THE GLOBAL DIMENSION OF INFLATION – EVIDENCE FROM FACTOR-AUGMENTED PHILLIPS CURVES

by Sandra Eickmeier
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In 2009 all ECB publications feature a motif taken from the €200 banknote.

2 Corresponding author: Deutsche Bundesbank, Economic Research Center, Wilhelm-Epstein- Straße 14, 60431 Frankfurt am Main, Germany; e-mail: sandra.eickmeier@bundesbank.de
3 Johann Wolfgang Goethe-Universität Frankfurt, Senckenberganlage 31, 60325 Frankfurt am Main, Germany; e-mail: kmoll@wiwi.uni-frankfurt.de. This paper was written while the author was visiting the Deutsche Bundesbank.

CONTENTS

Abstract

We examine the global dimension of inflation in 24 OECD countries between 1980 and 2007 in a traditional Phillips curve framework. We decompose output gaps and changes in unit labor costs into common (or global) and idiosyncratic components using a factor analysis and introduce these components separately in the regression. Unlike previous studies, we allow global forces to affect inflation through (the common part of) domestic demand and supply conditions. Our most important result is that the common component of changes in unit labor costs has a notable impact of inflation. We also find evidence that movements in import price inflation affect CPI inflation while the impact of movements in the common component of the output gap is unclear. A counterfactual experiment illustrates that the common component of unit labor cost changes and non-commodity import price inflation have held down overall inflation in many countries in recent years whereas commodity import price inflation has only raised the short-run volatility of inflation. In analogy to the Phillips curves, we estimate monetary policy rules with common and idiosyncratic components of inflation and the output gap included separately. Central banks have indeed reacted to the global components.

Key words: Inflation, globalization, Phillips curves, factor models, monetary policy rules

JEL classification: E31, F41, C33, C50

Non-technical summary

The global dimension of inflation recently attracted major interest among academics and policy makers due to two observations: low inflation rates in many countries in recent years (and until very recently) which coincided with an ongoing globalization process and strong international comovements of inflation rates.

In this paper we shed light on the global dimension of inflation. We decompose inflation and its determinants in 24 OECD countries between 1980 and 2007 into common and idiosyncratic components using factor analysis. Of the determinants of inflation we consider, among others, the output gap and changes in unit labor costs. (We also consider movements in import prices as global determinants and distinguish between commodity and non-commodity import prices.) We assume that movements in the common components can result from global shocks or from foreign shocks that are transmitted to the domestic economy. We assess the relevance of the common components. We then examine the impact of global determinants on inflation in a traditional backward-looking Phillips curve framework.

The main contribution of the paper is to introduce the common and the idiosyncratic components of the output gap and changes in unit labor costs separately in the regression equations. Unlike previous studies which directly introduce for example the foreign output gap in Phillips curves, we allow global forces to affect inflation also indirectly *through* (the common part of) domestic demand and supply conditions.

We find relatively small effects of movements in import price inflation and the common component of the output gap on inflation. A greater impact comes from movements the common component of changes in unit labor costs. Coefficients vary considerably across countries. A counterfactual experiment illustrates that the low rates of changes in the common components of unit labor costs and non-commodity import prices have held down overall inflation in several countries in recent years. Evidence that the importance of global/national determinants of inflation rises/decreases with a country's degree of openness is weak at best.

Our results imply that monetary policy makers need to carefully monitor global forces when assessing and predicting inflation. In analogy to the Phillips curves, we estimate monetary policy rules with common and idiosyncratic components of inflation and the output gap included separately. Central banks have indeed reacted to the global components in recent times.

1.   Introduction

Due to two observations the global dimension of inflation has recently attracted major public interest. (i) The first observation is that inflation rates in many countries were quite low by historical standards in the last few years and until very recently. At the same time, globalization – defined as an ongoing process of integration through trade, financial markets and labor markets – proceeded. Observers speculate about whether globalization is responsible for low inflation rates and provide several arguments in favor of this hypothesis (see IMF 2006, Ihrig et al. 2007 and Deutsche Bundesbank 2007 for comprehensive overviews). The increased entry of emerging countries in global markets which are able to produce at low costs could have held down import price inflation. Technological advances are spurred by international competition, which puts pressure on firms to innovate. Moreover, open economies specialize in relatively efficient sectors, which should lead to productivity gains. In addition, greater international competition, together with mobile labor and the possibility for firms to relocate production abroad, will contain wage claims and, hence, inflation. (ii) The second observation is reflected by Figure 1 which shows quarterly CPI inflation rates in 24 OECD countries since the 1980s. During the entire sample period, inflation rates are strongly correlated across countries with mean and median bivariate correlations of 0.56 and 0.61, which clearly suggests that inflation has a global component. These two observations initiated research in academic and policy institutions which tries to understand the global dimension of inflation, and the present paper fits in this research.

We analyze the global dimension of inflation in a traditional, backward-looking Phillips curve model. Such a model typically explains inflation with domestic demand and supply conditions such as the output gap and cost push terms capturing productivity developments, input prices and labor market developments. Work based on closed-economy Phillips curve models, however, disregard that these factors are not only determined nationally but also globally. I.e. they are typically affected by national shocks, but also by global shocks which hit different economies simultaneously or with some lag or by shocks that occur in one country but are then transmitted to other countries. The impact of global or foreign shocks on domestic inflation varies with the type of shocks (e.g. supply, demand or monetary shocks) and their relevance (also in relation to national shocks) with their (relative) frequencies and size, but also with the strength of transmission. The latter in turn depends a country's integration in the world economy.

In section 2 of this paper, we explain the methodology. In section 3, we document the international comovement of inflation rates and of major determinants of inflation in 24 OECD countries between 1980Q3 and 2007Q1. We decompose them into global or common components and idiosyncratic components using factor analysis and assess how much of the variance is explained by the common factors. In section 4, we then estimate modified traditional Phillips curves. In our baseline specification, inflation is regressed on past inflation

and non-commodity and commodity import price inflation. Moreover, we include the common and idiosyncratic components of output gaps and unit labor cost changes separately. We focus on the coefficients of global variables/components in the inflation equations, i.e. import price inflation and the common components of the output gap and changes in unit labor costs, and address questions such as: Are global variables/components able to explain domestic inflation? How important are they relative to country-specific determinants of inflation? In various robustness checks, we also consider in section 5 other possible determinants such as a proxy of foreign competition and monetary credibility.

Sections 2 to 5 constitute the main part of our paper. They are complemented by two additional exercises. In section 6, we examine whether the influence of global/national components/variables increases/decreases with openness. We provide cross-sectional and time-series evidence. In section 7 finally, we estimate, in analogy of the Phillips curves, monetary policy rules with common and idiosyncratic components of inflation and the output gap included separately to assess whether monetary policy makers have in the past reacted to the global components of inflation and output.

Our paper is related to several papers which have analyzed empirically the global dimension of inflation. Based on traditional or micro-founded New Keynesian Phillips curve frameworks, previous papers have investigated the role of foreign output gaps (or capacity utilization), import price inflation and/or other global variables such as changes in the terms of trade, exchange rates and other measures of relative prices, foreign inflation, a measure of foreign competition and import shares for domestic inflation (which allows to verify the first observation (i)). Borio and Filardo (2006), Ihrig et al. (2007), Pain et al. (2006), Mody and Ohnsorge (2007), Gerlach et al. (2008), Ball (2006), IMF (2006), Calza (2008), Gamber and Hung (2001), Tootell (1998) apply traditional Phillips curve frameworks to panels of developed countries or individual developed countries. Batini et al. (2005), Balakrishnan and Lopez-Salido (2002), Galí and Lopez-Salido (2002), Razin and Yuen (2002), Gadzinski and Hoffmann (2008), Calza (2008), Dées et al. (2008), Leith and Malley (2007) and Rumler (2007) all employ New Keynesian setups.

Borio and Filardo (2006) find positive and significant effects of foreign output gaps on domestic inflation between 1985 and 2005 in almost all 15 industrial countries they consider (an exception being Germany) and the euro area. Their finding is confirmed for the US and the sample period 1971 to 1999 by Gamber and Hung (2001). Ihrig et al. (2007) and Gerlach et al. (2008) show that this result is, however, not robust with respect to the measurement of the foreign output gap, to other variables included in the equation and to the estimation period considered. It is therefore not surprising that the other papers find either no or only a very weak influence of foreign output gaps on domestic inflation or results which are not robust

with respect to the specification. Results regarding import price inflation[1] and other global variables[2] are also not robust with respect to the sample period and the specification. Based on Phillips curve setups, some papers also analyze whether the parameters, for instance the sensitivity of inflation to fluctuations in the domestic and foreign output gaps (cf. IMF, 2006, Gadzinski and Hoffmann 2008, Ihrig et al. 2007, Ball 2006) or in import price inflation (cf. Ihrig et al. 2007, IMF 2006) have changed over time and whether globalization is responsible for these changes, with inconclusive results as we will discuss below.

Another literature strand has recently emerged (dealing with observation (ii)). Ciccarelli and Mojon (2008), Mumtaz and Surico (2008) and Monacelli and Sala (2007) employ dynamic factor models to assess the degree of international comovements of inflation rates by decomposing inflation into common (or global) and idiosyncratic components. They find considerable synchronization between inflation rates.

The main contribution of our paper is to divide major inflation determinants – namely the output gap and changes in unit labor costs in our baseline specification – into common and idiosyncratic components and to include these two components separately into the Phillips curve. Given the very inconsistent results from the Phillips curve literature on the impact of global determinants on domestic inflation, we believe that it is useful to provide additional evidence. Moreover, to that extent, we merge the two literature strands presented above (the Phillips curve literature and the factor applications). The common components may reflect global shocks (as defined above) or spillovers. The possibility that the common components are governed by correlated shocks, for instance similar policies, cannot be ruled out, either. Movements in the common components of the output gap or changes in unit labor costs hence have to be interpreted as movements in the domestic output gap or changes in unit labor costs due to global forces (or correlated shocks). It is important to notice that this is different from including the foreign and the domestic output gaps in the equation, where both can vary due to global forces. In this respect, we do justice to those who criticize the literature which includes foreign output gaps in Phillips curve equations and who argue that foreign demand conditions should affect domestic inflation through their effect on the domestic output gap or

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[1] Positive effects of import price inflation on domestic inflation are found by Balakrishnan and López-Salido (2002) for the UK, Galí and López-Salido (2000) for Spain, Gamber and Hung (2001) for the US, IMF (2006) for a panel of eight developed countries, Pain et al. (2006) for 21 developed countries and Rumler (2005) for nine euro-area countries and the euro-area aggregate. Ihrig et al. (2007), Gerlach et al. (2008) and Batini et al. (2005) show that these results are not robust.

[2] While Balakrishnan and Lopez-Salido (2002) and Mody and Ohnsorge (2007) find a significant impact of changes in the terms of trade and the nominal effective exchange rates on inflation in the UK and in 25 members of the European Union, respectively, Batini et al. (2005) shows that real oil price inflation does not robustly affect inflation in the UK across specifications. The latter authors also find that foreign competition significantly lowers inflation in the UK in only one out of six specifications. Dées et al. (2005) find no significant role of foreign inflation for domestic inflation in their entire sample of 26 developed and developing countries and the sample period 1980-2003, but they find a significantly positive impact when Latin American countries are excluded from the sample as well as for the US. The latter findings, however, disappear when domestic interest rates are introduced in the equation. Romer (1993) shows a significantly negative effect of the import share on inflation for his sample of 114 developed and developing countries between 1973 and 1992. The import share turns, however, insignificant when a reduced sample of OECD countries is considered only.

on import prices (Gerlach et al. 2008; see also the discussion in Ihrig et al. 2007) or that inflation depends on firms' marginal costs which depend on their own output and not foreign output (Ball, 2006). Our approach allows global shocks to affect domestic inflation *through* domestic demand and supply conditions.

Another advantage over previous approaches is that common and idiosyncratic components are orthogonal by construction, which alleviates the multicollinearity problem. Moreover, our approach allows us to consider additional international dimensions of inflation. Besides business cycle fluctuations due to common shocks we focus on global movements in labor markets and productivity by including the common component of changes in unit labor costs in our baseline equation. Later on, we will also consider the role of monetary credibility and disentangle common and idiosyncratic components of this measure and foreign competition (which affects the markup).

2. Methodology

Our empirical analysis is based on quarterly data for $N = 24$ OECD countries observed from 1980Q3 to 2007Q1.[3] In a traditional backward-looking Phillips curve framework à la Rudebusch and Svensson (1999, 2002), inflation can be described as:

$$\Delta p_{it} = \sum_{j=1}^{4} \widetilde{\alpha_{ij}} \Delta p_{it-j} + \widetilde{\beta_i} y_{it} + \sum_{j=0}^{4} \widetilde{\gamma_{ij}} \Delta ulc_{it-j} + \sum_{j=0}^{4} \widetilde{\delta_{ij}} \Delta imc_{it-j} + \sum_{j=0}^{4} \widetilde{\phi_{ij}} \Delta imnc_{it-j} + \tilde{e}_{it}, \qquad (1)$$

where Δp_{it} is the log (quarter-on-quarter) difference in the CPI of country i which is regressed on past inflation, on the output gap (measured as the Hodrick Prescott (HP)-filtered real GDP) (y_{it}), log differences of unit labor costs (Δulc_{it}) and commodity and non-commodity import prices (Δimc_{it} and $\Delta imnc_{it}$). A detailed description of the data can be found in Appendix A. We follow most of the literature and consider the output gap at only one point in time. The results do not change much if we include output gaps at lags 0 to $t-4$.

