Towards an Explanation of Cross-Country Asymmetries in Monetary Transmission

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Abstract

I quantify the importance of financial structure, labor market rigidities and industry mix for cross-country asymmetries in monetary transmission. To do so, I determine how closely the impulse responses to a monetary policy shock obtained from country-specific vector autoregressive (VAR) models and a novel panel VAR model match. In the country-specific VAR models, the impulse responses vary across countries in an unrestricted fashion. In the panel VAR model, the impulse responses also vary across countries, but only to the extent that countries differ regarding their financial structure, labor market rigidities and industry mix. For a sample of 20 industrialized countries over the time period from 1995 to 2009, I find that up to 70% of the cross-country asymmetries in the responses of output and 50% in the responses of prices to a monetary policy shock can be accounted for by cross-country differences in financial structure, labor market rigidities and industry mix. While in the short run the output effects arise almost entirely through the interest rate channel, in the medium and long run the credit channel and the presence of labor market frictions are more important. The interest rate channel is of rather minor importance for prices.

Keywords: Panel VAR, Heterogeneity, Conditional Homogeneity, Monetary Transmission, Financial Structure, Labor Market Rigidity, Industry Mix.  
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1 Introduction

In this paper, I quantify the importance of financial structure, labor market rigidities and industry mix for cross-country asymmetries in monetary transmission. For a sample of 20 industrialized countries over the time period from 1995 to 2009, I find that up to 70% of the asymmetries in the responses of output and 50% in the responses of prices to a monetary policy shock can be accounted for by cross-country differences in financial structure, labor market rigidities and industry mix. While in the short run the output effects arise almost entirely through the interest rate channel, in the medium and long run the credit channel and the presence of labor market friction are more important. The interest rate channel is of rather minor importance for prices. These results suggest that policies aimed at harmonizing labor markets and fostering financial integration as well as structural change may markedly reduce asymmetries in monetary transmission in currency unions. Moreover, because of financial market development, globalization and structural change central banks should be aware of potentially large variations in the future monetary transmission mechanism. Finally, financial structure, labor market rigidities and industry mix should be key elements of any theoretical business cycle model used for policy advice.

This paper is primarily related to the empirical literature on monetary transmission. In this literature, cross-country asymmetries in monetary transmission are exploited to learn about the determinants of the monetary transmission mechanism. The standard approach is to regress a statistic of countries’ impulse responses to a monetary policy shock (typically the maximum or the cumulated response) on time averages of countries’ structural characteristics, see Carlino and DeFina (1998), Hayo and Uhlenbrock (1999), Mihov (2001), Arnold and Vrugt (2004), Dedola and Lippi (2005), and Peersman and Smets (2005). This approach is subject to several problems. First, it does not exploit the time-series variation in countries’ structural characteristics to identify the determinants of the monetary transmission mechanism. This is inefficient as at least financial structure, labor market rigidities and industry mix (see Section 3) do display variation over time. The panel VAR model proposed in this paper does exploit the time series variation in countries’ structural characteristics and may therefore pin down more precisely the importance of financial structure, labor market rigidities and industry mix for the monetary transmission mechanism. Second, the standard approach focuses only on a few of the aspects of the monetary transmission mechanism. However, besides the maximum and the cumulated impulse response to a monetary policy shock routinely examined in the existing literature, other important aspects of the monetary transmission mechanism involve the persistence of the response or the

\[1\] A different approach is pursued by Assenmacher-Wesche and Gerlach (2008) who split their sample based on the value of one structural characteristic and compare the averages of the impulse responses across country subsamples. The results of this approach may be hard to interpret as one cannot control for more than one structural characteristic at a time. This is because the full country sample in this type of analysis is rather small (about ten to fifteen countries), so that sample splits based on more than one structural characteristic will result in country subsamples too small for averaging to produce reliable estimates.
time it takes until the maximum response is reached. In order to gain a more comprehensive understanding of the role of financial structure, labor market rigidities and industry mix for the monetary transmission mechanism, in the panel VAR model proposed in this paper I condition the entire shape of the impulse responses to a monetary policy shock on countries’ structural characteristics. Third, because the standard approach focuses on identifying the determinants of the monetary transmission mechanism rather than assessing their quantitative importance, it provides no guidance to policy in a currency union as to how large the returns of different harmonization policies (in terms of reducing asymmetries in monetary transmission) are. In contrast, the purpose of this paper is to quantify the importance of financial structure, labor market rigidities and industry mix for cross-country asymmetries in monetary transmission.

This paper is also related to the literature on heterogeneity in cross-country panel data models. Panel datasets are appealing because they allow to combine information stemming both from the cross-section and the time-series dimension. In order to exploit both dimensions, one needs to pool - that is to impose homogeneity of - at least one slope coefficient across cross-sectional units. However, pooling in dynamic panel data models when the dynamics are in fact cross-section specific entails - even asymptotically - a heterogeneity bias, see Pesaran and Smith (1995). If the dynamics are heterogenous, the panel nature of the dataset can be exploited only for estimation of the mean of the slope coefficients by averaging cross-section specific estimates in the mean-group estimator. The mean-group approach treats heterogeneity as nuisance, and therefore does not lend itself to an individual analysis of the underlying cross-sectional units. Unfortunately, most policies investigated in empirical cross-country studies are country specific. For example, national governments decide whether or not to embrace international trade integration. It is therefore unclear whether the mean-group approach to heterogeneity can be of any help for many of the problems national policymakers face. A different approach to heterogeneity is taken by Canova and Ciccarelli (2009), who propose to model slope heterogeneity by cross-section specific, unobserved factors. The advantage of their approach is that efficiency gains stemming from the panel nature of the data can be achieved, even if the dynamics in the data are allowed to be cross-section specific. However, the approach of Canova and Ciccarelli (2009) does not allow to learn about the sources of heterogeneity, and it assumes heterogeneity to be random across countries. The panel VAR model proposed in this paper also exploits the panel nature of the dataset, but in addition links heterogeneity systematically to countries’ observed structural characteristics.

The remainder of this paper is organized as follows: Section 2 presents the empirical evidence on cross-country asymmetries in the monetary transmission mechanism. In Section 3 I report empirical evidence on cross-country differences in financial structure, labor market rigidity and industry mix, discuss the mechanisms through which these structural characteristics may affect monetary transmission, and document that these structural characteristics are systematically related to asymmetries in monetary transmission. In Section 4 I motivate the design of the PCHVAR model, lay out how impulse responses can be constructed, and describe the empirical model specification. Section 5 presents results and Section 6 robustness checks. Finally, Section
2 Cross-Country Asymmetries in Monetary Transmission

