova, Ciccarelli and Ortega (2005), for each country we plot the median values of the world indicator (in dark) together with the sum of the world and the country indicators (in dotted red), and actual inflation (in blue). Sizable differences between the dark and red lines identify periods in which domestic conditions matter.

National and international factors track CPI inflation remarkably well. Country indicators are important determinants of national inflation during the second half of the 1970s and the first years of the 1980s, consistently with the conventional wisdom that national income policies were insufficient to achieve durable control of inflation in the U.K., Spain, Germany and New Zealand.

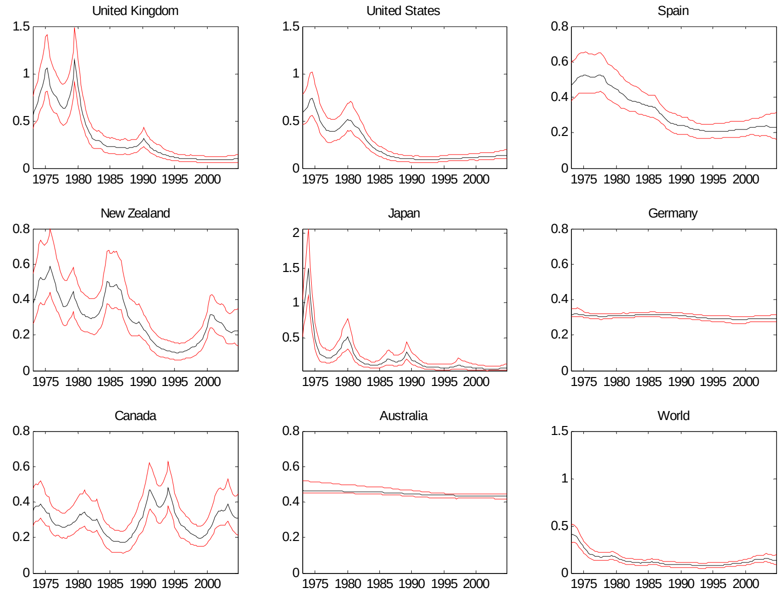

Figure 4: Factor Stochastic Volatilities

Except for Canada and Japan, the inflation peaks in 1974 are typically associated with small gaps between dark and red lines, implying that a worldwide event, such as the first oil price shock, was behind the rise in inflation. The second peak in U.S. inflation is mainly country specific; similarly, the pick up in U.K. inflation at the beginning of the 1990s is shared by no other country. Canada and Australia represent two extremes, with inflation in the former mainly driven by domestic conditions and in the latter by the world factor. During the last two decades the difference between world indicators (dark line) and the sum of world and country indicators (red line) virtually disappear in all countries but Canada.

Country specific conditions may be important for explaining the variance of inflation. Figure 3 plots the stochastic volatility of world and country factors. Country characteristics are associated with far larger volatilities than the international common feature. National innovation variances matter during the 1970s and the beginning of the 1980s for all countries but Germany and Australia. The decline is particularly pronounced for the U.K., U.S. and Japan.

The stochastic volatility of the world factor, in contrast, displays smaller magnitude and time variation. Until the mid-1980s national conditions were relatively more important than the world factor for the variance of inflation. During the last two decades, however, international elements have outweighed domestic sources of volatility.

3.2 The Evolution of Variance Decomposition

This section identifies the relative contributions of world and country factors using variance decomposition. To take into account both time-varying coefficients and stochastic volatility in the factor equations, at each point in time we compute the integral of the spectral density of national and international common features using the parametric estimate of the population spectrum (see Hamilton, 1994, Section 6.1). Figure 4 plots the fraction of inflation variance explained by the domestic factor in each country.

Significant declines in the relative importance of the country factors are apparent for the U.K., the U.S., New Zealand, Japan, and to a lesser extent Spain. Country specific considerations were the dominant sources of variation in U.K. inflation during the 1970s and at the beginning of the 1990s. The fraction of variance explained by domestic conditions moved from values around 70% between 1975 and 1980 to values around 34% in the period 1981-1992. The average contribution over the last decade is just below 7%.

In the U.S., domestic factors accounted for the bulk of inflation fluctuations during the 1970s and at the beginning of the 1980s. The most significant decline in the share of variance accounted for by national conditions occurred in 1983 and coincided with the end of Volcker's experiment of non-borrowed reserve targeting (see Goodfriend, 1993). The contribution of national features declined from an average of 42% before 1983 to 6% after.