Such a framework was originally designed to describe the inflation process, and variations of it are popular in the literature. Past inflation captures the persistence in the inflation process that could potentially be caused by structural rigidities or inflation expectations of backward-looking agents. Demand conditions are reflected by the output gap and supply shocks by changes in unit labor costs and import price inflation. We have included commodity and non-commodity import price inflation separately since the effects of globalization on inflation through these two channels can differ: production from low-cost countries lowers non-commodity import prices, whereas the increased demand from emerging markets raises commodity import prices, the net effect being unclear.

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[3] We are unable to conduct the analysis for a longer sample. Longer time series are not available for many countries we consider.

It should be kept in mind that the traditional Phillips curve framework is a reduced-form model and hence needs to be interpreted with care. In spite of this drawback, we prefer a traditional Phillips curve model to a fully micro-founded forward-looking New Keynesian Phillips curve model since the latter has been shown to be a poor fit with the data.[4] [5]

Let us, nevertheless, consider the relationship between our specification and the New Keynesian Phillips curve. In the latter setup inflation depends on real marginal costs. Real marginal costs are often approximated by the output gap, since they have been shown to be, under certain circumstances, proportional to the output gap (Rotemberg and Woodford 1997). However, potential output, and therefore the output gap, are measured imperfectly. This as well as labor market rigidities and imported intermediate inputs in production may break down this relationship and make the output gap an imperfect proxy of real marginal costs. Moreover, as argued by Galí and Gertler (1999), while marginal costs directly account for the effects of productivity gains on inflation, this is often not the case for the simple output gap measure. This provides a rationale for including, besides the output gap, changes in unit labor costs and import price inflation in the equation. Other papers including the output and changes in unit labor costs are, for example, Mody and Ohnsorge (2007), Lown and Rich (1997), Batini et al. (2005) and Borio and Filardo (2006). Below, we provide robustness checks with respect to the exclusion of either of the three measures.

Lastly, it should be kept in mind that the parameters in equation (1) are reduced-form parameters. They are, however, functions of the structural parameters. Most importantly, the slope of the New Keynesian Phillips curve depends negatively on the degree of price stickiness, which can be affected by openness. This will be relevant when we assess parameter changes below.

We now turn to our baseline specification in which we include the idiosyncratic and the common components of the output gap and changes in unit labor costs separately in the equation. A price-setting firm from country i may respond differently to economic fluctuations that affect all international competitors than to fluctuations affecting only national firms. In the former (unlike the latter) case, the firm plausibly takes into account possible repercussions of its foreign competitors' reactions and spillovers from abroad.

Our baseline equation is as follows:

$$\Delta p_{it} = \sum_{j=1}^{4} \alpha_{ij} \Delta p_{it-j} + \beta_i y_{it}^{ic} + \gamma_i y_{it}^{cc} + \sum_{j=0}^{4} \delta_{ij} \Delta ulc_{it-j}^{ic} + \sum_{j=0}^{4} \phi_{ij} \Delta ulc_{it-j}^{cc} +$$
$$\sum_{j=0}^{4} \chi_{ij} \Delta imc_{it-j} + \sum_{j=0}^{4} \varphi_{ij} \Delta imnc_{it-j} + e_{it} \qquad , \qquad (2)$$

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[4] As argued by Galí and Gertler (1999), the New Keynesian Phillips curve cannot fully capture the persistence of inflation. Moreover, it implies certain lag-lead-relationships between inflation, the business cycle and the labor income share which are at odds with the data. In addition, as already argued by Rudd and Whelan (2005, 2006) expected future inflation is a black box. For this reason, we omit expected inflation from the equation.
[5] We would have liked to consider survey-based inflation expectations. Those are, however, only available for a too short time span in most countries.

where y_{it}^{ic} and y_{it}^{cc} are the idiosyncratic and the common components of the output gap, and Δulc_{it}^{ic} and Δulc_{it}^{cc} the corresponding components of changes in unit labor costs.

The common and idiosyncratic components of a specific series x_{it} – in our baseline case, x_{it} can be y_{it} or Δulc_{it} – are obtained by factor analysis. Let us suppose that x_{it} can be described as follows:

$$x_{it} = x_{it}^{cc} + x_{it}^{ic} = \lambda_i^x \,{}' \mathbf{f}_t^x + x_{it}^{ic} , \qquad (3)$$

where $\mathbf{f}_t^x$ and λ_i^x are $r \times 1$ vectors of common (global) factors and factor loadings, respectively. The common components x_{it}^{cc} are orthogonal to the idiosyncratic components x_{it}^{ic}. The common factors of $\mathbf{x}_t = \begin{bmatrix} x_{1t} & \cdots & x_{Nt} \end{bmatrix}'$ are estimated as the first r principal components of XX', where $\mathrm{X} = \begin{bmatrix} \mathbf{x}_t & \cdots & \mathbf{x}_T \end{bmatrix}'$, i.e. $\hat{\mathbf{f}}^x = \sqrt{T}\mathbf{v}$, where T denotes the number of observations, $\mathbf{v}$ is the $T \times r$ matrix of eigenvectors corresponding to the first r eigenvalues of XX', an estimate of the $r \times N$ matrix of factor loadings $\hat{\lambda}_i^x = \begin{bmatrix} \lambda_{1i}^x & \cdots & \lambda_{ri}^x \end{bmatrix}'$ is given by $\hat{\mathbf{f}}\mathrm{X}/\mathrm{T}$.[6] Hence, $\widehat{x_{it}^{cc}} = \hat{\lambda}_i^x \,{}' \hat{\mathbf{f}}_t^x$. Estimates of the idiosyncratic components are obtained as $\widehat{x_{it}^{ic}} = x_{it} - \widehat{x_{it}^{cc}}$. The common and idiosyncratic components in equation (2) are replaced by their estimates.

The principal component analysis is applied, as usual in the factor literature, to the de-meaned and standardized (variance = 1) data. After decomposing the variables into common and idiosyncratic components, those components are re-multiplied by the standard deviation of the corresponding series. This allows us to interpret the coefficients of equation (2) as elasticities. Some series contain missing observations. The unbalanced panels are converted into balanced panels by employing the expectation maximization (EM) algorithm, as suggested by Stock and Watson (2002a). For more details on the EM algorithm, the reader is referred to Appendix A.

Equations (1) and (2) are estimated as a system using a Seemingly Unrelated Regression estimator (SUR) (Zellner 1962).[7] This takes possible correlation between the residuals into account but allows the coefficients to vary across countries.[8] A panel estimation which would require all coefficients to be equal across countries would clearly be more efficient. However, based on a likelihood ratio test, we had to reject the null of all coefficients being the same across countries for our baseline equation (2).[9] Since the data have been demeaned prior to the estimation, we do not need to include constants in the regression.

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[6] '^' denotes estimates here and in the following.

[7] In spite of having lagged inflation included on the right-hand side, we estimate the equation with least squares (or SUR). The Nickell bias in dynamic panel analyses is small if T is relatively large, since the bias has the size $O(1/T)$. For this reason, the bias can be neglected (Judson and Owen, 1999).

[8] In our baseline equation, the absolute correlations of the residuals range from 0.00 to 0.48, and the mean and median absolute correlations are at 0.16 and 0.15 supporting the estimation with SUR.

[9] The likelihood ratio test statistic can be computed for our baseline equation (2) as $-2(\lambda_r - \lambda_u) = -2(10055.70 - 11124.55) = 2137.70$, where λ_r and λ_u are the log likelihoods of the restricted and the unrestricted models, respectively. In the restricted model, coefficients do not differ across countries, whereas in

For the sake of brevity, here and throughout most of the paper (except for subsection 4.2. where we focus on individual countries' coefficients) we do not report coefficients for each of the N countries and lags in our sample. Instead, we provide the mean group (MG) estimators of all countries' coefficients and the sums of the lags. Let us suppose the aim is to compute the MG estimator $\tilde{\theta}$ of any $N \times 1$ coefficient vector $\hat{\theta} = \begin{bmatrix} \hat{\theta}_1 & \cdots & \hat{\theta}_N \end{bmatrix}'$ where $\hat{\theta}_i$ can be any estimated coefficient from equations (1) or (2). Let H be a $N \times 1$ vector $H = \begin{bmatrix} N^{-1} & N^{-1} & \cdots & N^{-1} \end{bmatrix}'$. Then $\tilde{\theta} = H'\hat{\theta}$, which corresponds to the simple arithmetic average of the coefficients, and the *t*-statistic of $\tilde{\theta}$ is computed as $\tilde{\theta} / \begin{bmatrix} H'\hat{\Omega}H \end{bmatrix}^{1/2}$, where $\hat{\Omega}$ is the estimated covariance matrix of $\hat{\theta}$.

3. The international comovement of inflation rates and their determinants

To estimate the common and idiosyncratic components, we need to determine r, the number of common factors driving our panels of variables. Bai and Ng (2002) have suggested formal information criteria for selecting r which, however, will work only in a setup where $N, T \to \infty$. Since our $N = 24$ is rather small, we rely on informal criteria and focus on the variance share explained by the first r factors. Table 1 provides the variance shares explained by the first five factors of CPI inflation, the output gap and unit labor cost changes.

There is considerable comovement between CPI inflation rates. The bulk (59%) of the variation is explained by the first factor. The second factor still accounts for 11%, but the third to fifth factors contribute less to the overall variance of inflation, with shares at 5%, 4% and 3%, respectively. Table 1 also shows variance shares for individual countries' CPI inflation rates. The variance shares explained by the first factor vary notably, from 0.17 in Mexico to 0.89 in Italy. The second factor explains a relatively small share of inflation in most countries, but accounts for more than 10% in Australia, Austria, Germany, Iceland, Korea, Mexico, the Netherlands, Norway and Switzerland, and the third factor still explains more than 10% in Belgium, Greece, Ireland, Japan, Korea and the Netherlands. Figure 2 (a) shows the first five factors of (standardized) CPI inflation. Factors are not uniquely identified, but clearly, the time series of the first factor shows that the disinflation is indeed a global phenomenon. The first factor is also highly correlated with the simple unweighted average of all inflation rates; the correlation coefficient is 0.9995.

We now turn to the determinants of inflation. The bulk of the overall variation of the output gap and changes in unit labor costs is also explained by the first factor. Interestingly, the share explained by the first factor is lower for the output gap (35%) than for CPI inflation. The second factor still accounts for 16% and is perhaps not negligible when explaining inflation.

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the unrestricted model, all coefficients are allowed to vary across countries. The test statistic exceeds the critical values at all usual significance levels. This is in line with previous studies; cf. IMF (2006), Borio and Filardo (2006), and Pain et al. (2006).

This suggests that there are other reasons for inflation comovements besides business cycle comovements. Changes in unit labor costs in the various countries also comove quite strongly: one factor explains 41% of the variation. The second factor still accounts for 8% of the variation. The second factors of the output gap and changes in unit labor costs also play some role in a number of countries explaining more than 40% in Australia, Canada and the US (output gap) as well as in the Netherlands (unit labor cost changes).[10]

Overall, one factor accounts for the bulk of variation in CPI inflation and its determinants, but the second factor seems to explain a non-negligible part as well, in particular of the output gap and for some countries also of changes in the unit labor costs. Therefore, in the following, the output gap and changes in unit labor costs are decomposed into common and idiosyncratic components based on two factors. Another rationale for doing so is that common and idiosyncratic components are still estimated consistently if the number of factors is overestimated, as opposed to underestimated (Stock and Watson, 2002b; Kapetanios and Marcellino, 2003). Finally, when decomposing the output gap and unit labor cost changes into common and idiosyncratic components based on one factor and estimating equation (2) based on this decomposition, it turns out that the common component of the output gap is insignificant in the baseline regression equation, whereas – as we will see in the next section – it is significant when the decomposition is made based on two factors. This indicates that the second factor of the output gap has some explanatory power for inflation and supports our decomposition based on two factors. Notice that our focus on two factors differs from Ciccarelli and Mojon (2008), Mumtaz and Surico (2008) and Monacelli and Sala (2007) who only consider the first factor of inflation; however, those authors also mainly focus on inflation itself and not so much on the determinants of inflation.

4. Baseline regression results

4.1. Mean group estimates

We start by estimating equation (1) (*specification (1), 'NO FACTORS'*). Table 2 shows that all variables are highly significant and enter with the expected sign. *Specification (2), 'BASELINE'* is our baseline specification, into which common and idiosyncratic components of the output gap and changes in unit labor costs are included separately. The common components of both the output gap and unit labor cost changes enter the equation significantly. The coefficients are positive and exceed the coefficients of the idiosyncratic components. While differences between the coefficients of the two components of changes in unit labor costs are significant as suggested by a Wald test (test statistic: 67.50), the null

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[10] The correlation between the first factor of the output gap and changes in unit labor costs and their simple unweighted averages is also very high: 0.9800 and 0.9983, respectively.

hypothesis of equal coefficients cannot be rejected for the two components of the output gap at the 5% significance level (Wald test statistic: 3.36).