There has been extensive empirical work on cross-country asymmetries in monetary transmission, especially during the run-up and the first few years of the European Monetary Union (EMU), see Table 2 for an overview. If any, the consensus in this literature has been that cross-country asymmetries in monetary transmission are likely to exist, but that the responses of output and prices to a monetary policy shock are too imprecisely estimated to make reliable statements about how large these asymmetries are. Most of the literature on cross-country asymmetries in monetary transmission has used VAR models, and I pursue the same approach in this paper. In particular, I estimate parsimonious, country-specific but identical VAR models

\[ y_{it} = \delta_i + \sum_{j=1}^{p} A_{ij} \cdot y_{i,t-j} + \sum_{j=0}^{q} D_{ij} \cdot x_{i,t-j} + u_{it}, \quad u_{it} \sim i.i.d. (0, \Sigma_{u,i}), \]  

where \( i = 1, 2, \ldots, N \) indexes countries, \( t = 1, 2, \ldots, T \) indexes time, \( y_{it} \) is a \( K \times 1 \) vector of endogenous variables, \( x_{it} \) is an \( M \times 1 \) vector of exogenous variables, \( u_{it} \) is a vector of serially uncorrelated reduced-form disturbances, and \( A_{ij}, D_{ij} \) are \( K \times K \) and \( K \times M \) coefficient matrices, respectively. The vector of endogenous variables \( y_{it} \) includes the logarithm of real GDP, the logarithm of the price level, and a three-month money market rate. The vector of exogenous variables \( x_{it} \) includes the Commodity Research Bureau’s index of commodity prices to account for interest rate increases in anticipation of supply side shocks. To conserve degrees of freedom (in particular because the panel VAR model laid out in Section 4 is highly parameterized), I include only six lags of the endogenous variables in the model, \( p = 6 \), and only the contemporaneous value, \( q = 0 \), of the exogenous variable. Table 1 provides the list of countries included, the time periods covered and the variables used for each country. The data are monthly and for

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2One might argue that an accurate measurement of the effects of monetary policy shocks requires different country-specific models (see, for example, Ehrmann, 2000). However, there is also the risk that results obtained from models that are not identical across countries display asymmetries in monetary transmission that are “artifacts of econometric methodology” (p.43 Gerlach and Smets, 1995). This is particularly relevant for this paper, as I intend to compare the results of the country VAR models to those of a panel VAR model, in which all countries are - except for fixed effects and the heterogeneity in financial structure, labor market rigidities and industry mix - modeled identically. See Gerlach and Smets (1995), Kim (1999), Mihov (2001), and Assenmacher-Wesche and Gerlach (2008) who also use identical country VAR models for the analysis of the monetary transmission mechanism.

3Recent work has emphasized the importance of common factors in output and inflation, see Canova, Ciccarelli and Ortega (2007) and Ciccarelli and Mojon (2010). The commodity price index may be able to pick up part of this cross-section dependence. A more explicit approach to addressing cross-section dependence is the global VAR model of Pesaran, Schuermann and Weiner (2004). However, I leave the integration of systematic state-dependence into the global VAR model to future research. Another approach to accounting for cross-section dependence is the common correlated effects augmentation (CCEA) proposed by Pesaran (2006). While the results for the panel VAR model introduced below are hardly changed when using the CCEA, the corresponding impulse responses of the country VAR models turn out to be rather implausible (the results are available upon request).
most countries cover the time period from 1995:1 to 2009:10. The monetary policy shocks are identified using the Choleski decomposition with the interest rate ordered last, assuming that a monetary policy shock does not contemporaneously affect output and prices, but that the monetary authority has information on the current levels of output and prices.

Figure 1 combines the impulse responses of output and prices to an unsystematic 100 basis points increase in the short-term interest rate for the 20 countries in the sample. The top panel in Figure 1 displays the responses of output, starting from the period of impact of the monetary policy shock up to a horizon of 48 months. The bottom panel in Figure 1 depicts the corresponding responses of prices. Figures 2 and 3 provide the impulse responses for each country separately together with 95% asymptotic (bright shaded area) and bootstrap (dark shaded area) confidence bands. All impulse responses comply with the consensus view in the literature of how output and prices respond to a monetary policy shock (see Christiano, Eichenbaum and Evans, 1999): A delayed and persistent decline of prices, and a faster but only temporary drop in output. Tables 3 and 4 report the country rankings of the maximum, mean, and value of the impulse responses of output and prices after 48 months. The results in Figure 1, Tables 3 and 4 suggest that in the sample considered in this paper there are substantial cross-country heterogeneities in monetary transmission. For example, while Ireland features a maximum decline in output of 1.9% relative to baseline in response to a contractionary monetary policy shock, output declines only by 0.3% relative to baseline in Poland. Moreover, while the average trough in output after a monetary policy shock across countries is 1.0% below baseline, country-specific troughs fluctuate around that average by about 52%. This heterogeneity does not diminish after 48 months, when country-specific responses fluctuate by about 81% around the average response across countries. Similarly, for prices country-specific troughs and responses after 48 months fluctuate by about 52% and 55% around the country averages, respectively.

3 Countries’ Structural Characteristics and Asymmetries in Monetary Transmission

In this section, I discuss how cross-country differences in financial structure, labor market rigidities and industry mix may give rise to cross-country asymmetries in monetary transmission. I show that these structural characteristics do indeed vary across the countries considered in this paper, and that they are systematically related to cross-country asymmetries in monetary transmission.

4To obtain impulse responses that comply with the consensus view (see below), for Canada and the UK I also include the nominal effective exchange rate as country-specific exogenous variable. Monthly real GDP figures are obtained from interpolation of quarterly figures using industrial production and the unemployment rate using the procedure suggested by Chow and Lin (1971).
3.1 Financial Structure: Banking Sector Competition and the Importance of Bank Credit

An economy’s financial structure may affect the monetary transmission mechanism in numerous ways, see Barran, Coudert and Mojon (1996), Dornbusch, Favero and Giavazzi (1998), and Assenmacher-Wesche and Gerlach (2008). In this paper, I focus on the degree of competitive pressures in the banking sector and the importance of bank credit in the economy. I first provide the rationales for how these aspects of financial structure may affect the monetary transmission mechanism, and then describe how they are measured in this paper.

Cottarelli and Kourelis (1994), Borio and Fritz (1995) as well as Mojon (2000) find cross-country differences in the (short-run) pass-through from policy to market rates. These differences may give rise to cross-country asymmetries in monetary transmission, as monetary policy should be more effective the more strongly and the faster changes in the policy rate are passed through to interest rates faced by firms and households. When there are adjustment costs for changing lending rates, the absence of competitive pressures from other banks and/or alternative sources of financing results in a low demand elasticity of bank loans, see Klein (1971) and Hannan and Berger (1991). This leaves room for banks not to pass through changes in policy rates to savers and borrowers. Indeed, Cottarelli and Kourelis (1994), Borio and Fritz (1995), Mojon (2000), Gropp, Kok Sørensen and Lichtenberger (2007) and van Leuvensteijn, Kok Sørensen, Bikker and van Rixtel (2008) find that stronger competitive pressures are associated with more complete and faster interest rate pass-through.

Monetary policy should be more effective the more of households’ consumption and firms’ investment relies on bank credit. Once bank interest rates have responded to changes in the monetary policy stance and interest rate channel effects have started to unfold, declines in output and prices are amplified through the components of the credit channel, that is, the balance sheet, the bank lending and the bank capital channel. In the balance sheet channel, a deterioration of the value of collateral and firms’ net worth raises the cost of external finance, and thereby leads to a contraction in spending. In the bank lending channel, as long as banks are subject to reserve requirements a tightening of monetary policy drains reserves from the banking system and leads to a reduction in banks’ supply of loans to firms. In the bank capital channel, a monetary tightening reduces banks’ profits as their refinancing costs (deposit rates) tend to increase relative to their earnings (loan rates), eventually leading to an erosion of bank capital. The decline in bank capital leads to a reduction of bank loans in order to meet regulatory capital.