In Spain, small variations characterized the pattern of variance decomposition with the highest national contribution associated with the income policies of the 1970s and mid-1980s. A similar picture emerges for New Zealand where the most notable decline occurred around the end of the 1980s. It is interesting to notice that explicit inflation targets began to be announced in 1989. The

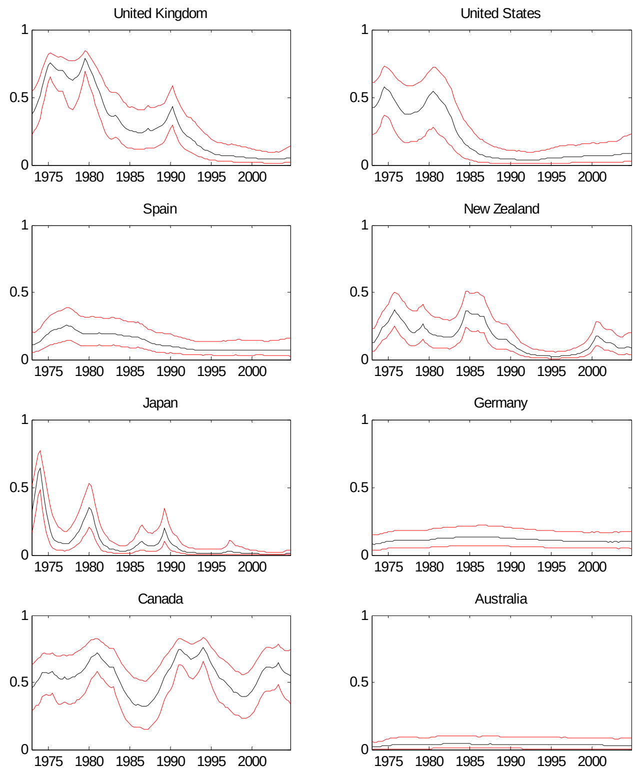

Figure 5: Variance Decomposition: Country Contributions

dating of domestic contributions for Japan accords with conventional wisdom: 1980 was an important year for the liberalization of financial markets; 1990 was associated with the bursting of the asset price bubble. The Russian default in 1997 and the Bank of Japan independence granted in 1998 do not seem to have affected the variance of inflation.

The picture for Germany contrasts with those for the other countries in that it reveals a remarkable stability in the domestic contribution to inflation over the entire sample. Interestingly, these years were characterized by rigorous national policies. The results for Canada are less clear cut in that no obvious tendency emerges over time. And, the national factor explains, on average, more than 50% of fluctuations. In Australia, domestic conditions seem to have little impact on the variance of inflation. It is worth emphasizing that the decline in the fraction of variance accounted for by country factors coincided with the decline in the volatility of inflation documented by several authors including Cogley and Sargent (2005) for the U.S., and Benati and Mumtaz (2006) for the U.K..

Figure 5 shows the relative contribution of the world factor to the volatility of national inflation rates. In most countries, the evolution of variance decomposition is U-shaped and the largest fractions, just under 50%, are associated with the oil price increase in 1974. The second half of the 1970s was a period of significant decline in the volatility accounted for by international conditions. The fall of explained variance at the beginning of the 1980s is less pronounced and during the period 1985-1994 the fraction accounted for by the world component reached its lowest historical levels around 5%.

A feature common to most countries is that since 1995 international factors have become quantitatively more important relative to the past. In particular, today, world conditions explain a fraction of variance of U.K. and U.S. inflation that is as high as the share explained in 1974. Furthermore, a comparison with the results for the country contributions reveals that over the last decade international factors have accounted for an increasingly larger share of inflation variation than have national factors. In this sense, inflation has become a more global phenomenon.

It is worth to note that while the falls in volatility are broadly concentrated around the middle of the sample, they are not synchronized across nations,