The remaining variables also affect inflation significantly. The pass-through of commodity and non-commodity import price changes to inflation amounts to 0.03 and 0.10, respectively, which is rather low, but magnitudes are in line with those found in other studies (Gerlach et al. 2008, Ihrig et al. 2007; Borio and Filardo 2006). The difference between the coefficients of the two import price inflation variables is significant: the Wald test statistic is at 27.80. This result is consistent with Pain et al. (2006). Finally, inflation is quite persistent with a coefficient of past inflation of 0.41. Overall, global forces seem to affect domestic inflation through the common components of changes in unit labor costs and the output gap as well as movements in import price inflation.

4.2. Individual countries

As pointed out in section 2, the likelihood ratio test suggests that coefficients differ across countries. It may therefore be instructive to look at regression results for individual countries. Let us focus on the global variables/components. Table 3 shows that the coefficient of the output gap's common component is positive and significant in Australia, Canada, Denmark, Finland, New Zealand, Norway, Switzerland and the UK. These countries dominate insignificant or – in the case of France – even negative significant coefficients of the common components in the other countries and lead to a positive and significant mean group estimator.[11] The common components of unit labor cost changes enter the equations significantly and with a positive sign in all countries except for Austria, Denmark, Germany, Ireland, Italy, Korea, the Netherlands and the US. We also find a significant commodity import price pass-through in Austria, Belgium, Canada, Finland, France, Germany, Greece, Iceland, the Netherlands, Portugal, Sweden and the UK. Non-commodity import price inflation significantly explains domestic inflation in Australia, Austria, Belgium, Canada, France, Greece, Iceland, Korea, New Zealand, Portugal, Spain, Sweden and the US.

Next, we examine, in a counterfactual experiment, how much the various regressors have contributed to estimated inflation over time. We are mostly interested in recent years when, so the argument goes, globalization and in particular low import price inflation, but also favorable productivity and labor market developments were responsible for the low inflation rates. Figure 3 shows, for each country, the contribution of global variables/components for inflation, measured as the variables/components of interest times the corresponding coefficient estimates.[12] The contribution of the global component of the output gap is

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[11] Also, our finding of a significant mean group estimator of the coefficient of the idiosyncratic component of the output gap is due to very large positive and highly significant coefficient estimates for only 4 out of 24 countries (Finland, Norway, Spain and Great Britain). Idiosyncratic components of the output gaps are insignificant in all other countries.

[12] It has been taken into account that past inflation is a function of the other explanatory variables in equation (2).

negligible in all countries except for Australia, Denmark, Finland, Norway, Switzerland and the UK, where effects are small (panel (a)). By contrast, in a number of countries, the common components of changes in unit labor costs seem to explain the relatively high inflation in the first half of the period and the relatively low inflation in the second half of the sample (panel (b)). This finding is particularly pronounced in Australia, Canada, Finland, France, Greece, Iceland, Italy, Mexico, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland and the UK, but not at all present in Korea, the Netherlands and the US. The decline in unit labor cost changes and its effect on inflation may be due to common globalization-related trends such as increased migration flows, actual and feared production relocation as well as other worldwide common structural developments such as composition shifts away from unionized manufacturing towards services, institutional changes in labor markets such as lower wage indexation, common technological developments, etc.

Commodity import price inflation shows no major systematic influence on overall inflation in recent years but only raises the short-run volatility of inflation (panel (c)). By contrast, we find that non-commodity import price inflation can explain the relatively low inflation rates in the last few years in Australia, Austria, Belgium, Canada, France, Germany, Greece, Iceland, Ireland, Korea, Mexico, New Zealand, Portugal, Spain, Sweden and the UK (panel (d)). The effects are, however, relatively small.[13] As usual, counterfactual experiments in reduced-form settings are not without controversy. The Lucas critique applies also here, and interpretation should not be pushed too far.

5. Robustness checks and other variables

Table 4 shows the results of various robustness checks. Moreover, we have included other variables which have been considered in the literature and which may also explain inflation.

Removing the components of the output gap and of unit labor cost changes as well as import price inflation in *specifications (3), 'WITHOUT Y', (4) 'WITHOUT ΔULC'* and *(5) 'WITHOUT ΔIM'*, respectively, leaves the remaining coefficients basically unaffected. This suggests that possible collinearity due to the simultaneous inclusion of the output gap, changes in unit labor costs and in import prices is not a problem.

In *specification (6), 'GDP WEIGHTS'*, we have used GDP weights instead of equal weights to compute the MG estimators from individual countries' coefficients, i.e. H now equals $\left[\omega_1^{-1} \quad \omega_2^{-1} \quad \cdots \quad \omega_N^{-1} \right]'$ where ω_i denotes the GDP weight of country i and GDPs were averaged over the period 1980Q3-2007Q1. All coefficients but the constant decline slightly, and the components of the output gap turn insignificant.

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[13] Balakrishnan and López-Salido (2002) have also pointed out the fact that traditional Phillips curves (with no global variables or components included) have tended to overpredict inflation in the recent low inflation, low unemployment era in the US, the UK and the euro area and have found that taking into account imported intermediate goods helps to mitigate the problem.

Previous studies have shown that the US economy leads the rest of the world and that US shocks are transmitted to other countries to a great extent (cf. Canova and Marrinan 1998; Monfort et al. 2003; Artis et al. 2007; Dées et al. 2007; Eickmeier 2007; Gerlach et al. 2008). It may thus well be that movements in the global factors of the output gap and unit labor cost changes are due partly to US shocks. In this case, the US economy's common components would reflect domestic (US) rather than external forces, and this might affect (misleadingly) mean group estimates of idiosyncratic and common components' coefficients. We exclude the US from our sample and re-estimate our baseline equation with 23 countries (*specification (7), 'WITHOUT USA'*). The results barely change. Another interesting question is whether the US cycle dominates our baseline results. In *specification (8), 'WITHOUT USA AND WITH US y'* we have inserted in specification (7) the contemporaneous US output gap to capture US influences and to separate them from other global cyclical developments. The US output gap does not enter the equation significantly, and the remaining coefficient estimates are basically unaffected.

One possible problem is that common and idiosyncratic components are generated regressors which may lead to unreliable standard errors. Stock and Watson (2002a) and Bai and Ng (2002) have argued that the uncertainty associated with the factor estimates can be neglected if the factors are extracted from a dataset with large cross-section and time dimensions. Based on Monte Carlo studies, Boivin and Ng (2006) have shown that factors can already be estimated very precisely from datasets with about 40 or more variables. Due to data limitations, we are unable to work with more than 24 countries. To assess the severity of this problem, we use a bootstrap to take account of the uncertainty associated with the factor estimates. For details on the bootstrap, see Appendix B. The 95% confidence interval for the coefficients is provided in *specification (9), 'BOOTSTRAP'*. The results remain unaffected. This suggests that the uncertainty involved with the estimation of the common and idiosyncratic components is negligible.

As is apparent from Figure 1, most countries have experienced a disinflation which basically came to an end in the mid-1980s. In order to assess to what extent our results are driven by the downward trend during the early 1980s, we started our estimation in 1985 in *specification (10), '1985-2007'*. The overall message remains unaffected. Most coefficients only slightly decline, except for the coefficient of the common component of the output gap which increases. However, the idiosyncratic component of the output gap turns insignificant. An interpretation of the disinflation until the mid-1980s often provided in the literature is that inflation rates (and other nominal variables) have experienced structural breaks in their means (cf. Benati and Kapetanios 2003, Corvoisier and Mojon 2005). We follow this literature and identify structural breaks in the means of CPI inflation, import price inflation and unit labor cost changes using the sequential multiple breakpoint test suggested by Bai and Perron (1998,

2003).[14] In *specification (11), 'STRUCT BREAK'*, we account for these shifts by removing the possibly shifted means from these variables prior to estimation. The equation can also be interpreted as explaining only higher frequency movements of inflation since the declining trend will be reflected in the mean series. It is often argued that globalization's effect on inflation is merely transitory since, in the medium and long run, monetary policy brings inflation back to its target. One may therefore expect international influences to have a greater shorter-run impact. This is only partly confirmed by our estimation results. The coefficient of the common component of the output gap rises. By contrast, the coefficients of the common component of unit labor cost changes and non-commodity import price inflation decline. However, all variables and components remain significant, suggesting that our baseline results remain robust even after accounting for structural breaks in the means of inflation and nominal regressors.

In *specification (12), 'UNEMPL RATE'*, we replace the output gap with the unemployment rate. The components enter with the expected negative sign, but are insignificant. In *specifications (13) and (14), 'PPI' and 'GDP DEFL'*, CPI inflation is replaced with PPI and GDP deflator inflation, respectively. Interestingly, the import price pass-through is greater for PPI inflation than for CPI and GDP deflator inflation. Moreover, the idiosyncratic component of the output gap is insignificant in both specifications, and the corresponding common component is only marginally significant in specification (13). Overall, the robustness checks presented in this paragraph suggest that the finding from our baseline that the common component of demand conditions has significant explanatory power for domestic inflation is fragile.

We introduce in *specification (15), 'FOR COMP'*, imports over GDP as a measure of exposure to foreign competition. One rationale for this is given by Batini et al. (2005) who show that, in a New Keynesian Phillips curve framework, if the optimal price of a firm depends on variable equilibrium markup, so will aggregate inflation. Direct markup measures for the countries and the sample period considered here are difficult to obtain. Batini et al. (2005) argue that the equilibrium markup has a cyclical element (which we have already captured by the output gap) and is also influenced by the extent of competition faced by the firm in the product market which depends on the weakness or strength of foreign competition. We find that our proxy of foreign competition dampens inflation significantly.[15] Batini et al. (2005) measure foreign competition by relative prices and argue that, if the world price of domestic GDP decreases because of an appreciation of the domestic currency, domestic firms face increased international competition and will tend to lower their equilibrium markup. They estimate New Keynesian Phillips curves for the UK and find that foreign competition

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[14] We used the Gauss routines provided by Pierre Perron on his website. The break dates are available upon request.
[15] Pain et al. (2006) use a similar variable, the import penetration or import content of domestic demand, to approximate foreign competition. We have also used their variable, and results are virtually the same.

lowers inflation, although this result is not robust across various specifications. Following their approach, we have, alternatively, approximated the degree of competition with a measure proposed by the OECD which reflects a country's competitive position and is based on relative consumer prices (for details on the indicator see Appendix A). That measure has the expected sign and is significant. In Table 4, we only provide results for imports over GDP, but make results for the competitiveness indicator available upon request.

In *specification (16), 'OIL SUP'*, we introduce oil supply shocks, constructed using a method proposed by Kilian (2008), who explicitly disentangles oil supply and oil demand effects[16]. Movements in commodity import prices may not only be demand-driven (and therefore at least partly globalization-driven), but may also reflect oil supply effects. Including oil supply shocks should help us to isolate movements in commodity import prices related to globalization from those unrelated to globalization. The oil supply shocks, however, do not enter the equation significantly, and the coefficient of commodity import price inflation does not change.

Exchange rate fluctuations are also a major determinant of import prices. To separate the effects of movements in import prices due to exchange rate fluctuations from those of movements in import prices due to other reasons, in *specification (17), 'NEER'* we include changes in nominal effective exchange rates. We find that an appreciation of the domestic currency tends to lower inflation, which is consistent with the finding by Honohan and Lane (2003) and Mody and Ohnsorge (2007), but that the effect is insignificant. The coefficient of non-commodity import price inflation is barely changed by the inclusion of the exchange rate changes.

To control for shifts in central banks' inflation targets and inflation expectations, we introduce in *specification (18), 'MON CRED'*, a measure of monetary credibility in the equation. That measure is calculated from bond yields (for details see Appendix A) and has been proposed by Laxton and N'Diaye (2002) and also used by the IMF (2006). We find that monetary credibility has significantly dampened inflation in the past. The coefficients of most other variables remain largely unaffected by the inclusion of monetary credibility in the equation. However, the coefficient of the common component of unit labor cost changes declines slightly, as does the coefficient of past inflation.

Finally, we also apply a principal component analysis to this measure of monetary credibility and split it into a common and an idiosyncratic part. Monetary policy is increasingly similar across countries. The simultaneous tendencies in many countries toward greater independence of central banks, better communication strategies and improved techniques, as emphasized by Rogoff (2003), are one aspect of the issue. The fact that central bankers exchange views on a global level through official meetings, conferences and publications may have contributed to

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[16] We are grateful to Lutz Kilian for providing us with his measure of real economic activity. For further details on the construction of the oil supply shock measure, see Appendix A.

a convergence of monetary strategies (Ciccarelli and Mojon 2008). Another aspect is that globalization itself may have affected monetary policy. Greater competition may lead to more flexible prices and wages, tempering the real effects of monetary policy. Moreover, it reduces the wedge between employment and output and their competitive levels which is typically created by monopolistic power in product and labor markets. Both factors may reduce the incentive for a central bank to inflate, contribute to greater monetary policy credibility and lower inflation targets (Rogoff, 2003, 2006). All this will be reflected in the common component. We find an important global component of monetary credibility, with the first factor explaining 79% of the variance. The second factor accounts for 7% of the total variation, while the third to fifth factors explain much less (4%, 4% and 2%, respectively). To investigate whether the common component or the country-specific component of monetary credibility matters for inflation, we have included these components separately in the equation (*specification (19), 'MONCRED F'*). Both components enter the equation significantly and with similar coefficients.[17]

We have carried out further robustness checks not presented in Table 4. The results remain robust (compared to the baseline regression) when we replace CPI inflation with core CPI (excluding food and energy) or when we compute the output gap as deviations from a quadratic trend. We have also separately included the common and idiosyncratic components of past inflation in the equation and find that the persistence of inflation is common rather than idiosyncratic. The coefficients are at 0.59 and 0.24, respectively. To address possible endogeneity problems, we have removed the contemporaneous regressors and replaced the contemporaneous output gap components with output gap components of lag $t-1$. The results remain unaffected. These findings are available upon request.