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5Of course, many other aspects of financial structure may also affect the monetary transmission mechanism. For example, substantial down payment requirements may let households and firms hit borrowing constraints more frequently in periods of monetary tightening; the prevalence of fixed-rate instead of variable-rate mortgages may insulate households from changes in the stance of monetary policy; an unhealthy banking system with low capital ratios and high loan default probabilities may restrict lending more severely in periods of monetary tightening. Due to data limitations and the curse of dimensionality capturing a much richer array of financial structure aspects is beyond the scope of this paper.
requirements. The more important bank credit in an economy, the stronger the amplification through the components of the credit channel, see Dornbusch et al. (1998), Cecchetti (1999) and Mihov (2001) for empirical evidence.

For the measurement of competitive pressures in the banking sector, I rely on proxies of banking sector efficiency. In particular, I use the net interest margin of the banking sector and bank costs relative to assets. The net interest margin represents a bank’s accounting value of its net interest (loan minus deposit rate) revenue. Bank costs comprise all costs except for direct labor, direct materials and direct expenses. For the measurement of the importance of bank credit in an economy, I use the amount of bank credit relative to deposits and private credit issued by deposit money banks and other financial institutions relative to GDP.

All data for financial structure stem from the World Bank’s Financial Structure Database (see Beck, Demirgüç-Kunt and Levine, 2009). To construct an index of financial structure, I

1. re-scale the data on net interest margins, bank costs, bank credit relative to deposits and private credit relative to GDP to lie in \([0, 1]\),
2. reverse the net interest margin and bank cost data so that higher values reflect banking sectors with stronger competitive pressures,
3. take the average across the four variables.

The resulting financial structure index ranges from zero to one, with higher values reflecting financial structures in which interest rate pass-through should be faster and more complete as well as in which credit channel effects should be more pronounced.

### 3.2 Labor Market Rigidities

In the baseline New Keynesian business cycle model, the less frequently nominal wages can be adjusted, the more dampened the response of firms’ marginal costs to a monetary policy shock (see, for example, Gali, 2008). As a result, the response of inflation is more subdued and the real interest rate remains above its equilibrium for a longer period of time because of the moderate endogenous response of the central bank, which leads to a stronger response of output. However, in the New Keynesian model labor market rigidities and their effects on the dynamics of output and inflation are not bound to nominal wage stickiness. Walsh (2005) finds that search and matching frictions may lead to a reduction in the elasticity of marginal costs with respect to output, and thereby to a dampened response of inflation as well as a stronger response of output to a monetary policy shock. Zanetti (2007) shows that unionized wage bargaining entails a muted and persistent response of wages to a monetary policy shock, implying a muted and

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6These measures do not include the amount of bank loans from foreign banks. These should, however, be of relatively minor importance given the evidence for a home bias in banking, see Carey and Nini (2007) as well as Vazquez and Garcia-Herrero (2007).
gradual response of inflation as well as a strong and persistent response of output. Christoffel and Kuester (2008) find that inflation displays a dampened response to a monetary policy shock when there are fixed costs associated with maintaining existing job relationships. Campolmi and Faia (2010) document that inflation responds more strongly to monetary policy shocks in countries with lower replacement rates and higher employment protection. Lechthaler, Merkl and Snower (2010) demonstrate that hiring and firing costs render the responses of inflation and output to a monetary policy shock more persistent. While the precise mechanisms depend on the model specification, in general economies with more rigid labor markets should display stronger and more persistent responses of output as well as more muted but potentially more persistent responses of inflation to a monetary policy shock.

As a proxy for the degree of a country’s labor market rigidity, I use the Strictness of Employment Protection indicator provided by the Organization for Economic Development and Cooperation (OECD, see Venn, 2009). This indicator is compiled from 21 items covering three aspects of employment protection: individual dismissal of workers with regular contracts (notification and consultation requirements, notice periods and severance pay, compensation and reinstatement in case of dismissal contestation), additional provisions for collective dismissals (additional delays, costs, notification procedures), and the regulation of temporary contracts (pertaining to the operations of temporary work agencies).

3.3 Industry Mix

Countries may display asymmetric responses to monetary policy shocks if their sectoral composition and sectors’ sensitivity to monetary policy are different. All else equal, in countries with a large share of output accounted for by industries producing durable goods, the interest rate sensitivity of demand should be high, and output as well as prices should display strong responses to a monetary policy shock through the interest rate channel. Bernanke and Gertler (1995) find that durable consumption expenditures and residential investment drop more strongly than non-durable consumption and business fixed investment in response to a monetary policy shock. Carlino and DeFina (1998), Mihov (2001), and Arnold and Vrugt (2004) find that asymmetries in monetary transmission are partially explained by differences in the share of total output accounted for by manufacturing. Dedola and Lippi (2005) and Peersman and Smets (2005) find that within the manufacturing sector, sectors that produce durable goods feature stronger responses to monetary policy shocks. I use the share of total value added by durable goods producing industries in the manufacturing sector to capture cross-country differences in the interest

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7 Measuring the degree of labor market rigidity at the cross-country level is a non-trivial task. Numerous frictions such as wage stickiness, employment protection legislation, the power of unions and the efficiency of labor agencies affect the degree of labor market rigidity. Moreover, even within a country there may be inter-sectoral differences in labor market regulation. The OECD’s Strictness of Employment Protection indicator does not account for many of these issues, but is the only measure of labor market rigidity available for a broad set of countries over a reasonably long time period.
rate sensitivity of demand. The data stem from the OECD’s Structural Analysis Database (see OECD, 2010).

3.4 Countries’ Structural Characteristics and Asymmetries in Monetary Transmission: The Standard Approach

The left-hand side panels in Figure 4 depict the time averages of the financial structure index, labor market rigidities and industry mix. The financial structure index is bounded between zero and one, and larger values reflect financial systems in which bank credit is more important and in which the banking sector competitive pressures are stronger. The Strictness of Employment protection indicator is bounded between zero and four, and larger values reflect more rigid labor markets. For the time period from 1995 to 2009, Ireland had the highest average value of the financial structure index, Portugal had the most rigid labor markets, and Korea featured the highest share of durable goods manufacturing in total output. Overall, the left-hand side panels in Figure 4 suggest there has been a sizeable degree of heterogeneity in financial structure, labor market rigidities and industry mix across countries. The right-hand side panels in Figure 4 depict the Hodrick-Prescott-filtered evolution over time. In addition to the sizeable cross-country differences there has also been substantial variation in financial structure index, labor market rigidities and industry mix within countries over time. For example, the importance of bank credit has substantially expanded in Ireland and Denmark. Belgium and Germany have markedly removed labor market rigidities. While South Korea has become considerably more dependent on durable goods manufacturing, production has moved to other sectors in Australia and Spain. Figure 4 suggests both the cross-sectional spread and the time-series variation in countries’ structural characteristics should be useful to identify the determinants of the monetary transmission mechanism.