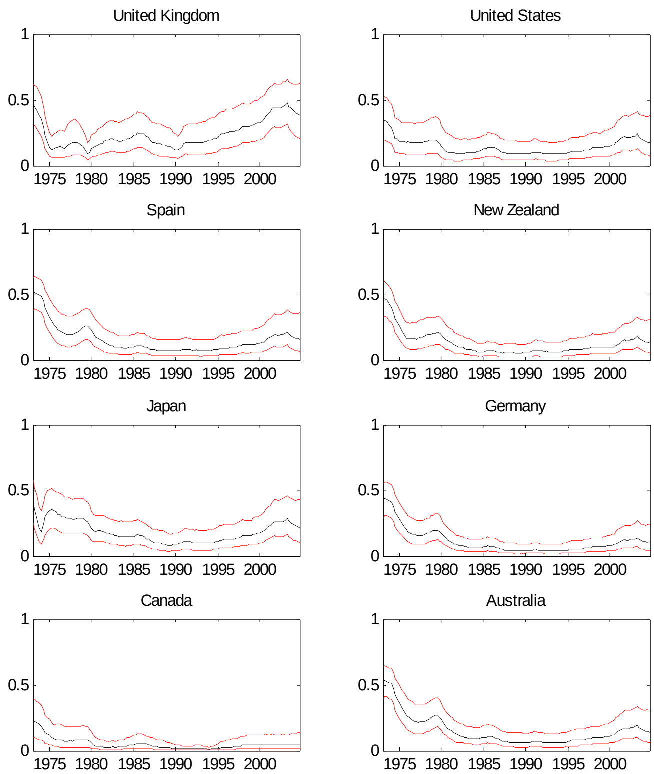

Figure 6: Variance Decomposition: World Contribution

suggesting that the source of change is truly country specific. Differences in the transmission mechanism, as implied by different structures of the economy, and national economic policies are thus still consistent with the different timings in the reduction of volatility. A common international shock evenly spread across countries, in contrast, is inconsistent with events.

In summary, the world factor accounted for the fall in the level of national inflation rates. On the other hand, country characteristics were responsible for both the rise in volatility between the end of the 1970s and the first years of the 1980, and its subsequent decline, which extends from the second half of the 1980s to the present day.

4 Interpreting the Geographic Contributions

In this section, we characterize the relationship between structural features of the national economies and the relative contributions of world and country factors. In particular, we regress the factors and the fraction of variance explained by each factor on a panel of explanatory variables that are related to country and world characteristics.

The estimates of the panel regressions are only suggestive and caution should be used when interpreting the statistics. As Kose, Otrok and Whiteman (2003) emphasize, however, this kind of regressions can be helpful for identifying which regularities merit further study.[5]

We begin with interpreting the world and country factors. The explanatory variables are a measure of domestic monetary policy activism and real GDP growth. Cross-sectional effects capture heterogeneity in the national economies. Time dummies account for the effects shared by all countries in a particular period and thus represent comovements other than policy synchronization. As far as the measure of monetary policy is concerned, we consider a rule of the kind proposed by Taylor (1993):

$$i^*_{j,t} = (1-\rho)\left(\alpha + \beta\pi_{j,t} + \gamma y_{j,t}\right) + \rho i^*_{j,t-1} \tag{7}$$

The monetary authorities set the interest rate, i_t, in response to movements in both inflation, π_t, and output growth, y_t. Changes in the policy rate are implemented smoothly with the parameter ρ measuring the degree of policy

[5] Moreover, differences in scale make units difficult to interpret.

inertia. The superscript * denotes the path of interest rate recommended by a Taylor rule.[6]

We measure monetary policy activism, $MP_{j,t}$, in country j as the deviations of the actual interest rate, $i_{j,t}$, from the prescriptions of a Taylor rule: $MP_{j,t} = i_{j,t} - i^*_{j,t}$. The parameters in (7) are set as follows: $\alpha = 4.0$, $\beta = 1.0$, $\gamma = 0.25$ and $\rho = 0.7$.[7]

Positive values of *MP activism* identify periods of strong policy response to inflation whereas negative values correspond to a path for the interest rate below the path recommended by a Taylor rule. The hypothesis test is that relatively low (high) levels of the interest rate are associated with high (low) levels of the factors and large contributions of the factors to inflation volatility.

Table 1: *Interpreting the Factors*

	Country Factor		**World Factor**	
Dependent Variable: factors				
Regression	Coeff (s.e.)	Coeff (s.e.)	Coeff (s.e.)	Coeff (s.e.)
MP activism	-0.146 (0.020)	-0.152 (0.020)	-0.395 (0.069)	-0.400 (0.068)
GDP growth	-0.093 (0.013)	-0.089 (0.013)	0.116 (0.066)	0.110 (0.066)
Openness	-	-0.063 (0.019)	-	-0.162 (0.072)
time dummies	yes	yes	-	-
fixed effects	yes	yes	-	-
	$AdjR^2 = 0.282$	$AdjR^2 = 0.292$	$AdjR^2 = 0.236$	$AdjR^2$ =0.260

Table 1 reports the results. The left (right) hand side of the table refers to the regressions in which the country factors (world factor) are used as dependent variable. The first column shows that whenever interest rates are lower than recommended by a Taylor rule the level of the country factor is high. Low output growth rates are associated with high levels of the national features.

[6] It should be emphasized that a Taylor rule is used here because it appears a simple way to describe monetary policy empirically, though actual policy making is far more complex than a simple rule could capture.

[7] The choice of $\beta = 1.0$ appears to be a minimum requirement for characterizing active monetary policy in the sense of Taylor (1993). Results are robust to alternative parameterisations such as $\alpha = 3.5$ and 4.5, $\beta = 1.2$ and 1.4, $\gamma = 0.125$ and 0.5, and $\rho = 0.6$ and 0.8. Notice that the intercept can be interpreted as $\alpha = i^{t\arg et} - \beta\pi^{t\arg et}$.