6. Globalization and estimated coefficients

In this subsection, we consider explicitly the role of globalization and try to provide cross-sectional and time-series evidence on whether the coefficients of global determinants (i.e. the common components of the output gap, changes in unit labor costs and import price inflation)/national determinants (i.e. the idiosyncratic components of the output gap and changes in unit labor costs) increase/decrease with greater openness.

It is unclear *a priori* how globalization would affect the coefficients. Due to the increased share of trade in GDP, one may expect the effects of global determinants on inflation to have increased over time and those of country-specific determinants to have a smaller impact. However, there are also arguments which lead us to expect that the effects of both global and national components may change with the same sign. Greater competition makes it hard for firms to raise prices during booms which would lower the sensitivity of inflation with respect

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[17] The results are similar if we only average coefficients across EMU countries.

to movements in marginal costs and hence flatten the Phillips curve (IMF 2006). By contrast, if prices become more flexible as a consequence of greater competition, this should steepen the Phillips curve, as is pointed out by Rogoff (2006). If global competition is more intense than national competition, the global components' coefficients can be expected to change more. To understand the net effect of globalization on the coefficients an empirical investigation is required.

There is some consensus in previous empirical studies that the sensitivity of inflation to the domestic output gap has decreased, although no distinction is made between global and idiosyncratic components. It is, however, unclear whether and to what extent this is due to globalization. IMF (2006) and Ball (2006) find some support for this hypothesis. Ihrig et al. (2007) and Mody and Ohnsorge (2007), however, do not confirm their findings. According to the latter study, however, openness has a significantly negative impact on the effects of changes in unit labor costs in its sample of European countries. Lastly, there is no consensus on whether globalization has altered the import price pass-through. While IMF (2006) and Pain et al. (2006) find evidence in favor of this effect, Ihrig et al. (2007) emphasize that it is unclear whether the coefficient of import price inflation has indeed increased and whether this is due to globalization. The latter authors interact import price inflation with openness, but find it to be positive and significant only if the interaction term, and not both the interaction term and import price inflation itself, are included in the equation.

We first provide cross-sectional evidence based on our baseline estimates. Figure 4 shows no clear relationship between openness – here measured by imports divided by GDP averaged over our sample period – and coefficients of either global or country-specific determinants of inflation.

We then depart from our constant parameter approach and re-estimate our baseline equation (2) based on a rolling window.[18] The reason for this is that globalization is an ongoing process and may have altered parameter estimates. The time-varying MG coefficient estimates are provided in Figure 5.[19] We compute estimates based on both 10- and 15-year rolling windows in order to examine whether results are robust with respect to the width of the window. Based on the 15-year window it seems that the coefficient estimates are fairly stable over time. Only the coefficients of import price inflation and the idiosyncratic component of changes in unit labor costs seem to have come down somewhat. When estimated based on a 10-year rolling window coefficients are more volatile and it is difficult to identify clear trends. Only the coefficient associated to the common component of the output gap visibly tends downward.

Has globalization led to parameter changes? In *specification (20), 'PC SLOPE'*, we interact the components of the output gap and changes in unit labor costs with openness, measured as

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[18] Factors were estimated based on the full sample.
[19] Time-varying coefficient estimates for individual countries are available upon request.

imports divided by GDP. To control for the influence of monetary policy, we also interact these components with monetary credibility.[20] The results are mixed. Openness indeed seems to have increased the impact of fluctuations of the global component of unit labor cost changes on inflation. However, it has reduced the impact of movements in the global component of the output gap. The remaining interaction terms with openness involved, however, are insignificant. Monetary policy credibility has lessened the sensitivity of inflation to the global component of the output gap and the idiosyncratic component of changes in unit labor costs, but – surprisingly – increased its sensitivity to the output gap's idiosyncratic component.

In *specification (21), 'IM PRICES'*, we interact import price inflation with openness and monetary credibility. Most interaction terms are insignificant except for the interaction term between openness and commodity import price inflation, which is significantly negative. This puzzling result suggests that globalization has not led to a greater import price pass-through, but is compatible with the findings in Ihrig et al. (2007). To investigate whether this result is driven by the decline in the exchange rate pass-through observed for many countries (cf. White 2008), we have included exchange rate changes in the equation, yet the results remain the same. We also re-introduce oil supply shocks in the equation to investigate whether reduced oil dependence in many industrial countries could have driven this result. The coefficient of the interaction term of openness with commodity import price inflation is now insignificant. Lastly, following Ihrig et al. (2007), we have investigated whether multicollinearity may be a problem and removed import price inflation from the equation, only leaving the interaction terms; however, contrary to the authors' findings, the result that openness has not increased the commodity import price pass-through remains unaffected. When focusing on individual countries, openness interacted with commodity import price inflation is positive and significant at the 5% level only in Ireland and with non-commodity import price inflation in the Netherlands and Sweden and at the 10% significance level in New Zealand. This issue certainly deserves further investigation.

Overall, results are mixed. One interpretation of our results of sections 4 and 5 is that spillovers which should depend on openness do not or not only lie behind the common components, but rather global shocks or internationally correlated shocks, which is consistent with what Ciccarelli and Mojon (2008) find.

7.   Factor-augmented monetary policy rules

Our finding that inflation rates have an important global component and that both import price inflation and the global component of unit labor cost changes have an important impact on

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[20] Due to data limitations, we do not capture other possible determinants such as tighter fiscal policy, deregulation and technological progress here (Rogoff 2003).

inflation implies that monetary policy makers need to carefully monitor common forces to successfully assess and predict inflation. To illustrate whether central banks have in the past (explicitly or implicitly) reacted to the global components of inflation and the output gap when defining monetary policy, we estimate monetary policy rules for the 1980Q3-2007Q1 period. In analogy to our Phillips curve regressions, we do not estimate forward-looking monetary policy rules.

We start by estimating a standard monetary policy rule:

$$r_{it} = \tilde{\rho}_i r_{it-1} + (1 - \tilde{\rho}_i)\tilde{\vartheta}_i 400\Delta p_{it} + (1 - \tilde{\rho}_i)\tilde{\varsigma}_i 100 y_{it} + \tilde{w}_{it}, \tag{4}$$

where the r_{it} is the short-term (3-month money market) rate and $400\Delta p_{it}$ and $100 y_{it}$ the annualized CPI inflation rate and output gap, both in percent. The estimation is carried out with TSLS to avoid endogeneity problems. We follow Clarida et al. (1998, 1999) and use past regressors (up to lag 4) as well as the past spread between long- and short-term interest rates and changes in unit labor costs as instruments. The estimation is made for all OECD countries which are not members of EMU since there has been a single monetary policy in the euro area since 1999. Under the assumption that euro-area monetary policy is well approximated by German monetary policy, we have repeated the estimation for all countries except for EMU countries but including Germany. The results are similar and are available upon request. Table 6 (*specification (22)*) shows the cross-country averages of the estimates for $\tilde{\rho}_{it}$, $\tilde{\vartheta}_i$ and $\tilde{\varsigma}_i$. The output gap and the inflation rate both enter the standard monetary policy rule significantly. The coefficient of inflation exceeds unity, indicating that the Taylor principle is satisfied.[21]

In *specification (23)*, we include the common and idiosyncratic components of the output gap and inflation separately in the equation:

$$r_{it} = \rho_i r_{it-1} + (1 - \rho_i)(\vartheta_i 400\Delta p_{it}^{ic} + \tau_i 400\Delta p_{it}^{cc}) + (1 - \rho_i)(\varsigma_i 100 y_{it}^{ic} + \upsilon_i 100 y_{it}^{cc}) + w_{it}, \tag{5}$$

and in Table 6 the cross-section averages of the estimates for ρ_i, ϑ_i, τ_i, ς_i and υ_i are presented. We allow monetary policy to respond differently to common and idiosyncratic components, which can be justified with possible repercussions of common shocks on other countries and other central banks' reactions to such common shocks on the domestic economy. Interestingly, the coefficients of the common components of both inflation and the output gap exceed the coefficients of the corresponding idiosyncratic components. The standard error of the coefficient of the output gap's common component, however, is large, and that component is insignificant at the 5% level. Again, we can assess whether central

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[21] The output gap coefficient is greater than what is usually found (cf. Clarida et al. 1998, 1999). The reason is that we compute the output gap throughout the paper as the HP-filtered GDP, whereas in those papers the output gap is measured as deviations from a quadratic trend. When we replace our output gap measure with deviations of GDP from the quadratic trend, the size of the coefficient declines and becomes consistent with the coefficients estimated in Clarida et al. (1998, 1999), but the main message remains unaffected. We therefore continue to compute output gaps as HP-filtered GDPs.

banks' reactions to common and idiosyncratic components are significantly different. The Wald test rejects the null hypothesis of equal coefficients for the inflation components (test statistic: 28.75), but not for the output gap components (test statistic: 0.66). We conclude that central banks reacted significantly to movements in the idiosyncratic component of the output gap and the common and idiosyncratic components of inflation.

One interpretation of the finding that monetary policy has in the past significantly reacted to the common component of inflation is that it has reacted to global forces. Again, the interpretation of our finding that global components matter in monetary rules differs from findings of studies which augment monetary rules with foreign variables such as exchange rates and terms of trade and generally do not find an important role for these variables (see Rogoff 2006 and references therein). With regard to these studies, Rogoff (2006) argues that "[i]t remains to be shown that there are large gains to separately incorporating the terms of trade [or exchange rates], once output and inflation already enter the central bank's rule". Due to our approach of considering common and idiosyncratic components of domestic inflation and output gap, we allow global forces to affect monetary policy instruments *through* their impact on the domestic output gap and inflation.

The significant coefficient of the common component of inflation in the monetary rule could, however, also be due to the fact that the common component may represent a better signal for monetary policy makers. The common factors have been estimated as weighted averages of individual countries' inflation rates. If high-frequency movements have been "averaged out", and given the medium-run orientation of central banks, a relatively large coefficient of the common component may not come as a surprise. As shown in Figure 6, the spectral density averaged over all countries of the (standardized) idiosyncratic components of both inflation and the output gap exceeds the corresponding spectral density of the common components at relatively high frequencies, whereas the opposite holds for lower frequencies. Which of the two possible explanations for the differing coefficients holds cannot be ultimately clarified here and is left for future work.

8.   Conclusion

The paper has examined the global dimension of inflation in 24 OECD countries between 1980 and 2007 in a traditional Phillips curve framework. Its main contribution has been to decompose output gaps and changes in unit labor costs into common and idiosyncratic components based on a factor analysis and to introduce these components separately in the regressions. This approach differs from previous studies which have included the foreign output gap in addition to the domestic output gap in the regression, by allowing global forces to affect inflation through (the common part of) domestic demand and supply conditions. Our most important result is that the common component of changes in unit labor costs has a notable impact of inflation. We have also found evidence that movements in import price

inflation affect CPI inflation while the impact of movements in the common component of the output gap is unclear.

Our analysis further suggests that coefficients vary considerably across countries. A counterfactual experiment has illustrated that the common component of unit labor cost changes and non-commodity import price inflation have held down overall inflation in many countries in recent years, whereas commodity import price inflation has only increased the short-run volatility of inflation.

What do our results imply for policy makers? Policy makers need to take global forces into account when assessing and predicting inflation. As noted by Ciccarelli and Mojon (2008), neglecting global conditions may severely worsen the quality of forecasts. We have estimated monetary policy rules with common and idiosyncratic components of inflation and the output gap included separately. Central banks have, indeed, reacted to the common components of inflation and the output gap in recent times. Another implication is that policy makers, against the background of their medium-term focus, should not worry too much about movements in commodity import prices by itself which only raise short-run volatility.

This paper has uncovered scope for future work. First, the question arises what lies behind the common component of changes in unit labor costs. The international dimension of labor markets and productivity growth and their impact on inflation have been largely neglected in the literature on globalization and inflation. An exception is Jaumotte and Tytell (2008), who show that globalization has contributed to the decline of the labor income share worldwide. However, technological progress, and especially the ICT revolution, are found to be another determinant, although the authors also argue that technological progress and globalization are not independent. Further work assessing the international forces driving unit labor costs would be useful. It would also be interesting to embed the hypothesis that globalization has lowered inflation and that one channel might be productivity and wage dynamics into a fully micro-founded New Keynesian Phillips curve model, which would facilitate interpretation.

Appendix A

We consider the following countries in our sample: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the UK, and the US.

The variables used throughout the paper are defined as follows. CPI, PPI, GDP deflator and core CPI inflation are the log quarter-on-quarter differences of the consumer, producer, GDP deflator price index and the consumer price index without food and energy. The output gap is obtained by applying a Hodrick-Prescott filter to real GDP. Changes in unit labor costs and in import prices are log (quarter-on-quarter) differences (of indices in the case of import prices).