In order to confirm that financial structure, labor market rigidities and industry mix are systematically related to cross-country asymmetries in monetary transmission, I follow the standard approach and regress some impulse response statistics on countries’ structural characteristics (see Carlino and DeFina, 1998; Dedola and Lippi, 2005; Peersman and Smets, 2005) that is I estimate

\[
    f \left( \left\{ \hat{\text{ir}}_{ih}^{(VAR)} \right\}_{h=1,2,...,H} \right) = a + \left( \frac{1}{T_i} \sum_{t=1}^{T_i} z_{it} \right) \cdot b + u_i,
\]

where \( \hat{\text{ir}}_{ih}^{(VAR)} \) denotes the estimated country VAR impulse responses of country \( i \) at horizon \( h \), the scalar function \( f(\cdot) \) returns the maximum (that is smallest negative) response, the mean response, or the response after 48 months. The results reported in Tables 6 and 7 suggest that

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8I adopt the classification of durable goods producing sectors of Dedola and Lippi (2005). The sectors are wood and products of wood and cork, other non-metallic mineral products, basic metals and fabricated products, machinery and equipment as well as transport equipment.

9All series are transformed to monthly frequency by linear interpolation before smoothing.
financial structure and labor market rigidities are statistically significantly and in intuitively appealing ways related to all impulse response statistics. For example, an increase in the financial structure index from the minimum (0.34, see Table 5) to the maximum (0.87) value, ceteris paribus implies a maximum output response to a monetary policy shock stronger by about one percentage point (−0.019 × .53). Industry mix does not appear to be statistically significantly related to almost all of the impulse response statistics, and even features the wrong sign for prices. However, this might be due to the drawbacks of the standard approach mentioned in the Introduction and in Section 4. Nevertheless, overall the results displayed in Tables 6 and 7 are compatible with the reasoning in Section 3.1.

4 The Panel Conditionally Homogenous Vectorautoregressive Model

The standard approach for establishing links between countries’ structural characteristics and asymmetries in the monetary transmission mechanism uses only the cross-sectional spread in countries’ structural characteristics. In addition, it focuses only on a few of the aspects of monetary transmission (typically the maximum and the cumulated responses), and neglects several interesting aspects such as the persistence of monetary transmission. Moreover, existing work using the standard approach has not attempted to quantify the importance of specific sets of structural characteristics for the monetary transmission mechanism. In this paper, in order to fill these gaps I set up a panel VAR framework that embeds a direct link between countries’ monetary transmission mechanisms and their structural characteristics. While there already exist panel data frameworks that account for heterogeneity, these typically treat it as a (random) nuisance, and can therefore not be used to investigate cross-country asymmetries in monetary transmission. In this section, I motivate the Panel Conditionally Homogenous VAR (PCHVAR) model as a remedy to these limitations. I describe how estimation of the PCHVAR model can be carried out, how impulse responses can be constructed, and lay out the empirical specification of the PCHVAR model I estimate.

4.1 The PCHVAR Model

Except for fixed effects, standard dynamic panel data models with homogenous slope coefficients do not allow for heterogeneity and are likely to be subject to heterogeneity bias. The mean-group framework proposed by Pesaran and Smith (1995) accounts for heterogeneity and provides consistent estimates of the cross-sectional means of the slope coefficients, but does not allow to

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10The results in Table 7 are not directly comparable to those of the theoretical literature on the role of labor market rigidities reviewed in Section 3.2 which pertain to inflation: A dampened but more persistent drop in inflation in response to a monetary policy shock in countries with more rigid labor markets may, but need not, be equivalent to a stronger, permanent decline in the price level.
exploit the panel nature of the dataset to recover country-specific dynamics. The unobserved factors approach of Canova and Ciccarelli (2009) models heterogeneity by unobserved factors. The approach of Canova and Ciccarelli (2009) allows to exploit the panel nature of the data to estimate country-specific dynamics, but does not allow to learn about the sources of heterogeneity. In addition, the factors are assumed to be random even though parameter variation across countries is likely to be linked to country characteristics systematically. To overcome these limitations, more structure needs to be imposed on the data, and I build on the work of Binder and Offermanns (2007) to do so. However, I move beyond the work of Binder and Offermanns (2007) by extending the single-equation, univariate, conditional long-run homogeneity framework to trivariate conditioning of short-run dynamics in a multiple equations context. Consider a simple panel VAR model with systematic parameter variation

$$y_{it} = A(z_{it}) \cdot y_{i,t-1} + u_{it}, \quad u_{it} \overset{i.i.d.}{\sim} (0, \Sigma_u), \quad (3)$$

where $y_{it}$ is a $K \times 1$ vector of endogenous variables, $z_{it}$ is an $R \times 1$ exogenous, generally multivariate conditioning state variable reflecting a country's structural characteristics, and $A(z_{it})$ is a $K \times K$ coefficient matrix with each scalar element being a function of countries' structural characteristics. Notice that while the matrix function $A(\cdot)$ is not country-specific, the coefficient matrix $A(z_{it})$ nevertheless varies across countries and over time with the realization of the country-specific structural characteristics. The countries' dynamics are therefore identical only for countries sharing the same structural characteristics, that is, the countries' dynamics are conditionally homogenous.

### 4.2 Estimation of the PCHVAR Model

The functionals collected in the coefficient matrix $A(\cdot)$ linking countries' dynamics to their underlying structural characteristics are unknown. In order to operationalize the PCHVAR framework, I assume that each scalar coefficient functional $a_{sm}(z_{it})$, $s, m = 1, 2, \ldots, K$, in the coefficient matrix $A(\cdot)$ can be approximated reasonably well by a scalar polynomial in countries' structural characteristics, that is

$$a_{sm}(z_{it}) \approx \pi(z_{it}) \cdot \gamma_{sm}, \quad (4)$$

where $\pi(z_{it}) = [\pi_1(z_{it}), \pi_2(z_{it}), \ldots, \pi_\tau(z_{it})]$ is a $1 \times \tau$ vector with polynomials in $z_{it}$, and $\gamma_{sm} = (\gamma_{sm1}, \gamma_{sm2}, \ldots, \gamma_{sm\tau})'$ is a $\tau \times 1$ vector of polynomial coefficients. With this approximation the

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11Binder and Offermanns (2008) set up a GVAR model in which some of the cross-country heterogeneities are linked to differences in countries' exposure to international trade and financial integration. Towbin and Weber (2010) specify a panel VAR model very similar to the PCHVAR model.
coefficient matrix $A(\cdot)$ can be written as

$$A(z_{it}) \approx \begin{bmatrix} \pi(z_{it}) \cdot \gamma_{11} & \cdots & \pi(z_{it}) \cdot \gamma_{1K} \\ \vdots & \ddots & \vdots \\ \pi(z_{it}) \cdot \gamma_{K1} & \cdots & \pi(z_{it}) \cdot \gamma_{KK} \end{bmatrix}$$

$$= \begin{bmatrix} \gamma'_{11} & \gamma'_{12} & \cdots & \gamma'_{1K} \\ \vdots & \ddots & \vdots \\ \gamma'_{K1} & \gamma'_{K2} & \cdots & \gamma'_{KK} \end{bmatrix} \cdot [I_K \otimes \pi'(z_{it})]$$

$$= \Gamma \cdot [I_K \otimes \pi'(z_{it})]. \quad (5)$$

Using Equation (5), Equation (3) can then be written as

$$y_{it} = \Gamma \cdot [I_K \otimes \pi'(z_{it})] y_{i,t-1} + u_{it}$$

$$= \Gamma \cdot \mathbf{X}_{i,t-1}(z_{it}) + u_{it}, \quad (6)$$

where $\mathbf{X}_{i,t-1}(z_{it})$ is a $K \tau \times 1$ vector. The model in Equation (6) is a standard multiple equations panel time-series model with the same explanatory variables in every equation. Consequently, standard least squares estimation techniques can be applied. Once the polynomial coefficients $\gamma_{smj}$, $s, m = 1, 2, ..., K$, $j = 1, 2, ..., \tau$, collected in the matrix $\Gamma$ have been estimated, the reduced form coefficient matrix $A(\cdot)$ can be calculated for different values of countries’ structural characteristics.