The world factor can be interpreted using standard results for single equation regressions. To summarize the national characteristics of monetary policy and structure of the economy, we compute the average of *MP activism* and *GDP growth* across countries, and then use these measures as explanatory variables. The third column of Table 2 shows that active monetary policy is associated with low levels of the international common feature. In the world factor regression the absolute value of the coefficient on *MP activism* is significantly larger than its country factor regression counterpart. Output growth has no explanatory power.

An interesting literature pioneered by Romer (1993) has documented a negative relationship between trade openness and the level of inflation. Our framework allows us to decompose the relationship geographically. The second and fourth columns reveal that openness, defined as the sum of import and exports over GDP, is negatively correlated with world and country factors, though the contribution to the former is significantly larger that the contribution to the latter. The coefficients on monetary policy and GDP growth are robust to including trade openness and show that monetary policy is the most important explanatory variable in the regressions.

Table 2: *Interpreting the Inflation Variance Decomposition*

Country Factor		**World Factor**	
Dependent Variable: fractions of variance explained by the factor			
Regression	Coeff (s.e.)	Regression	Coeff (s.e.)
MP activism	-0.021 (0.006)	*MP activism*	0.007 (0.003)
GDP growth	-1.500 (0.335)	*GDP growth*	1.044 (0.219)
time dummies	yes	*time dummies*	yes
fixed effects	yes	*fixed effects*	yes
	$AdjR^2 = 0.748$		$AdjR^2 = 0.772$

Table 2 reports the panel estimates of the shares of inflation variance explained by the country and the world factor on *MP activism* and *GDP growth*. Five main results emerge. First, the coefficient on monetary policy activism in the regression for the variance accounted by the country factor is negative and statistically different from zero, implying that when the interest rate response to inflation is weaker than recommended by a Taylor rule the country factor is more important in explaining inflation fluctuations. As national factors matter during periods of high inflation volatility, the evidence in Table 2 suggests that monetary policy was a significant source of instability in the 1970s and at the beginning of the 1980s.

Second, time effects have little impact on the results of the country regression, suggesting that common features other than monetary policy play only a minor role in explaining country specific fluctuations. Third, when output growth is weak (strong) the contribution of national features to the volatility of inflation is significantly larger (smaller). Fourth, monetary policy activism has far less impact on the contribution of the world factor to inflation volatility than on the contribution of the country factor. The time effects, on the other hand, are strongly correlated with the international common feature and account for most of the contribution of the world factor.[8] Fifth, international comovements are more important during periods of strong output growth.

5 Conclusions

Inflation is today a more global phenomenon than it was thirty years ago. We use a dynamic factor model with time-varying coefficients and stochastic volatility to identify national and international common features in a panel of 164 series for the most industrialized economies in the world. A common international factor tracks the *level* of national inflation rates reasonably well while country conditions are more important to explain the *volatility* of inflation.

The national factors account for a large portion of variance during the second half of the 1970s and the beginning of the 1980s. The rise and fall of national contributions are not synchronized across economies and their timing confirms conventional wisdom on the conduct of national policies: income policies and accommodative monetary policies are associated with periods of volatile inflation in the U.K., the U.S., Spain, New Zealand and Japan. Furthermore, the

[8] Excluding the time effects from the regression reduces the adjusted R^2 by 17%. This number is 7% in the regression involving the contribution of the country factor. More importantly, the inclusion of time effects in the world factor regression substantially reduces the size of the coefficient on *MP activism*. The impact of *MP activism* on the country factor regression is, in contrast, significantly smaller, suggesting that common time effects are particularly important for explaining movements in the contribution of the world factor. The estimates are robust to adding oil price inflation, which has no explanatory power in the regressions.

German experience of stable and small country specific contributions over the entire sample is consistent with the notion that effective domestic policies generate only small variations in inflation.

The international component of national inflation rates has become increasingly more important in the last decade. Today, the fraction of variance attributable to a world common feature in the U.K. and the U.S. is almost as large as it was during the first oil price spike in 1974. It is worth emphasizing that large country specific contributions in the 1970s coincided with highly volatile inflation. The large world contribution of the most recent period, in contrast, has not translated into large inflation fluctuations.

The impact of country specific conditions for inflation has tended to disappear in the recent past. Canova, Ciccarelli and Ortega (2006) find evidence of similarities and convergences in G7 business cycles but also document that national conditions still matter for real activity. It will be interesting to investigate in future research what national features are responsible for the difference between nominal and real variables, and whether effective domestic policies have indeed insulated inflation from international common shocks.