The unit labor cost data we use refer to the manufacturing sector. The OECD provides so called trend-cycle series which it obtains from applying TRAMO-SEATS to the raw series. Those trend-cycle series can be seen as a smoothed series, where the degree of smoothing is dependent on the underlying ARIMA model. The OECD recommends the use of trend-cycle series, arguing that this treatment reduces the volatility of estimated quarter-on-quarter rates of change and effectively extracts the underlying signal in the raw data. We follow the OECD's recommendation and use the trend-cycle data throughout our paper. For a few countries, only annual data were available, which we interpolated using a quadratic matching function. Our baseline results do not change if we use seasonal adjusted instead of trend-cycle series nor if we use seasonal adjusted series for the total economy instead of only the manufacturing sector.[22] These estimations are available upon request.

Break points in the means of CPI inflation, changes in unit labor costs and import price inflation were estimated using the sequential multiple breakpoint test procedure suggested by Bai and Perron (1998, 2003). We accounted for the breaks in the means by removing (potentially) shifted means prior to the estimation. $\Delta neer$ is an appreciation of the log of the nominal effective exchange rates. All series are seasonally adjusted.

The estimation of oil supply shocks is based on Kilian (2008), where the reader may want to look for details. The shocks are estimated from a VAR(24) fitted to the log differences of oil production, an index of real economic activity which was constructed and provided to us by Lutz Kilian, and the log of the real price of oil which is also the ordering for the Cholesky decomposition. The oil supply shocks are the shocks in the oil production equation.

Openness is measured as imports over GDP. As an alternative measure of foreign competition, we have used the competitiveness positive based on relative consumer prices provided by the OECD.

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[22] We are grateful to David Brackfield for sending us the unit labor cost data. For details on the data, see http://stats.oecd.org/metadata/publish.asp?ds=1&co=.ULQBBU.......&lvl=0&forma for details.

Monetary policy credibility is constructed as in Laxton and N'Diaye (2002): $moncred_{it} = \left(rl_{it} - rl_i^{high}\right)^2 / \left(\left(rl_{it} - rl_i^{high}\right)^2 + \left(rl_{it} - rl_i^{low}\right)^2\right)$, where rl_{it} is the long-term interest rate in period t for country i, rl_i^{high} denotes the maximum yields of country i over the sample period and rl_i^{low} is set to 2%. As argued by Laxton and N'Diaye (2002) that measure is based on the notion that long-term interest rates contain an inflation premium that may be useful for identifying periods of low and high credibility of monetary policy. When long-term interest rates are low $\left(rl_{it} = rl_i^{low}\right)$, the credibility of a low and stable inflation regime is likely to be high and when long-term interest rates are high $\left(rl_{it} = rl_i^{high}\right)$, credibility is likely to be low. The functional form is chosen so that the variable lies between 0 and 1. Notice that the measure is based on the implicit assumption that most of the variation in long-term interest rates between low and higher inflation regimes was the result of variation in inflation expectations rather than of variation in the real interest rate. Laxton and N'Diaye (2002) show for the UK that this is indeed the case. The IMF (2006) also uses that measure in a traditional Phillips curve framework and argues that, in a sample of advanced countries, the measure mostly reflects inflation expectations and therefore also the record of previous stabilization policies and various institutional arrangements, including central bank independence, transparency and accountability.

As we have pointed out in the main text, some series contain gaps where values are missing, which we have filled using the EM algorithm. This algorithm involves, in a first step, extracting factors from datasets which include all time series with missing values where the latter are replaced with initial estimates. We have taken as initial estimates the unconditional means of the series. These factors are then used in a second step to obtain improved estimates of the missing observations. The estimation procedure is repeated until convergence. The EM algorithm enables us to consider a large number of countries and periods. For more details on the EM algorithm, the reader is referred to Stock and Watson (2002a). In our baseline regression equation (2), values are missing only for import commodity and non-commodity prices for Denmark between 1980Q3 and 1999Q4 which we replaced by estimates. To assess whether this represents a problem, we repeat the estimation of equation (2) without Denmark. The results remain the same, however.

German unification is accounted for by applying West German growth rates to the levels of total German data backwards in the past. All time series are taken from the OECD Main Economic Indicators and the Economic Outlook.

Appendix B

This appendix describes the bootstrap used to assess whether and to what extent accounting for the uncertainty involved with the estimation of the common and idiosyncratic components matter for the coefficient estimates of the baseline equation (2).

It is assumed that common factors and the idiosyncratic components of the variable x_{it} (here the output gap and unit labor cost changes), f_t^x and x_t^{ic}, follow VAR(1) and AR(1) processes:

$$f_t^x = B^x f_{t-1}^x + \varepsilon_t^x, \tag{B1}$$

$$x_{it}^{ic} = b_i^x x_{it-1}^{ic} + \varepsilon_{it}^x, \forall i, \tag{B2}$$

with $\mathrm{E}\left(\varepsilon_t^x \varepsilon_t^x{}'\right) = \Gamma^x$ and $\mathrm{E}\left((\varepsilon_{it}^x)^2\right) = \sigma_i^x$. Estimation of equations (B1) and (B2) yields estimates for B^x, b_i^x, Γ^x and σ_i^x.

We start the bootstrap by drawing $\breve{\varepsilon}_t^x \sim N(0, \hat{\Gamma}^x)$ and $\breve{\varepsilon}_{it}^x \sim N(0, \hat{\sigma}_i^x)$. We generate $\breve{f}_t^x$ and $\breve{x}_{it}^{ic}$ recursively using $\breve{\varepsilon}_t^x$ and $\hat{B}^x$, $\breve{\varepsilon}_{it}^x$ and $\hat{b}_i^x$, respectively. The factors are normalized to have a variance of 1. The common components are generated as $\breve{x}_{it}^{cc} = \hat{\lambda}_i^x{}' \breve{f}_t^x$ and the variables x_t are generated as $\breve{x}_{it} = \breve{x}_{it}^{cc} + \breve{x}_{it}^{ic}$.

Next, we estimate common and idiosyncratic components of the output gaps and unit labor cost changes generated in this manner. We then draw from the residuals of the baseline equation (2), u_{it}, thereby taking into account the cross-section correlation, yielding $\breve{u}_{it}$. $\breve{u}_{it}$, the coefficient estimates of equation (2), the generated common and idiosyncratic components of the output gap and changes in unit labor costs and the true series of commodity and non-commodity import price inflation and past CPI inflation are used to generate hypothetical inflation series, $\Delta\breve{p}_{it}$. We replace Δp_{it} with $\Delta\breve{p}_{it}$ and y_{it}^{cc}, y_{it}^{ic}, Δulc_{it}^{cc} and Δulc_{it}^{ic} with the corresponding generated components in equation (2). We re-estimate that equation and save the coefficient estimates. This procedure is repeated 1,000 times. The lower and upper 2.5 percentiles of the coefficients are reported in Table 4 (*specification (9)*).

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Table 1: Variance shares of CPI inflation, the output gap and changes in unit labor costs explained by the first five factors

	CPI inflation					Output gap					Δ unit labor costs				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
AUS	0.45	0.21	0.00	0.03	0.05	0.16	0.50	0.00	0.13	0.06	0.26	0.10	0.00	0.14	0.02
AUT	0.55	0.14	0.00	0.02	0.01	0.42	0.22	0.04	0.01	0.07	0.29	0.10	0.18	0.00	0.03
BEL	0.71	0.02	0.10	0.02	0.01	0.80	0.02	0.00	0.01	0.01	0.27	0.28	0.01	0.04	0.00
CAN	0.75	0.00	0.00	0.10	0.00	0.32	0.47	0.00	0.03	0.01	0.35	0.04	0.17	0.13	0.06
DNK	0.67	0.01	0.06	0.03	0.02	0.06	0.09	0.13	0.24	0.25	0.49	0.04	0.03	0.07	0.00
FIN	0.80	0.01	0.00	0.00	0.03	0.53	0.06	0.17	0.01	0.01	0.54	0.09	0.05	0.00	0.00
FRA	0.86	0.00	0.06	0.00	0.01	0.56	0.19	0.04	0.01	0.00	0.66	0.06	0.02	0.03	0.01
DEU	0.37	0.34	0.00	0.02	0.04	0.36	0.15	0.22	0.09	0.01	0.37	0.12	0.08	0.14	0.04
GRC	0.62	0.04	0.12	0.07	0.01	0.09	0.01	0.05	0.00	0.10	0.43	0.09	0.14	0.00	0.00
ISL	0.63	0.11	0.02	0.03	0.04	0.08	0.07	0.00	0.11	0.25	0.52	0.19	0.03	0.03	0.01
IRL	0.66	0.01	0.16	0.02	0.00	0.53	0.04	0.00	0.01	0.04	0.35	0.01	0.02	0.13	0.02
ITA	0.89	0.00	0.01	0.01	0.02	0.69	0.00	0.01	0.05	0.01	0.68	0.04	0.00	0.08	0.00
JPN	0.39	0.06	0.16	0.03	0.05	0.28	0.07	0.02	0.03	0.12	0.16	0.01	0.16	0.00	0.05
KOR	0.29	0.15	0.16	0.16	0.13	0.01	0.00	0.13	0.53	0.06	0.33	0.04	0.00	0.00	0.28
MEX	0.17	0.57	0.03	0.01	0.00	0.09	0.05	0.31	0.21	0.04	0.20	0.09	0.02	0.41	0.01
NLD	0.31	0.38	0.11	0.00	0.00	0.62	0.00	0.16	0.01	0.00	0.19	0.49	0.03	0.00	0.03
NZL	0.64	0.09	0.00	0.08	0.00	0.00	0.37	0.02	0.05	0.15	0.30	0.02	0.28	0.02	0.09
NOR	0.44	0.19	0.00	0.07	0.07	0.00	0.21	0.37	0.13	0.04	0.41	0.01	0.02	0.12	0.02
PRT	0.68	0.04	0.01	0.14	0.00	0.36	0.26	0.13	0.03	0.04	0.70	0.02	0.10	0.00	0.02
ESP	0.82	0.02	0.01	0.02	0.00	0.57	0.10	0.06	0.00	0.02	0.54	0.01	0.15	0.00	0.02
SWE	0.68	0.00	0.09	0.02	0.00	0.65	0.07	0.03	0.05	0.04	0.53	0.00	0.14	0.00	0.00
CHE	0.58	0.10	0.08	0.01	0.11	0.69	0.00	0.08	0.03	0.02	0.72	0.01	0.00	0.00	0.08
GBR	0.70	0.01	0.04	0.00	0.01	0.20	0.34	0.27	0.00	0.04	0.21	0.03	0.03	0.00	0.39
USA	0.57	0.08	0.03	0.08	0.02	0.24	0.42	0.11	0.03	0.00	0.32	0.06	0.00	0.19	0.00
Total	0.59	0.11	0.05	0.04	0.03	0.35	0.16	0.10	0.08	0.06	0.41	0.08	0.07	0.06	0.05

Table 2: Baseline regression results – mean group estimates

	(1) NO FACTORS		(2) BASELINE	
	coeff	tstat	coeff	tstat
$\Delta p_{t-1,\dots,t-4}$	0.51	22.58	0.41	15.99
y_t	0.04	4.66		
y^{ic}_t			0.03	2.59
y^{cc}_t			0.07	3.43
$\Delta ulc_{t,t-1,\dots,t-4}$	0.17	10.69		
$\Delta ulc^{ic}_{t,t-1,\dots,t-4}$			0.12	6.83
$\Delta ulc^{cc}_{t,t-1,\dots,t-4}$			0.37	12.61
$\Delta imc_{t,t-1,\dots,t-4}$	0.02	5.38	0.03	6.20
$\Delta imnc_{t,t-1,\dots,t-4}$	0.11	10.53	0.10	8.41
R^2	0.90		0.91	

Notes: The sums of the coefficients associated with the indicated lags and the cross-country average of the coefficients are provided. The estimation is carried out with cross-section SUR. For details on the estimation and the variables, see the text.