### 4.3 Impulse Responses

The impulse responses in the PCHVAR model do not only depend on a country’s structural characteristics in the impact period, but also on their subsequent path. To see why, substitute recursively in Equation (3)

$$y_{it} = A(z_{it}) \cdot A(z_{i,t-1}) \cdot y_{i,t-2} + u_{it} + A(z_{it}) \cdot u_{i,t-1}$$

$$= \prod_{j=0}^{s-1} A(z_{i,t-j}) \cdot y_{i,t-s} + \sum_{j=0}^{s} \prod_{k=0}^{j-1} A(z_{i,t-k}) \cdot u_{i,t-j} \quad (7)$$

$$y_{it} = \Upsilon_{s} \cdot y_{i,t-s} + \sum_{j=0}^{s-1} \Phi_{j}(Z_{it}^{(j)}) \cdot u_{i,t-j}, \quad (8)$$

12See Georgiadis (2011) for a description of the general PCHVAR($p$) case with deterministic terms and exogenous variables, polynomial order restrictions in the approximation of the autoregressive coefficients $a_{sm}(z_{it})$, and generalized least squares estimation taking into account cross-sectional heteroskedasticity.
where
\[ Z^{(j)}_{it} = [z_{it}, z_{i,t-1}, \ldots, z_{i,t-j}], \] (10)
and
\[ \Phi_j(Z^{(j)}_{it}) = \left[ \prod_{k=0}^{j-1} A(z_{i,t-k}) \right], \] (11)
which contains the path-dependent impulse responses. Unless a country’s structural characteristics do not change over time, the PCHVAR model will thus yield time-varying impulse responses. This complicates the comparison of the impulse responses of the country VAR model to those of the PCHVAR model, as the former features only a single, time-invariant impulse response. However, if one interprets the impulse responses of the country VAR model as an average impulse response over the sample period, this problem can be addressed by constructing a corresponding statistic for the time-varying impulse responses of the PCHVAR model. In particular, I construct a single, average impulse response for the PCHVAR model impulse responses as follows. For each country \( i = 1, 2, \ldots, N \) and for each time period \( t = 1, 2, \ldots, T \), I construct a country-specific and period-specific impulse response, \( \{\hat{IR}_{it}(h)\}_{h=0,1,\ldots,H} \). For the impulse response of country \( i \) in period \( t \), I fix the values of the country’s structural characteristics at the values observed in period \( t \) for all response horizons \( h = 0, 1, \ldots, H \). I repeat this for all time periods \( t = 1, 2, \ldots, T \) for country \( i \). Then, I obtain the country-specific, average impulse response as
\[ \hat{r}_{ih}^{(\text{PChVAR})} \equiv T^{-1} \cdot \sum_{t=1}^{T} \hat{IR}_{it}(h). \] (12)
This is the impulse response implied by the PChVAR model I compare to the impulse responses obtained from the country VAR models.\[ ^{13} \]

4.4 The Estimated Model

The baseline PCHVAR model I estimate is given by
\[ y_{it} = \delta_i + \sum_{j=1}^{p} A_j(z_{it}) \cdot y_{i,t-j} + \sum_{j=0}^{q} D_{ij} \cdot x_{i,t-j} + u_{it}, \quad u_{it} \sim (0, \Sigma_u), \] (13)
and is analogous to the country VAR models in Equation (1). For estimation, I re-scale the data for financial structure, labor market rigidities and industry mix to lie in \([0, 1]\), extract the long-run trend component using the Hodrick-Prescott filter, and use cubic polynomials to

\[ ^{13}\text{A similar approach would use the actual path of the structural characteristics upon impact. However, notice that under this approach for time periods } t = T - H + 1, T - H + 2, \ldots, T \text{ no impulse response could be computed, as the required history would extend beyond the last time-series observation in the sample. Because it would be based on shorter sample period, the resulting impulse response of the PCHVAR model would not be comparable to those of the country VAR models. Yet another approach would integrate out the path-dependence of the impulse responses using Monte Carlo techniques along the lines of Koop, Pesaran and Potter (1996). I report results for this approach in Section }^{11}. \]
approximate the unknown functionals in the coefficient matrices $A_j(\cdot)$, $j = 1, 2, \ldots, p$ without interacting the polynomials of different structural characteristics. The same data, time periods and lag order specifications are used for estimation of the PCHVAR model as for the country VAR models.

5 Results

In this section, I compare the impulse responses obtained from the country VAR models to those from the PCHVAR model. I first do so visually, and then move to a regression-based measure of match.

Figures 5 and 6 display the impulse responses of output and prices to a monetary policy shock of the country VAR models discussed in Section 2 (solid lines) and the impulse responses of the PCHVAR model (dotted lines). If financial structure, labor market rigidities and industry mix were the sole determinants of cross-country asymmetries in monetary transmission, then the impulse responses of the country VAR models and those of the PCHVAR model should coincide. Figure 5 suggests that for output, most of the impulse responses of the PCHVAR model match those of the country VAR model rather well. This is confirmed by Table 8, which reports strong and highly statistically significant rank correlations for the maximum, the mean and the value after 48 months between the impulse responses of the country VAR and those of the PCHVAR model. In contrast to output, Figure 6 seems to suggest that for prices cross-country differences in financial structure, labor market rigidity and industry mix are less relevant for cross-country differences in the responses to a monetary policy shock. Only for relatively few countries do the impulse responses of the PCHVAR model match closely those of the country VAR models. However, the rank correlations reported in Table 8 suggest that at least in the long-run the price level impulse responses of the PCHVAR model match those of the country VAR model reasonably well.

Of course, a more rigorous measure is needed in order to quantify the role of financial structure, labor market rigidities and industry mix for cross-country asymmetries in monetary transmission. I therefore regress the impulse responses of the country VAR models on those of the PCHVAR model

$$ \hat{r}^{(V AR)}_{ih} = \alpha_h + \beta_h \cdot \hat{r}^{(P CHV AR)}_{ih} + \delta_{ih}, $$