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Appendix A: Priors and Estimation

Consider the time varying factor model in (1) and (2).

Prior Distributions and starting values

Factors and Factor Loadings

Following Bernanke, Boivin and Eliasz (2005), we center our prior on the factors (and obtain starting values) by using a Principal Component (PC) estimator applied to the inflation series for each country. The covariance of the states ($P_{0/0}$) is set equal $I_{0.01}$ where I_n denotes an identity matrix with n on the main diagonal.

Starting values for the factor loadings are also obtained from the PC estimator. The prior on the diagonal elements of R is assumed to be inverse gamma:

$$R_{ii} \sim IG(3, 0.001)$$

In choosing a diffuse prior, we closely follow Bernanke, Boivin and Eliasz (2005).

AR coefficients

The prior for the VAR coefficients is obtained by estimating fixed coefficients AR regressions using data from 1961Q1 to 1972Q4. Φ_0 is therefore set equal to

$$\Phi_0 \sim N(\hat{\Phi}^{OLS}, V)$$

where V is set equal to $I_{1\times10^{-4}}$. This relatively tight prior is chosen mainly to reduce the incidence of explosive roots thereby speeding up the sampling algorithm.

Elements of Σ_t

The prior for the diagonal elements of the VAR covariance matrix (see equation 4) is as follows:

$$\ln h_0 \sim N(\ln \mu_0, I)$$

where μ_0 is set equal to 0.1.

Hyperparameters

The prior on Q is assumed to be inverse Wishart

$$Q_0 \sim IW\left(\bar{Q}_0, T_0\right)$$

where $\bar{Q}_0$ is assumed to be $I_{1\times 10^{-4}}$ and T_0 is the length of the sample used to for calibration.

In line with Cogley and Sargent (2002), we postulate an inverse-Gamma distribution for the elements of G,

$$\sigma_i^2 \sim IG\left(\frac{10^{-4}}{2}, \frac{1}{2}\right)$$

Simulating the Posterior Distributions

Factors and Factor Loadings

This closely follows Bernanke, Boivin and Eliasz (2005). Details can also be found in Kim and Nelson (2000).

Factors The distribution of the factors F_t is linear and Gaussian:

$$F_T \backslash X_{i,t}, R_t, \Xi \sim N\left(F_{T\backslash T}, P_{T\backslash T}\right)$$
$$F_t \backslash F_{t+1}, X_{i,t}, R_t, \Xi \sim N\left(F_{t\backslash t+1, F_{t+1}}, P_{t\backslash t+1, F_{t+1}}\right)$$

where $t = T-1, ..1$, Ξ denotes a vector that holds all the other FAVAR parameters and:

$$\begin{aligned}
F_{T\backslash T} &= E\left(F_T \backslash X_{i,t}, R_t, \Xi\right) \\
P_{T\backslash T} &= Cov\left(F_T \backslash X_{i,t}, R_t, \Xi\right) \\
F_{t\backslash t+1, F_{t+1}} &= E\left(F_t \backslash X_{i,t}, R_t, \Xi, F_{t+1}\right) \\
P_{t\backslash t+1, F_{t+1}} &= Cov\left(F_t \backslash X_{i,t}, R_t, \Xi, F_{t+1}\right)
\end{aligned}$$

As shown by Carter and Kohn (2004), the simulation proceeds as follows. First we use the Kalman filter to draw $F_{T\backslash T}$ and $P_{T\backslash T}$ and then proceed backwards in time using:

$$F_{t|t+1} = F_{t|t} + P_{t|t} P_{t+1|t}^{-1} \left(F_{t+1} - F_t\right)$$

$$P_{t|t+1} = P_{t|t} - P_{t|t} P_{t+1|t}^{-1} P_{t|t}$$

If more than one lag of the factors appears in the VAR model, this procedure has to be modified to take account of the fact that the covariance matrix of the shocks to the transition equation (used in the filtering procedure described above) is singular. For details see Kim and Nelson (2000).

Elements of R As in Bernanke, Boivin and Eliasz (2005), R is a diagonal matrix. The diagonal elements R_{ii} are drawn from the following inverse gamma distribution:

$$R_{ii} \sim IG\left(\bar{R}_{ii}, T + 0.001\right)$$

where

$$\bar{R}_{ii} = 3 + \hat{e}_i'\hat{e}_i + \beta_i' \left[\bar{M}_0^{-1} + \left(F_{i,t}'F_{i,t}\right)^{-1}\right]^{-1} \beta_i$$

and $M_0 = I$.