Table 3: Baseline regression results - individual countries

	AUS coeff	AUS tstat	AUT coeff	AUT tstat	BEL coeff	BEL tstat	CAN coeff	CAN tstat
$\Delta p_{t-1,...,t-4}$	0.46	3.01	0.47	4.48	0.65	6.22	0.26	2.77
y^{ic}_t	0.07	0.98	0.05	0.95	0.00	-0.04	-0.07	-1.29
y^{cc}_t	0.15	2.99	0.09	1.75	-0.03	-0.67	0.07	2.30
$\Delta ulc^{ic}_{t,t-1,...,t-4}$	0.10	1.02	0.17	2.59	-0.05	-0.62	0.23	3.89
$\Delta ulc^{cc}_{t,t-1,...,t-4}$	0.35	2.17	0.16	1.47	0.25	2.77	0.51	5.35
$\Delta imc_{t,t-1,...,t-4}$	0.03	1.48	0.03	2.96	0.04	3.61	0.05	2.75
$\Delta imnc_{t,t-1,...,t-4}$	0.11	2.99	0.12	2.19	0.11	2.47	0.09	2.46

	DNK coeff	DNK tstat	FIN coeff	FIN tstat	FRA coeff	FRA tstat	DEU coeff	DEU tstat
$\Delta p_{t-1,...,t-4}$	0.62	6.83	0.19	1.65	0.01	0.07	0.60	6.90
y^{ic}_t	0.03	0.91	0.07	3.19	-0.03	-0.48	-0.01	-0.40
y^{cc}_t	0.22	2.58	0.12	5.02	-0.10	-2.65	0.06	1.60
$\Delta ulc^{ic}_{t,t-1,...,t-4}$	0.06	0.86	-0.26	-4.14	0.56	6.16	0.01	0.12
$\Delta ulc^{cc}_{t,t-1,...,t-4}$	0.09	1.26	0.46	5.70	0.66	6.43	0.12	1.60
$\Delta imc_{t,t-1,...,t-4}$	0.00	0.23	0.02	2.84	0.02	3.03	0.03	2.71
$\Delta imnc_{t,t-1,...,t-4}$	0.11	1.27	-0.01	-0.32	0.14	2.91	0.04	0.88

	GRC coeff	GRC tstat	ISL coeff	ISL tstat	IRL coeff	IRL tstat	ITA coeff	ITA tstat
$\Delta p_{t-1,...,t-4}$	0.46	4.62	0.01	0.07	0.74	10.11	0.77	9.52
y^{ic}_t	0.06	1.90	-0.05	-0.87	-0.03	-0.74	0.03	0.77
y^{cc}_t	0.13	1.35	-0.11	-0.81	0.02	0.62	0.01	0.26
$\Delta ulc^{ic}_{t,t-1,...,t-4}$	0.26	3.95	0.62	5.69	0.04	0.95	0.02	0.52
$\Delta ulc^{cc}_{t,t-1,...,t-4}$	0.35	4.37	0.58	5.55	0.09	1.30	0.15	1.85
$\Delta imc_{t,t-1,...,t-4}$	0.05	2.21	0.10	2.88	0.03	1.83	0.01	0.93
$\Delta imnc_{t,t-1,...,t-4}$	0.16	3.28	0.28	3.89	0.07	1.24	0.02	1.16

	JPN coeff	JPN tstat	KOR coeff	KOR tstat	MEX coeff	MEX tstat	NLD coeff	NLD tstat
$\Delta p_{t-1,...,t-4}$	0.38	2.73	0.52	5.72	0.13	0.92	0.60	6.78
y^{ic}_t	0.05	0.97	0.01	0.37	-0.09	-1.00	0.06	1.61
y^{cc}_t	-0.04	-0.67	0.33	1.20	-0.34	-1.67	0.05	1.51
$\Delta ulc^{ic}_{t,t-1,...,t-4}$	0.08	1.32	0.15	2.27	0.67	5.23	0.06	0.65
$\Delta ulc^{cc}_{t,t-1,...,t-4}$	0.33	2.29	-0.01	-0.09	0.85	4.49	0.09	1.57
$\Delta imc_{t,t-1,...,t-4}$	0.01	0.88	-0.02	-0.90	0.06	1.28	0.03	3.86
$\Delta imnc_{t,t-1,...,t-4}$	0.03	0.77	0.06	2.48	0.11	1.68	0.01	0.30

	NZL coeff	NZL tstat	NOR coeff	NOR tstat	PRT coeff	PRT tstat	ESP coeff	ESP tstat
$\Delta p_{t-1,...,t-4}$	0.28	2.64	0.29	2.83	0.16	1.47	0.25	2.18
y^{ic}_t	0.02	0.53	0.28	4.44	-0.02	-0.20	0.15	2.43
y^{cc}_t	0.15	2.22	0.55	3.95	0.07	1.21	-0.03	-0.62
$\Delta ulc^{ic}_{t,t-1,...,t-4}$	0.10	1.70	-0.22	-1.38	0.19	1.64	0.06	0.70
$\Delta ulc^{cc}_{t,t-1,...,t-4}$	0.42	3.70	1.46	4.93	0.42	3.69	0.60	4.11
$\Delta imc_{t,t-1,...,t-4}$	0.01	0.55	0.02	0.75	0.05	2.31	0.01	1.20
$\Delta imnc_{t,t-1,...,t-4}$	0.09	2.35	0.02	0.27	0.34	5.30	0.19	5.60

	SWE coeff	SWE tstat	CHE coeff	CHE tstat	GBR coeff	GBR tstat	USA coeff	USA tstat
$\Delta p_{t-1,...,t-4}$	0.31	2.51	0.65	5.49	0.58	6.31	0.44	4.81
y^{ic}_t	-0.01	-0.11	-0.01	-0.25	0.11	2.52	0.00	0.10
y^{cc}_t	0.04	0.53	0.10	2.50	0.14	2.86	0.04	1.32
$\Delta ulc^{ic}_{t,t-1,...,t-4}$	0.09	1.03	-0.17	-1.34	0.11	2.17	0.01	0.18
$\Delta ulc^{cc}_{t,t-1,...,t-4}$	0.36	2.77	0.23	2.22	0.38	2.79	0.09	1.15
$\Delta imc_{t,t-1,...,t-4}$	0.03	2.35	0.01	0.79	0.03	2.05	0.01	1.42
$\Delta imnc_{t,t-1,...,t-4}$	0.14	2.22	-0.05	-1.11	0.05	1.46	0.07	1.99

Notes: The sums of the coefficients associated with the indicated lags are provided. The estimation is carried out with cross-section SUR and refers to specification (2).

Table 4: Regression results – robustness checks and other variables

	(3) WITHOUT Y		(4) WITHOUT ΔULC		(5) WITHOUT ΔIM		(6) GDP WEIGHTS		(7) WITHOUT USA		(8) WITHOUT USA AND WITH US y		(9) BOOTSTRAP		(10) 1985-2007		(11) STRUCT BREAK	
	coeff	tstat	coeff	tstat	coeff	tstat	coeff	tstat	coeff	tstat	coeff	tstat	lb	ub	coeff	tstat	coeff	tstat
$\Delta p_{t-1,...,t-4}$	0.48	19.50	0.67	35.72	0.49	20.11	0.43	9.81	0.41	15.38	0.39	14.26	0.37	0.45	0.35	10.60	0.29	10.06
y^{ic}_t			0.05	4.73	0.03	2.33	0.02	1.17	0.03	2.56	0.03	2.30	0.00	0.05	0.01	0.41	0.03	3.08
y^{cc}_t			0.07	3.90	0.05	2.42	0.03	1.40	0.08	3.50	0.08	2.94	0.03	0.12	0.12	4.42	0.09	4.21
$\Delta ulc^{ic}_{t,t-1,...,t-4}$	0.13	8.14			0.09	4.91	0.10	3.96	0.12	6.58	0.12	6.49	0.08	0.16	0.09	4.56	0.03	1.50
$\Delta ulc^{cc}_{t,t-1,...,t-4}$	0.30	10.48			0.36	12.33	0.26	6.28	0.39	12.80	0.42	13.35	0.34	0.42	0.34	9.16	0.16	5.48
$\Delta imc_{t,t-1,...,t-4}$	0.03	5.77	0.01	2.18			0.02	4.13	0.03	6.67	0.03	7.14	0.02	0.04	0.02	5.09	0.03	5.71
$\Delta imnc_{t,t-1,...,t-4}$	0.09	8.03	0.10	9.27			0.07	4.65	0.09	7.96	0.10	8.00	0.07	0.12	0.07	5.89	0.04	3.28
$imshare_{t,t-1,...,t-4}$																		
$oil\ sup_{t,t-1,...,t-4}$																		
$\Delta neer_{t,t-1,...,t-4}$																		
$moncred_t$																		
$moncred^{ic}_t$																		
$moncred^{cc}_t$																		
y^{us}_t											0.01	0.48						
R^2	0.91		0.88		0.87		0.91		0.91		0.85		0.92		0.85		0.71	

|	(12) UNEMPL RATE		(13) PPI		(14) GDP DEFL		(15) FOR COMP		(16) OIL SUP		(17) NEER		(18) MONCRED		(19) MONCRED F	
	coeff	tstat	coeff	tstat	coeff	tstat	coeff	tstat	coeff	tstat	coeff	tstat	coeff	tstat	coeff	tstat
$\Delta p_{t-1,...,t-4}$	0.36	13.07	0.32	9.52	0.13	7.29	0.34	12.64	0.40	15.67	0.41	15.84	0.28	9.86	0.22	7.25
y^{ic}_t	-0.00	-0.76	-0.00	-0.01	0.00	0.18	0.04	3.67	0.02	2.04	0.02	2.13	0.03	2.87	0.03	2.44
y^{cc}_t	-0.00	-1.13	0.06	1.91	0.07	2.48	0.09	4.32	0.07	3.52	0.07	3.51	0.08	3.79	0.07	3.52
$\Delta ulc^{ic}_{t,t-1,...,t-4}$	0.11	5.85	0.06	2.25	0.17	6.18	0.12	6.31	0.13	7.33	0.11	6.43	0.11	5.70	0.10	5.08
$\Delta ulc^{cc}_{t,t-1,...,t-4}$	0.36	11.00	0.09	2.31	0.56	16.99	0.32	9.75	0.38	12.47	0.38	12.80	0.33	9.32	0.33	8.53
$\Delta imc_{t,t-1,...,t-4}$	0.03	6.28	0.11	12.00	0.01	1.72	0.03	7.05	0.03	5.56	0.03	5.38	0.03	6.89	0.03	7.37
$\Delta imnc_{t,t-1,...,t-4}$	0.10	8.89	0.17	8.09	0.08	4.19	0.10	8.19	0.08	7.22	0.09	5.13	0.09	7.83	0.09	7.99
$imshare_{t,t-1,...,t-4}$							-0.03	-5.27								
$oil\ sup_{t,t-1,...,t-4}$									-0.00	-0.64						
$\Delta neer_{t,t-1,...,t-4}$											-0.01	-0.59				
$moncred_t$													-0.01	-6.87		
$moncred^{ic}_t$															-0.00	-2.29
$moncred^{cc}_t$															-0.01	-6.88
y^{us}_t																
R^2	0.91		0.81		0.83		0.91		0.92		0.92		0.92		0.92	

Notes: The sums of the coefficients associated with the indicated lags and the cross-country average of the coefficients are provided. The estimation is carried out with cross-section SUR. For details on the estimation and the variables, see the text.

	(20) PC slope		(21) IM PRICES	
	coeff	tstat	coeff	tstat
$\Delta p_{t-1,\dots,t-4}$	0.25	7.99	0.42	15.81
y^{ic}_{t}	0.03	1.84	0.02	1.54
y^{cc}_{t}	0.08	3.02	0.05	2.71
$\Delta ulc^{ic}_{t,t-1,\dots,t-4}$	0.13	4.97	0.12	6.89
$\Delta ulc^{cc}_{t,t-1,\dots,t-4}$	0.48	14.57	0.35	12.87
$\Delta imc_{t,t-1,\dots,t-4}$	0.03	7.22	0.03	5.70
$\Delta imnc_{t,t-1,\dots,t-4}$	0.13	9.34	0.10	8.49
$y^{ic}_{t} * imshare_{t}$	-0.39	-0.62		
$y^{ic}_{t} * moncred_{t}$	0.25	2.82		
$y^{cc}_{t} * imshare_{t}$	-1.70	-2.36		
$y^{cc}_{t} * moncred_{t}$	-0.31	-2.27		
$\Delta ulc^{ic}_{t,t-1,\dots,t-4} * imshare_{t,t-1,\dots,t-4}$	0.22	0.19		
$\Delta ulc^{ic}_{t,t-1,\dots,t-4} * moncred_{t,t-1,\dots,t-4}$	-0.35	-2.71		
$\Delta ulc^{cc}_{t,t-1,\dots,t-4} * imshare_{t,t-1,\dots,t-4}$	2.52	2.58		
$\Delta ulc^{cc}_{t,t-1,\dots,t-4} * moncred_{t,t-1,\dots,t-4}$	-0.20	-1.55		
$\Delta imc_{t,t-1,\dots,t-4} * imshare_{t,t-1,\dots,t-4}$			-0.31	-2.35
$\Delta imc_{t,t-1,\dots,t-4} * moncred_{t,t-1,\dots,t-4}$			-0.02	-0.68
$\Delta imnc_{t,t-1,\dots,t-4} * imshare_{t,t-1,\dots,t-4}$			-0.08	-0.19
$\Delta imnc_{t,t-1,\dots,t-4} * moncred_{t,t-1,\dots,t-4}$			0.00	-0.03
R^2	0.95		0.95	

Notes: The sums of the coefficients associated with the indicated lags and the cross-country average of the coefficients are provided. The estimation is carried out with cross-section SUR. For details on the estimation and the variables, see the text.