for each response horizon $h = 0, 1, 2, \ldots, H$ separately. The regression error $\delta_{ih}$ picks up heterogeneity in the impulse responses of the country VAR models not explained by financial structure, labor market rigidities and industry mix in the PCHVAR model.\footnote{Ideally, I should regress the probability limits of the impulse responses obtained from the country VAR models on the probability limits of the impulse responses implied by the PCHVAR model. Since these are not available, I need to resort to finite sample estimates. The difference between the probability limits and the finite sample estimates enters the regression error in Equation \ref{eq:14}. This introduces measurement error in both the dependent}
displays the evolution of the $R$-squared for Equation (14) over response horizons for output. The horizontal lines represent the averages of the $R$-squareds over response horizons. The bottom panels in Figure 7 depict the evolution of the intercept and the slope estimate of Equation (14) over response horizons. The results in Figure 7 confirm the previous findings for output: Up to 70% and on average 50% of the cross-country asymmetries in the responses of output to a monetary policy shock can be accounted for by differences in financial structure, labor market rigidity and industry mix. Interestingly, for almost all response horizons one cannot reject the null that the slope coefficient in Equation (14) is equal to unity and that the intercept is equal to zero. For prices, Figure 8 suggests that cross-country differences in financial structure, labor market rigidities and industry mix explain up to 50% of the cross-country asymmetries in monetary transmission at long horizons, but virtually nothing at medium horizons. This is in line with the results in Table 8. In the long run, cross-country asymmetries in monetary transmission are accounted for by cross-country differences in financial structure, labor market rigidities and industry mix. The fact that the slope estimate for Equation (14) in the bottom right-hand side panel in Figure 8 is substantially above unity at long horizons indicates that even though the PCHVAR model produces impulse responses that are systematically smaller in absolute value than those of the country VAR models, it still gets the ordering of country responses right. This is why the $R$-squareds at long horizons in Figure 7 are high although the impulse responses of the country VAR models and those of the PCHVAR model do not match too closely in Figure 6.

In order to gain an even better understanding of the importance of financial structure, labor market rigidities and industry mix for monetary transmission based on the results above, it would be necessary to decompose the $R$-squareds in Figures 7 and 8 into the contributions of the three structural characteristics. Unfortunately, as in a linear regression model dropping two of the three structural characteristics will in general not result in an exact decomposition of the $R$-squareds in Figures 7 and 8. In addition, due to the non-linear relationship between the impulse response estimates and the structural characteristics in Equation (14), the sum of the individual $R$-squareds can even exceed the $R$-squared of the baseline model. However, considering each of financial structure, labor market rigidities and industry mix individually one at a time may still be helpful to get an idea about the relative importance of the three structural characteristics. Moreover, it may also point to differences in the response horizons at which the structural characteristics affect the monetary transmission mechanism. Figures 9 and 10 present the baseline results for Equation (14) together with the results from considering

and the explanatory variable, which can be shown to bias downward the $R$-squared of Equation (14), see Section A.2. Thus, even if financial structure, labor market rigidity and industry mix are the only determinants of cross-country asymmetries in monetary transmission, estimation uncertainty will drive the $R$-squared of Equation (14) below unity.

15 The measurement error that arises because the explanatory variable in Equation (14) is a noisy measure of the probability limit of the impulse response implied by the PCHVAR model biases the slope estimate towards zero and the intercept estimate up, see Equation (A.5). For output, both effects render it easier to reject the null that the slope is equal to unity and the intercept is equal to zero. Moreover, in the presence of measurement error the confidence bands depicted in the bottom panels of Figure 7 are spuriously tight, see Equation (A.9).
only one structural characteristic at a time. For output, two observations stand out. First, at medium to long horizons only financial structure and labor market rigidities appear to be (of similar) importance for the monetary transmission mechanism. Second, in the short run industry mix appears to be much more important than financial structure and labor market rigidities. This is in line with the view that the monetary transmission mechanism first works through the interest rate channel and then gets amplified through credit channel effects and other rigidities. This result would typically not have been obtained from the standard approach, see the statistically insignificant coefficients for industry mix in Table 6. For prices, it appears that only financial structure and labor market rigidities appear to be (of similar) importance for the monetary transmission mechanism. This is in line with the results of the standard approach in Table 7.

6 Robustness and Discussion

In this section, I present results for alternative specifications of the country VAR model, for an alternative way of constructing impulse responses for the PCHVAR model, and I discuss several more general issues regarding the empirical approach taken in this paper.

6.1 Robustness

The parsimonious three-variable country VAR model does not account for the exchange rate channel that may be important for some of the more open countries considered in this paper. Moreover, the baseline country VAR models do not account for the fact that central banks may monitor monetary aggregates when setting policy rates. Finally, while in most of the countries considered in this paper monetary policy is implemented by targeting the overnight money market rate (see Table 10 and the discussion below), in the baseline specification I use the three-month money market rate to reflect monetary policy. I do so because the overnight money market rate series from the OECD’s Main Economic Indicators for the Euro area countries are available only from 1999, those from the IMF’s International Financial Statistics end in 1998 for most Euro area countries, and for the few countries and time periods for which both the OECD and the IMF provide data for the Euro area countries these do not exactly match. Figures 11 and 12 display the impulse responses of output and prices to a monetary policy shock obtained from country VAR models analogous to those in Equation 11, but including the nominal effective exchange rate (dash-dotted lines) or M3 (dashed lines) as additional endogenous variables, and with an overnight rate (dotted lines) instead of a three-month money market rate series obtained from a combination of data from the OECD and the IMF used to reflect monetary policy.

16 The exchange rate is ordered last as it should contemporaneously respond to monetary policy shocks; money is ordered before the interest rate. There are no results for the specification with money for the Euro area countries
solid lines represent the baseline country VAR model impulse responses from Figure 1. The results of the alternative specifications in Figures 11 and 12 are similar to the baseline results.

In the baseline country VAR model specifications, the lag orders of the endogenous variables are set to six and those of the exogenous variables to zero. The reason for not determining the lag orders optimally according to some information criterion is that I compare the results of the country VAR models to those of the PCHVAR model, in which all countries feature the same lag order by construction. In Figures 13 and 14, the impulse responses of the country VAR models estimated with a lag order of nine for the endogenous variables (dash-dotted line) and three for the exogenous variables (dashed line) are displayed. The solid lines represent the baseline impulse responses of the country VAR models. The results in Figures 13 and 14 suggest that the impulse responses of output and prices monetary policy shock in the country VAR models are similar across alternative lag order specifications.

For the Euro area countries, the inclusion of aggregate output and prices may be necessary for the identification of monetary policy shocks. Figures 15 and 16 display the impulse responses of output and prices to a monetary policy shock obtained from country VAR models analogous to those in Equation (1), but with Euro area aggregate output and prices included as additional endogenous variables (dash-dotted lines). The solid lines represent the baseline country VAR impulse responses. With the exception of the responses of Spain (with rather implausible impulse responses) and the price level responses of Denmark, Ireland and Portugal, the results with Euro area aggregates are again similar to those from the baseline specification.

It is plausible to assume that financial structure, labor market rigidities and industry mix evolve rather slowly over time and are to a large extent determined by technological as well as political economy factors. For example, La Porta, Lopez-de-Silanes, Shleifer and Vishny (1997) argue that differences in the importance of bank credit can be traced back to whether a country’s legal system has British, French, German or Scandinavian origin. In order to ensure that the results in this paper are not driven by disregarding potential feedback between monetary policy and economic activity on the one hand and countries’ structural characteristics on the other hand, Figures 17 and 18 display impulse responses of output and prices to a monetary policy shock obtained from the baseline country VAR models in Equation (1) augmented by financial structure, labor market rigidities and industry mix one at a time as additional endogenous variables. The solid lines represent the baseline country VAR model impulse responses from.

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17 Because national M3 data spanning from 1995 to 2009 are not available, I merge the overnight money market rate series for the Euro area from 1999 to 2009 from the OECD’s Main Economic Indicators with the overnight call money rate series from the IMF’s International Financial Statistics for 1995 to 1998.