Elements of β The factor loadings are sampled from

$$\beta_i \sim N\left(\bar{\beta}_i, R_{ii}\bar{M}_i^{-1}\right)$$

where $\bar{\beta}_i = \bar{M}_i^{-1}\left(F_{i,t}'F_{i,t}\right)\hat{\beta}_i$, $\bar{M}_i = \bar{M}_0 + \left(F_{i,t}'F_{i,t}\right)$ and $\hat{\beta}_i$ represents an OLS estimate.

Time Varying AR

Given an estimate for the factors, the model becomes an AR model with drifting coefficients and covariances. This model has become fairly standard in the literature and details on the posterior distributions can be found in a number of papers including Cogley and Sargent (2005), Primiceri (2005) and Benati and Mumtaz (2006). Here, we describe the algorithm briefly.

AR coefficients Φ_t As in the case of the unobserved factors, the time varying VAR coefficients are drawn using the methods described in Carter and Kohn (2004). Note that we require the roots of the AR process to be inside the unit circle for each t.

Elements of Σ_t Following Cogley and Sargent (2005) and Benati and Mumtaz (2006), the diagonal elements of the AR covariance matrix are sampled using the methods described in Jacquier, Polson and Rossi (2004).

Hyperparameters Conditional on F_t, $\Phi_{j,t}$ and Σ_t, the innovations to $\Phi_{j,t}$ and Σ_t are observable, which allows us to draw the hyperparameters—the elements of Q and G—from their respective distributions.