Table 6: Monetary policy rules

	(22)		(23)	
	coeff	tstat	coeff	tstat
r_{t-1}	0.85	62.85	0.82	53.76
Δp_{t}	1.00	11.25		
Δp^{ic}_{t}			0.38	3.25
Δp^{cc}_{t}			1.26	13.97
y_{t}	0.87	2.76		
y^{ic}_{t}			0.65	2.16
y^{cc}_{t}			1.22	1.81
R^2	0.86		0.85	

Notes: TSLS estimation with cross section SUR weights. The instruments are lags 1 to 4 of the explanatory variables and the short-term interest rate, the spread between long- and short-term interest rates and changes in unit labor costs. The countries in the sample are our 24 OECD countries minus EMU countries. Long-run coefficient estimates are provided. The sample period is 1980Q3-2007Q1. For details, see the text.
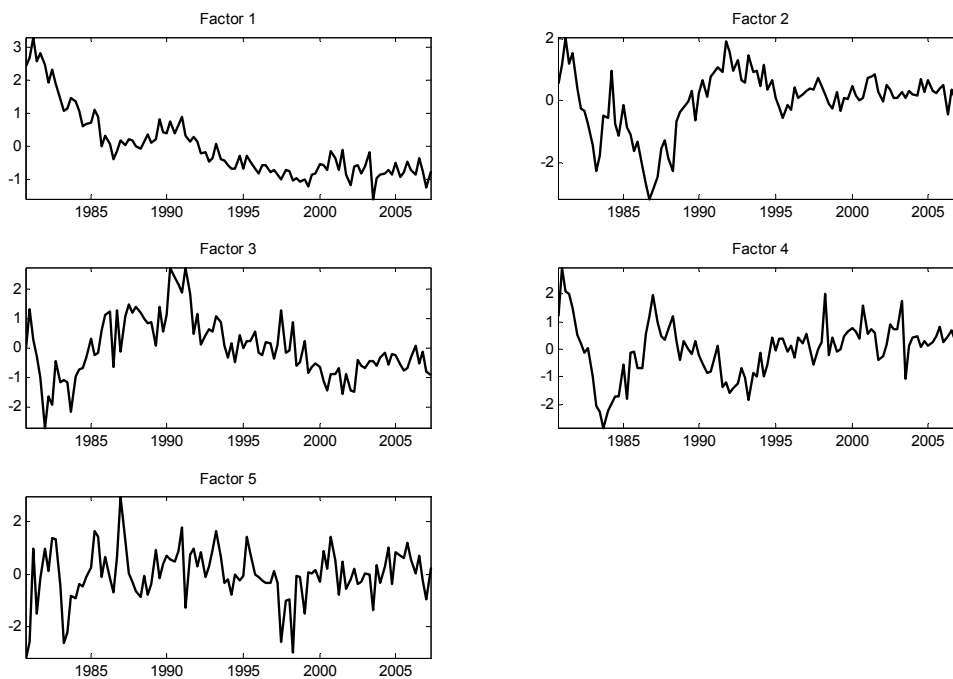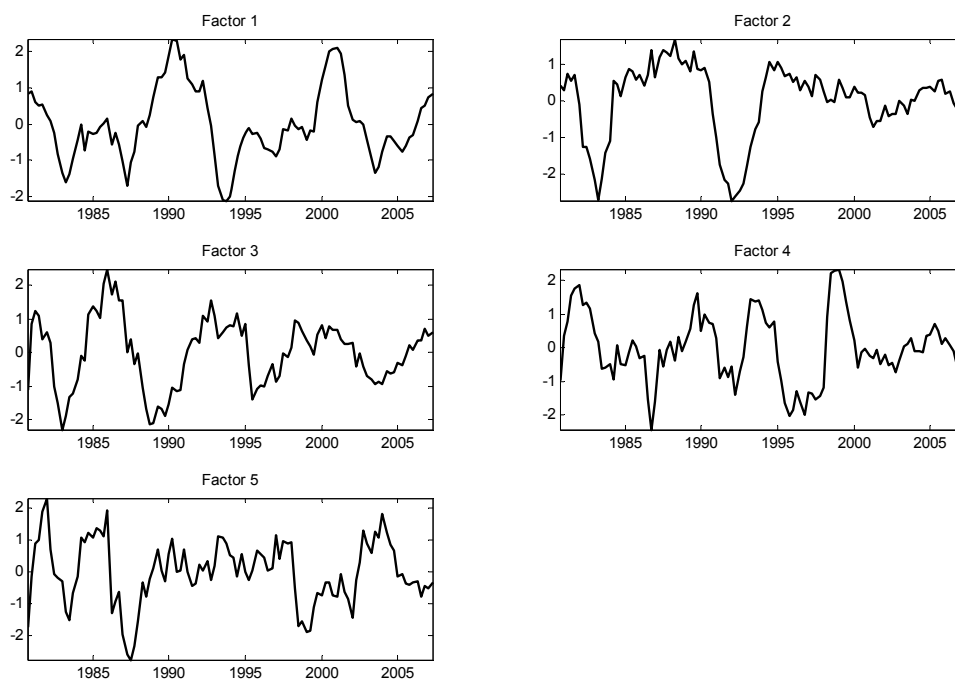
Figure 1: CPI inflation of all 24 countries
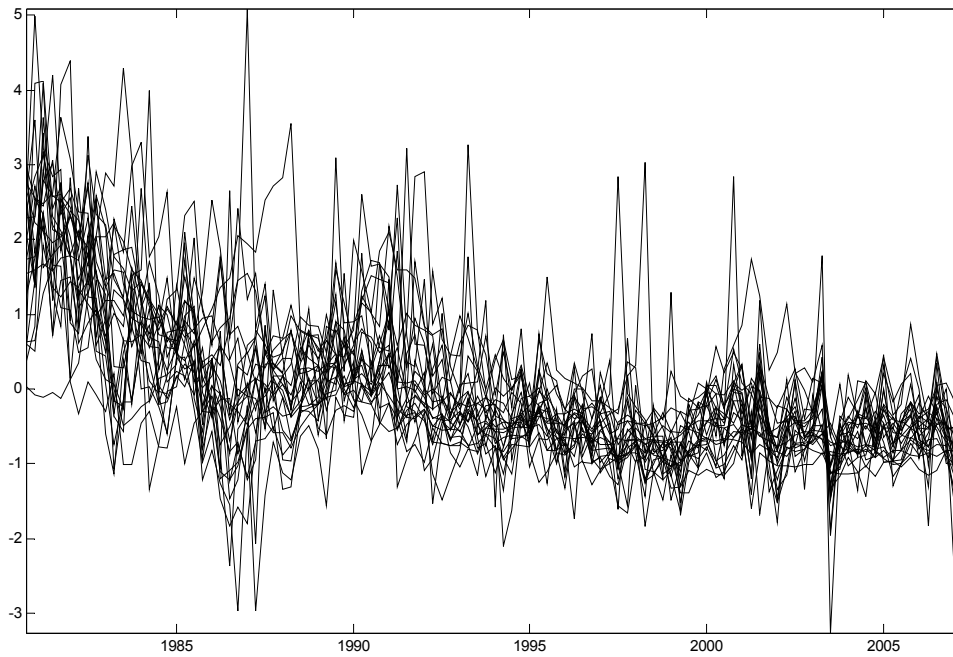
Notes: Standardized (mean = 0, standard deviation = 1) CPI quarter-on-quarter inflation rates of the 24 OECD countries.
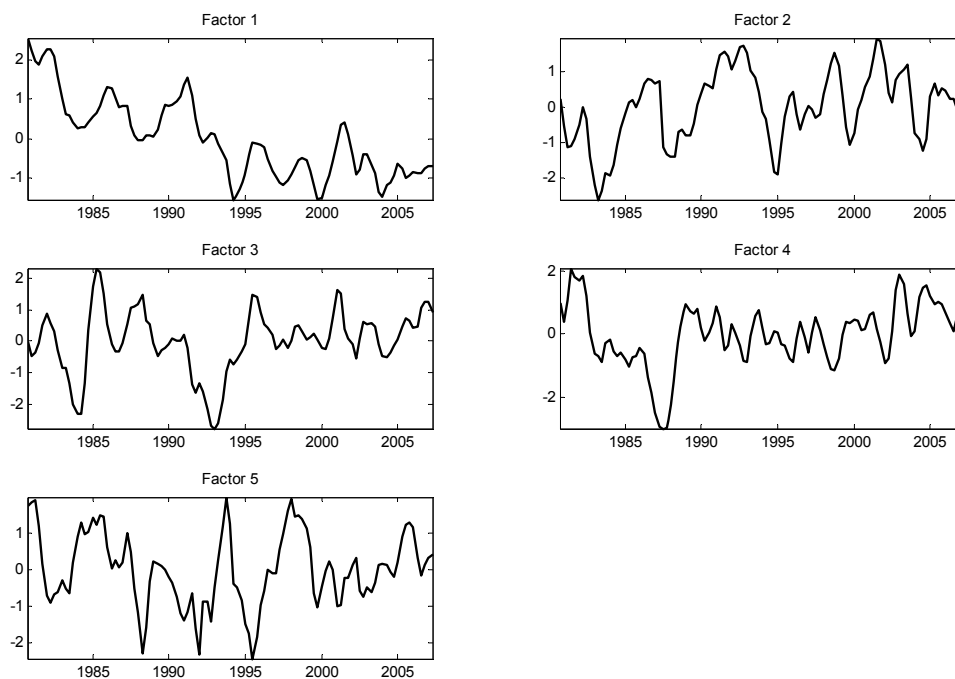
Figure 2: Time series of the first five factors

(a) CPI inflation

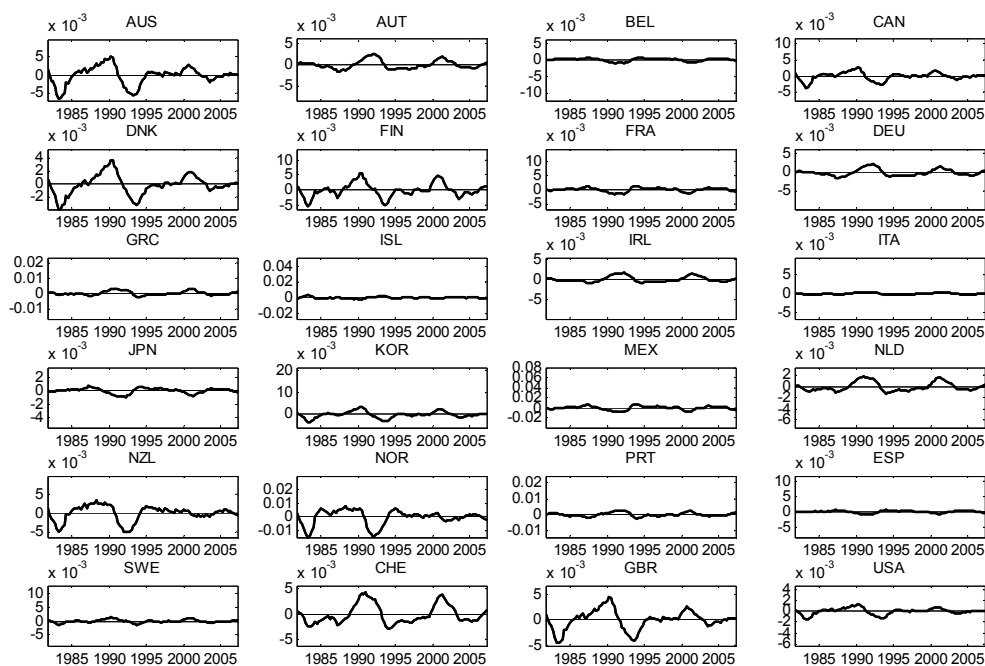**(b) Output gap**

(c) Changes in unit labor costs

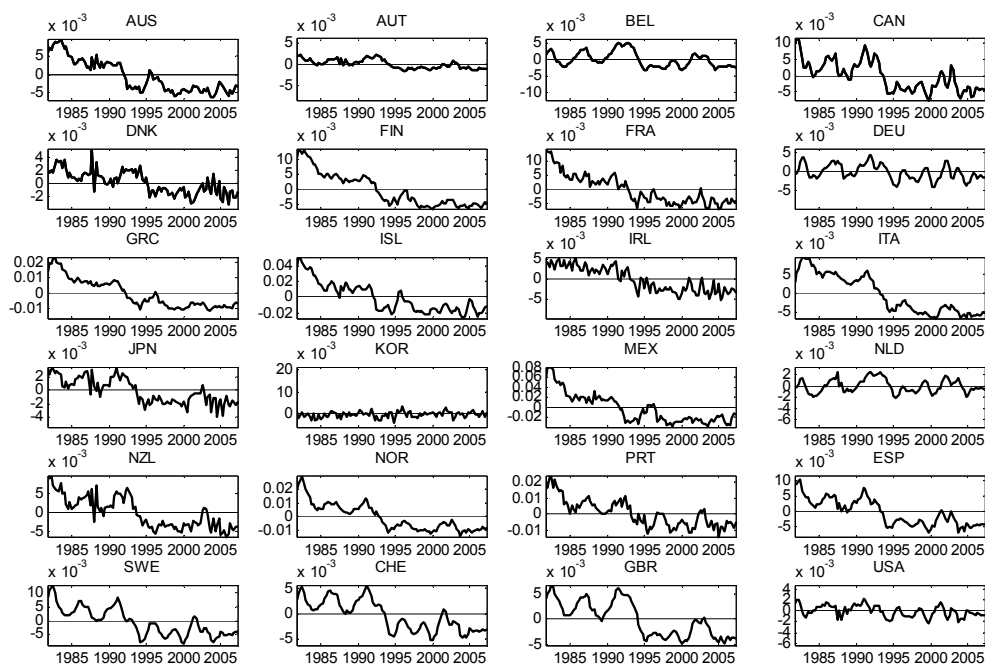Notes: The factors are normalized to be positively correlated with the corresponding US series.