18 In addition, Euro area aggregates might remove some of the cross-section dependence among European countries. Euro area output and prices are ordered first and second. Notice that since the harmonized index of consumer prices is available only from 1996 onwards, for Figures 15 and 16 I re-estimate the baseline model for the time period from 1996 to 2009. Moreover, in order to reduce the parametrization once the number of endogenous variables is increased to five instead of three as in the baseline specification, I reduce the lag order of the endogenous variables to three. The structural characteristics are ordered first.
Figure 1. With the exception of the output response of Austria when including financial structure or the share of durable goods manufacturing in total output as well as Ireland when including the share of durable goods manufacturing in total output, the results of the alternative specifications in Figures 17 and 18 are similar to the baseline results.

Table 9 reports the correlations between the impulse responses of the alternative specifications described above and the baseline results. In particular, the table reports four correlations: the correlation between the maximum responses, the responses after 48 months, the mean responses, and the raw responses over all horizons. All correlations are rather high. To sum up, the impulse responses obtained from the country VAR models are mostly unchanged when the lag orders are increased, the overnight money market rate is used to reflect monetary policy, or when the exchange rate, a monetary aggregate, Euro area aggregate output and prices or the structural characteristics are included as additional endogenous variables.

Finally, Figure 19 displays the evolution over response horizons of the $R^2$ of Equation (14) for the impulse responses implied by the PCHVAR model and constructed as described in Section 4.3 (solid lines) together with those obtained from integrating out the time-series variation of the structural characteristics along the lines of Koop et al. (1996) and described in more detail in Appendix B. The results are similar to the baseline results.

6.2 Discussion

Several papers in the literature on cross-country asymmetries in monetary transmission (see Table 2) argue that the true impulse responses of output and prices are in fact identical across countries, and that the asymmetries displayed in Figure 1 are random and due to sampling uncertainty. Since in this paper the cross-country asymmetries in monetary transmission are the major source of information for the identification of the importance of financial structure, labor market rigidities and industry mix for the monetary transmission mechanism, this would raise concerns that the results of this paper are spurious. However, it is unlikely that the results are biased because I exploit spurious variation in impulse responses across countries. Think of a standard linear regression framework, and suppose that (i) there is no variation in the dependent variable, and that (ii) only an imprecise estimate of the dependent variable is available. Only if the measurement error in the dependent variable is systematically related to the explanatory variables will the latter feature statistically significant coefficients. It appears hard to make the case for cross-country differences in financial structure, labor market rigidities and industry mix being systematically related to random variation in the estimates of countries’ monetary transmission mechanisms.\footnote{A similar reasoning applies to several other qualifications of the use of the VAR approach to cross-country asymmetries in monetary transmission in general: It is unclear whether the restriction to only output, prices and interest rates can plausibly capture the interaction of the central bank with the real economy; whether identical, country-specific VAR models can produce reliable estimates of the monetary transmission if central banks’}
Another concern might be the assumption of homoskedasticity in the baseline PCHVAR model in Equation (13). While erroneously assuming homoskedastic variances does not affect consistency, in general it is restrictive for impulse responses because it implies that contemporaneous correlations of structural shocks are identical across countries. Notice, however, that when identifying monetary policy shocks using the Choleski decomposition, ordering the interest rate last implies that country-specific impulse responses to a monetary policy shock do not depend on whether contemporaneous correlations between shocks are allowed to differ across countries. The intuition is that when neither output nor prices are assumed to respond contemporaneously to the monetary policy shock, the contemporaneous correlation between the monetary policy shock and the shocks in the output and price level equations is zero for all countries (of course, heteroskedasticity may still be relevant for the responses to the output and price level shocks). Technically, the responses of the endogenous variables to the monetary policy shock when the interest rate is ordered last are governed by the last column of the Choleski decomposition $P_i$ of $\Sigma_{u,i} = P_i \cdot \Sigma_{\varepsilon} \cdot P_i'$, which is invariant to heteroskedasticity in the variance matrices $\Sigma_{u,i}$.

A last issue is that differences in central banks' institutional frameworks might invalidate imposing the same empirical model framework on all countries. Table 1 provides an overview of the monetary policy strategies of the countries considered in this paper. All countries pursue an inflation targeting approach, either explicitly institutionalized ("full-fledged") or implicitly in connection with a price stability anchor ("eclectic"). All central banks target the overnight money market rate, with the exception of the Swiss and the Hungarian central banks which target the three-month money market rate. Almost all central banks aim to steer money market rates by maintaining an interest rate corridor with standing lending and/or deposit facilities. Taken together, it appears that the operating frameworks of the central banks for the countries considered in this paper are sufficiently similar to justify an approach that imposes the same empirical model framework on all countries.

7 Conclusion

In this paper, I propose the PCHVAR model in which units' structural characteristics shape heterogeneities in their dynamic behavior. In contrast to most of the existing literature, the framework proposed in this paper does not view cross-sectional parameter heterogeneity as a random nuisance. Instead, cross-sectional heterogeneity is viewed as a source of variation which can be exploited to learn about the state dependence of, for example, policies.
I apply the PCHVAR model to the conditioning of country-specific responses of output and prices to a monetary policy shock on countries’ financial structure, labor market rigidities and industry mix. In this context, the PCHVAR model allows to (i) exploit the time series variation in countries’ structural characteristics to learn about their role for monetary transmission, (ii) to take into account the entire shape of the responses of output and prices to a monetary policy shock rather than only the maximum response, and (iii) to quantify the importance of a set of countries’ structural characteristics for monetary transmission. I find that up to 70% (50%) of the heterogeneities in the responses of output (prices) to a monetary policy shock across countries can be accounted for by jointly incorporating cross-country differences in financial structure, labor market rigidities and industry mix. A tentative decomposition of these figures into the contributions of each structural characteristic shows that while in the short run the output effects arise almost entirely through the interest rate channel, in the medium and long run the credit channel and the presence of labor market friction are more important. The interest rate channel is of rather minor importance for prices.

These results suggest that policies aimed at harmonizing labor markets and fostering financial integration as well as structural change may markedly reduce asymmetries in monetary transmission in currency unions. Moreover, because of financial market development, globalization and structural change central banks should be aware of potentially large variations in the future monetary transmission mechanism. Finally, financial structure, labor market rigidities and industry mix should be key elements of any theoretical business cycle model used for policy advice.

A conceptual limitation of the empirical approach pursued in this paper is the inability to determine the quantitative importance of financial structure, labor market rigidities and industry mix for cross-country asymmetries in monetary transmission individually. Future work should also attempt to integrate the systematic analysis of cross-country heterogeneities in VAR models to the global VAR model to better account for cross-section dependence.

References


OECD (2010). OECD Structural Analysis Database.


A The Effects of Measurement Error

In this section, I first describe the effects of measurement error in the explanatory variable on the coefficient estimates. I then proceed to describing the effects of measurement error in the dependent and/or the explanatory variables on the regression $R$-squared.