Appendix B: Data

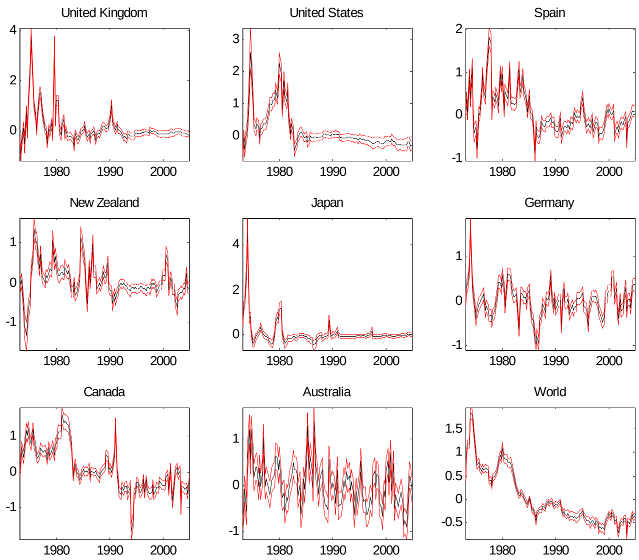
Description of Variables

No.	Description	Country
1	CPI	UK
2	PPI / WPI	UK
3	RPI Total Food	UK
4	RPI Total Non-Food	UK
5	RPI Total All items other than seasonal Food	UK
6	GDP Deflator	UK
7	QMA Data	UK
8	Total Wages and Salaries	UK
9	METALS	UK
10	AGR. RAW MATERIALS	UK
11	BEVERAGES	UK
12	FOOD	UK
13	Petrolium Average Crude Pounds Per barrel	UK
14	CPI	US
15	US CAPITAL EQUIPMENT	US
16	US CPI - ALL ITEMS LESS FOOD	US
17	US CPI - ALL ITEMS LESS ENERGY	US
18	US CPI - ALL ITEMS LESS FOOD and ENERGY	US
19	US CPI - DURABLES	US
20	US CPI - NEW VEHICLES	US
21	US CPI - SERVICES	US
22	US EXPORT PRICES	US
23	US GDP DEFLATOR VOLN	US
24	US IMPLICIT PRICE DEFLATOR - GNP	US
25	US IMPORT PRICES	US
26	US PPI - COMMERCIAL ELECTRIC POWER	US
27	US PPI - COAL	US
28	US PPI - CRUDE FUEL	US
29	US PPI - ELECTRICAL MACHINERY and EQUIPMENT	US
30	US PPI - IRON and STEEL	US
31	SD CPI - FOOD	SW
32	SD CPI - HOUSING, FUEL and ELECTRICITY	SW
33	ES CPI	SP
34	ES EXPORT UNIT VALUE	SP
35	ES CPI - RENT	SP
36	ES IMPORT UNIT VALUE	SP
37	ES PPI	SP
38	ES PPI - MANUFACTURING ALL ITEMS	SP
39	ES PPI WPI	SP
40	NZ CPI	NZ
41	NZ CPI - ENERGY	NZ
42	NZ CPI - HOUSING	NZ
43	NZ CPI: FOOD (QUARTERLY)	NZ
44	NZ EXPORT PRICE - BUTTER	NZ
45	NZ EXPORT PRICE INDEX	NZ
46	NZ EXPORT PRICE INDEX: DAIRY PRODUCTS	NZ
47	NZ EXPORT PRICE INDEX: MEAT	NZ
48	NZ EXPORT PRICE INDEX: MEAT, WOOL and BY-PRODUCTS	NZ
49	NZ EXPORT PRICE INDEX: PASTORAL and DAIRY PRODUCTS	NZ
50	NZ INFLATION RATE	NZ
51	NZ MARKET PRICE - LAMB, NEW ZEALAND (LONDON)	NZ
52	NZ PPI	NZ
53	NZ PPI - MANUFACTURING	NZ
54	NZ PPI WPI	NZ
55	NL CPI	NL
56	NL CPI - ENERGY	NL
57	NL CPI - EXCLUDING FOOD and ENERGY	NL
58	NL CPI - FOOD	NL
59	NL CPI: RENT INCLUDING IMPUTED RENT	NL
60	NL PPI	NL
61	NL PPI - OUTPUT	NL
62	NL EXPORT UNIT VALUE	NL
63	NL IMPORT UNIT VALUE	NL
64	NL PPI WPI	NL
65	JP CPI	JP
66	JP CPI - ENERGY	JP
67	JP DOMESTIC CORP.GOODS PRICE INDEX-CHEMICALS and RELATED PRODS.	JP
68	JP DOMESTIC CORP.GOODS PRICE INDEX-ELECTRICITY, GASand WATER	JP
69	JP DOMESTIC CORP.GOODS PRICE INDEX-GENERAL MACHINERY and EQUIP.	JP
70	JP DOMESTIC CORP. GOODS PRICE INDEX - METAL PRODUCTS	JP
71	JP DOMESTIC CORP.GOODS PRICE INDEX-PULP,PAPER and RELATED PRDS.	JP
72	JP DOMESTIC CORP.GOODS PRICE INDEX-PETROLEUM and COALPRODS.	JP
73	JP IMPORT UNIT VALUE	JP
74	JP MONTHLY EARNINGS - MANUFACTURING	JP
75	JP PPI - IRON and STEEL	JP
76	JP PPI - CHEMICALS and CHEMICAL PRODS	JP
77	JP PPI - MANUFACTURING	JP
78	JP UNIT LABOUR COST - MANUFACTURING	JP
79	JP WAGE INDEX: CASH EARN. - MANUFACTURING (SEE JPWAMFROE)	JP
80	IT CPI	IT
81	IT CPI - ENERGY	IT
82	IT CPI - EXCLUDING FOOD and ENERGY	IT
83	IT CPI - FOOD	IT
84	IT CPI - HOUSING	IT
85	IT CPI - SERVICES LESS HOUSING	IT

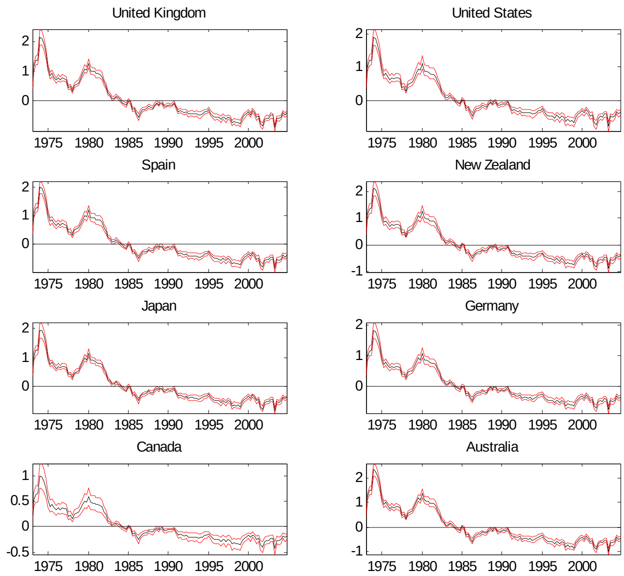
Description of Variables (continued...)