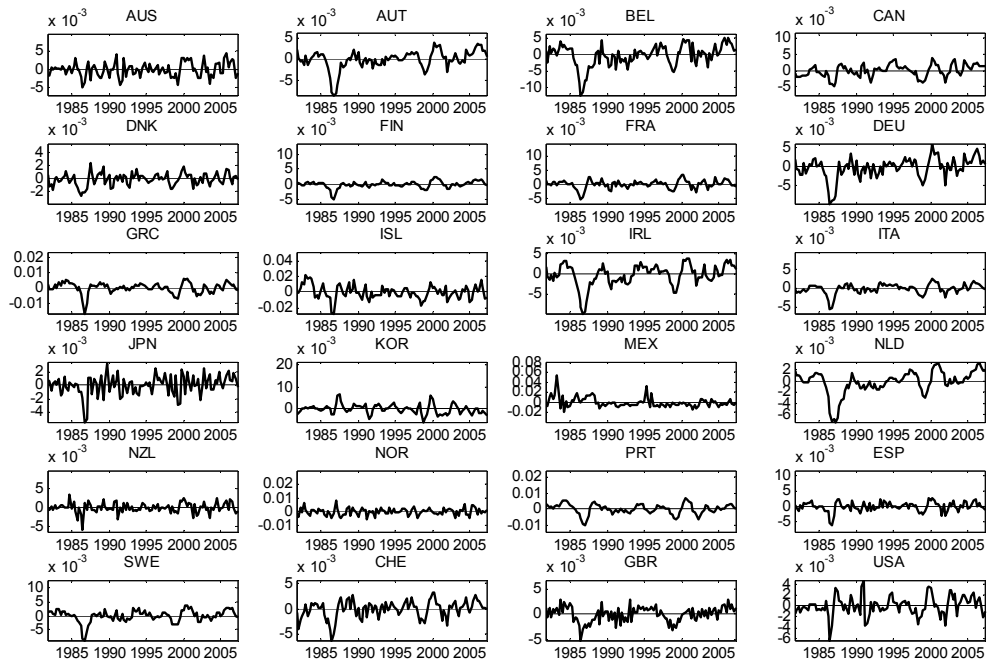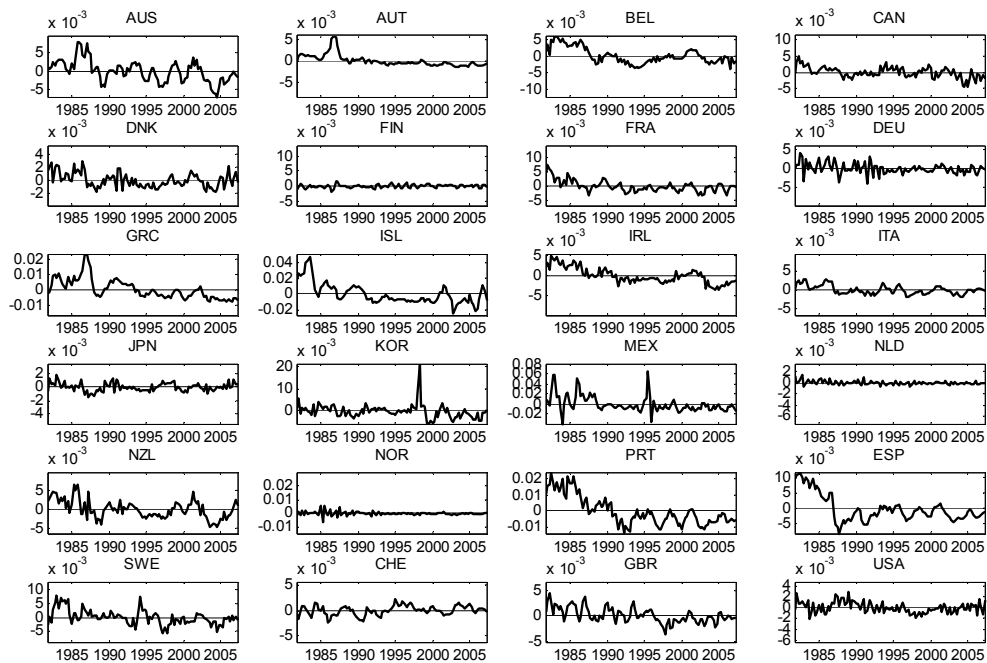# Figure 3: Contribution of global determinants to inflation dynamics

(a) y_t^{cc}

(b) $\Delta ulc_{t,t-1,\ldots,t-4}^{cc}$
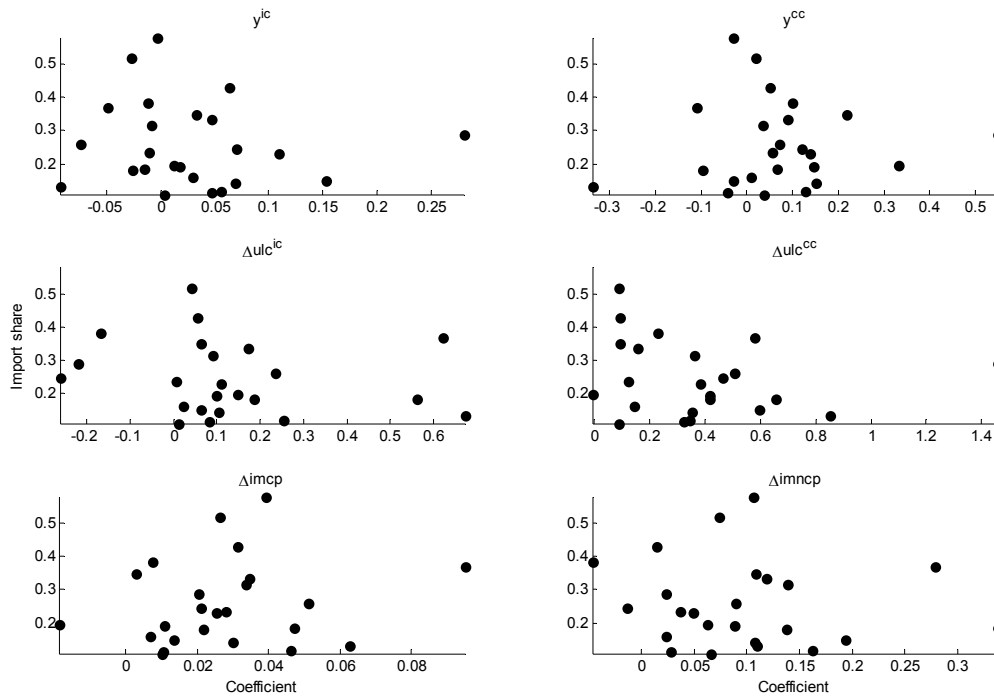
(c) $\Delta imcp_{t,t-1,\ldots,t-4}$


(d) $\Delta imncp_{t,t-1,\ldots,t-4}$

Notes: Difference between fitted CPI inflation and fitted CPI inflation when coefficients of global determinants are set to 0. Positive/negative values indicate a increasing/dampening impact on inflation.

Figure 4: Coefficient estimates and openness

Notes: Average import shares over period 1980Q3-2007 on the x-axis.

Figure 5: Time-varying coefficient estimates – mean group
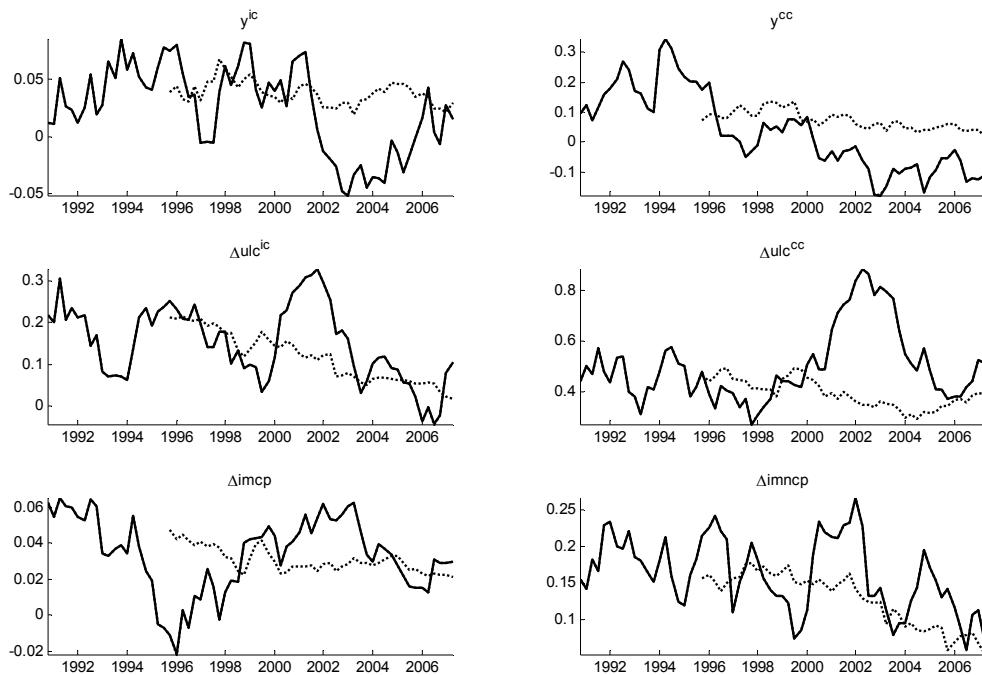
Notes: 10-year rolling window (solid), 15-year rolling window (dotted). A coefficient estimate shown for a specific point in time has been estimated based on the previous 10/15 years.

Figure 6: Spectral densities of common and idiosyncratic components of CPI inflation and the output gap

CPI inflation

Output gap
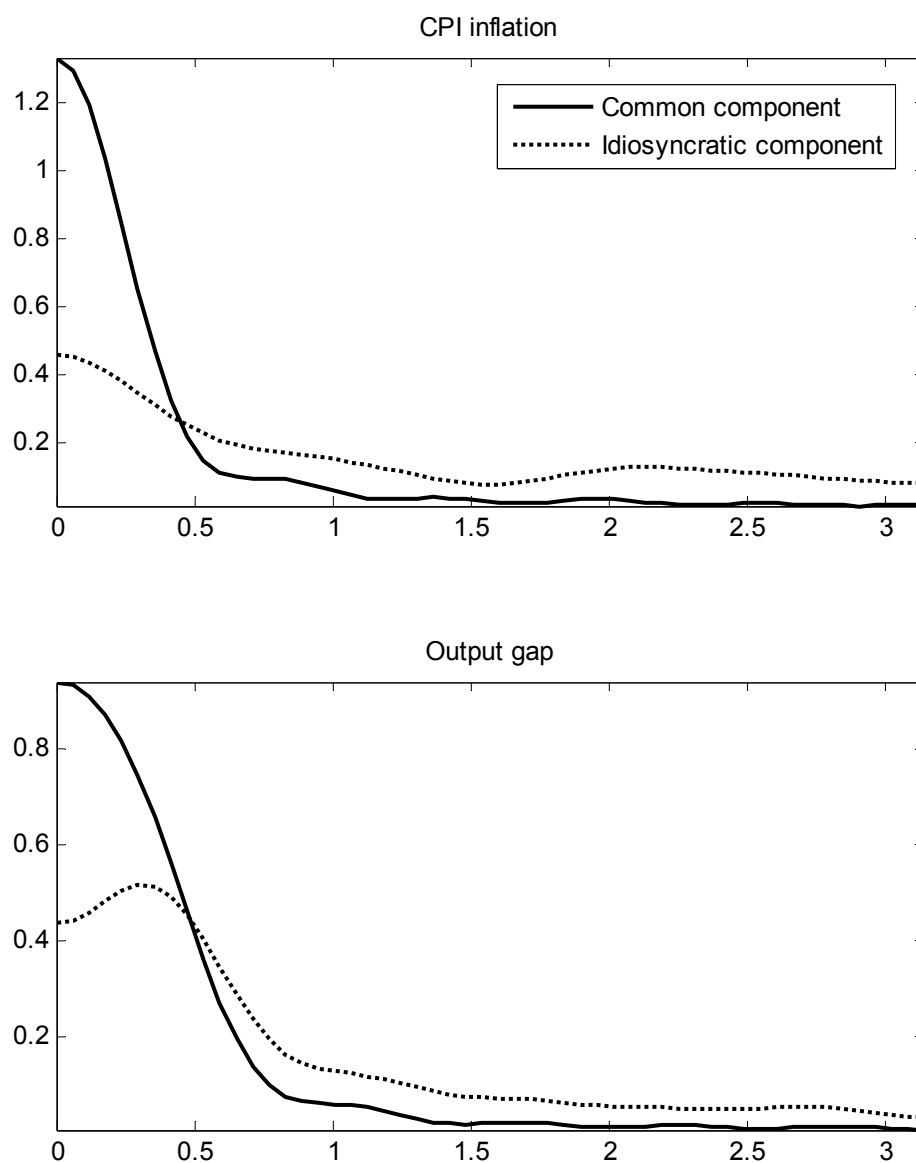
Notes: Averages over all countries of the spectral densities of the standardized components.

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