No.	Description	Country
86	IT CPI EXCLUDING TOBACCO (FOI)	IT
87	IT CPI INCLUDING TOBACCO (NIC)	IT
88	IT HOURLY WAGE RATE : INDUSTRY	IT
89	BD CPI	GER
90	BD CPI - FOOD AND ALCOHOL-FREE DRINKS (EXCL. REST)	GER
91	BD EXPORT PRICES	GER
92	BD HOURLY EARNINGS: MANUFACTURING	GER
93	BD IMPORT UNIT VALUE	GER
94	BD PERSONAL SAVINGS RATIO (PAN BD Q0191)	GER
95	BD PPI	GER
96	BD WAGE and SALARY RATES: MONTHLY-OVERALL ECONOMY(PANBD M0191)	GER
97	BD WHOLESALE OUTPUT PRICE INDEX REBASED TO 1975=100	GER
98	BD WPI	GER
99	FR CPI	FR
100	FR CONSTRUCTION COST INDEX - RESIDENTIAL PROPERTY	FR
101	FR CPI - ENERGY	FR
102	FR CPI - EXCLUDING FOOD and ENERGY	FR
103	FR CPI - FOOD	FR
104	FR CPI - SERVICES EXCLUDING RENT	FR
105	FR EXPORTS (IN US$)	FR
106	FR HOURLY WAGE RATE: INDUSTRY	FR
107	FR HOURLY WAGE RATES ALL ACTIVITIES	FR
108	FR IMPORT PRICE - GRADE A SETTLEMENT LEATHER (LONDON)	FR
109	FR IMPORT PRICE - GRAIN (CHICAGO)-PRICE PER 60 POUND BUSHEL	FR
110	FR IMPORT PRICE - SETTLEMENT LEAD (LONDON)	FR
111	FR IMPORT PRICE - SETTLEMENT ZINC (LONDON)	FR
112	FR IMPORTS CIF (IN US$)	FR
113	FR PPI - AGRICULTURAL GOODS	FR
114	FR PPI - METAL PRODUCTS	FR
115	FR PPI - MANUFACTURED PRODUCTS	FR
116	FR PPI - INTERMEDIATE GOODS EXCLUDING ENERGY	FR
117	FR PPI- IMPORTED RAW MATERIALS	FR
118	FR WAGE RATE : HOURLY - MANUAL WORKERS	FR
119	FN CPI	FI
120	FN CPI - ENERGY	FI
121	FN CPI - EXCLUDING FOOD and ENERGY	FI
122	FN CPI - FOOD	FI
123	FN CPI - HOUSING	FI
124	FN EXPORT UNIT VALUE	FI
125	FN EXPORTS (IN US$)	FI
126	FN HOURLY EARNINGS - MANUFACTURING	FI
127	FN IMPORTS CIF (IN US$)	FI
128	FN PPI	FI
129	CN CPI	CN
130	CN CPI - EXCLUDING FOOD and ENERGY	CN
131	CN CPI - SERVICES EXCLUDING RENT	CN
132	CN CPI ENERGY	CN
133	CN CPI: ALCOHOLIC BEVERAGES and TOBACCO PRODUCTS	CN
134	CN CPI: ALL ITEMS EXCLUDING FOOD	CN
135	CN CPI: ALL ITEMS EXCLUDING FOOD and ENERGY	CN
136	CN CPI: DURABLE GOODS	CN
137	CN CPI: FOOD	CN
138	CN CPI: GASOLINE	CN
139	CN CPI: GOODS	CN
140	CN CPI: HOUSING	CN
141	CN CPI: NONDURABLE GOODS	CN
142	CN EXPORTS (IN US$)	CN
143	CN GDP (IMPLICIT PRICE DEFLATOR)	CN
144	CN HOURLY EARNINGS - MANUFACTURING	CN
145	CN IMPORTS CIF (IN US$)	CN
146	CN INDUSTRIAL PRICE INDEX: ALL COMMODITIES	CN
147	CN INDUSTRIAL PRICE INDEX:BLEACHED SULPHATE WOODPULP	CN
148	CN INDUSTRIAL PRICE INDEX:LINER BOARD	CN
149	CN INDUSTRIAL PRICE INDEX:LUMBER and TIES, SOFTWOOD	CN
150	CN INDUSTRIAL PRICE INDEX:NEWSPRINT PAPER	CN
151	CN MARKET PRICE - ALUMINUM, CANADA (UK)	CN
152	CN MARKET PRICE - NICKEL, LONDON METALS EXCHANGE, SPOT, CIF	CN
153	CN MARKET PRICE-POTASH,FOB CANADA(VANCOUVER)(AVG OF DAILIES)	CN
154	CN PPI	CN
155	AU CPI	AUS
156	AU EXPORT PRICES	AUS
157	AU GDP DEFLATOR VOLN	AUS
158	AU GFCF:PRIVATE - DWELLINGS (IPD)	AUS
159	AU GDP (IMPLICIT PRICE DEFLATOR)	AUS
160	AU IMPORT PRICES	AUS
161	AU MARKET PRICE - BEEF, ALL ORIGINS (US PORTS)	AUS
162	AU GFCF:PRIVATE - MACHINERY (IPD)	AUS
163	AU GFCF:PUBLIC (IPD)	AUS
164	AU PPI	AUS

Appendix C: Factors and World Indicators



Factors



World Indicators for Each Country