A.1 The Effect of Measurement Error on the Coefficient Estimates

Consider a standard cross-section regression

\[ y_i^* = \alpha + \beta \cdot x_i^* + u_i \]

for observations $i = 1, 2, \ldots, N$, $Z_i^* \equiv (1, x_i^*)$, and $\gamma \equiv (\alpha, \beta)'$. Suppose we want to estimate Equation (A.1), but we only have an inaccurate measure of the explanatory variable given by

\[ x_i = x_i^* + e_i, \quad \text{Var}(e_i) = \sigma_e^2, \quad E(e_i) = E(e_i x_i^*) = E(e_i u_i) = 0 \]

Instead of Equation (A.1), the estimated equation is thus

\[ y_i^* = \alpha + \beta \cdot x_i + u_i - \beta \cdot e_i \]

\[ = \alpha + \beta \cdot x_i + \delta_i \]

\[ = Z_i \cdot \gamma + \delta_i, \]

with $\text{Var}(\delta_i) \equiv \sigma_\delta^2 = \beta^2 \sigma_e^2 + \sigma_u^2$. The ordinary least squares (OLS) estimator

\[ \hat{\gamma} = \left( \sum_{i=1}^{N} Z_i' Z_i \right)^{-1} \left( \sum_{i=1}^{N} Z_i' y_i^* \right), \]

entails an attenuation bias due to the non-zero correlation between the composite error, $\delta_i$, and the regressor, $x_i$, $E(x_i \delta_i) = -\beta \sigma_e^2$. It can be shown that

\[ \text{plim} \hat{\gamma} = \left[ \begin{array}{c} 1 \ r_x \cdot E(x_i) \\ 0 \ 1 - r_x \end{array} \right] \cdot \gamma = A \gamma, \quad r_x \equiv \frac{\sigma_e^2}{\sigma_e^2 + \sigma_{x^*}^2}. \]

Given the signal-to-noise ratio, $STN \equiv \sigma_{x^*}^2/\sigma_e^2$, one can obtain a corrected coefficient estimate and variance-covariance matrix

\[ \tilde{\gamma} = A^{-1} \hat{\gamma}, \]

\[ \text{Var}(\tilde{\gamma}) = A^{-1} \text{Var}(\hat{\gamma}) A^{-1'}, \]

24
for which \( \text{plim} \tilde{\gamma} = \gamma \). It turns out that
\[
\tilde{\beta} = \frac{1}{1 - r_x} \hat{\beta} = \left( 1 + \frac{1}{STN} \right) \hat{\beta},
\]
\[
\text{std}(\tilde{\beta}) = \frac{1}{1 - r_x} \cdot \text{std}(\hat{\beta}) = \left( 1 + \frac{1}{STN} \right) \cdot \text{std}(\hat{\beta}).
\]

The measurement error setting is similar but different to a generated regressors framework in the spirit of Pagan (1984):
\[
y^*_i = x^*_i \cdot \delta + u_i,
\]
\[
x_i = x^*_i + e_i = q_i \cdot \alpha + e_i,
\]
where \( x^*_i \) is an unobserved variable related to the observed, predetermined variables \( q_i \). For estimation of \( \delta \), \( x^*_i \) is replaced by \( \hat{x}^*_i = q_i \hat{\alpha} \) in the first equation. In the context of this paper, \( y^*_i \) represents the probability limit of the country VAR model impulse responses, \( ir_i^{(VAR)} \), \( x^*_i \) the probability limit of the PCHVAR model impulse responses, \( ir_i^{(PCHVAR)} \), and \( x_i \) the estimated PCHVAR model impulse responses, \( \hat{ir}_i^{(PCHVAR)} \). In the generated regressors framework, the coefficient estimates remain consistent, but the standard errors - unless corrected - do not take into account sampling uncertainty from the first stage regression. The difference between the generated regressors framework and the present setting is that the finite sample PCHVAR model impulse response estimate \( x_i \) is not an estimate \( \hat{x}^*_i \) of \( x^*_i \), but rather a noisy measure.

### A.2 The Effect of Measurement Error on the Goodness of Fit

Upon OLS estimation of the cross-section regression without measurement error in Equation \([A.1]\) for the \( R^2 \)-squared it holds that
\[
R^2 \equiv 1 - \frac{\hat{\sigma}_u^2}{\hat{\sigma}_y^2} \quad \xrightarrow{p} \quad 1 - \frac{\sigma_u^2}{\sigma_y^2}.
\]

As I show below, when the dependent and/or the explanatory variables are measured with error, the probability limits of the \( R^2 \)-squared will be different from - namely lower than - the probability limit in Equation \([A.12]\). Thus, even if the true fit is perfect, asymptotically the \( R^2 \)-squared will be below unity solely due to the presence of measurement error. If one has an estimate of the signal-to-noise ratio in the measures of the dependent and the explanatory variables, at least asymptotically one can correct for the downward bias in the actual \( R^2 \)-squared: The probability limit of the true \( R^2 \)-squared is equal to the probability limit of the actual \( R^2 \)-squared multiplied by one plus the inverse of the relevant signal-to-noise ratio. I first discuss the case when measurement error is present only in the dependent variable, followed by the case when only the explanatory variable is measured with error. Finally, I put pieces together and
describe the effect of measurement error in both the dependent and explanatory variables on the \(R\)-squared.

### A.2.1 Measurement Error in \(y^*_i\)

Suppose we want to estimate Equation (A.1) but we only have an inaccurate measure of the dependent variable, that is

\[
y_i = y^*_i + w_i, \quad \text{Var}(w_i) = \sigma^2_w, \quad E(w_i) = E(w_i y^*_i) = E(w_i u_i) = 0, \tag{A.13}
\]

with \(\text{Var}(y_i) \equiv \sigma^2_y = \sigma^2_{y^*} + \sigma^2_w\). Instead of Equation (A.1), the estimated equation is given by

\[
y_i = \alpha + \beta \cdot x^*_i + u_i + w_i
\]

with \(\text{Var}(\delta_i) \equiv \sigma^2_\delta = \sigma^2_w + \sigma^2_u\). For the \(R\)-squared of the model in Equation (A.14) it holds that

\[
R^2_y \equiv 1 - \frac{\hat{\sigma}^2_\delta}{\hat{\sigma}^2_y} \overset{p}{\longrightarrow} 1 - \frac{\sigma^2_\delta}{\sigma^2_y}, \tag{A.15}
\]

as the OLS estimator is consistent under measurement error in the dependent variable. Asymptotically, the ratio of the \(R\)-squareds of the model without any measurement error in Equation (A.1) and the model with measurement error in the dependent variable in Equation (A.14) is given by

\[
\text{plim} \frac{R^2_{y^*}}{R^2_y} = \frac{(\sigma^2_{y^*} - \sigma^2_u)/\sigma^2_y}{\sigma^2 - \sigma^2_\delta} = \frac{(\sigma^2_{y^*} - \sigma^2_u)/\sigma^2_y}{(\sigma^2_{y^*} + \sigma^2_w - \sigma^2_u - \sigma^2_w)/\sigma^2_y} = \frac{\sigma^2_y}{\sigma^2_{y^*}} = 1 + \frac{\sigma^2_w}{\sigma^2_y}. \tag{A.16}
\]

Thus,

\[
\text{plim} R^2_{y^*} = \left(1 + \frac{\sigma^2_w}{\sigma^2_{y^*}} \right) \cdot \text{plim} R^2_y. \tag{A.17}
\]
### A.2.2 Measurement Error in $x_i^*$

Suppose we want to estimate Equation (A.1) but we only have an inaccurate measure of the explanatory variable, that is

$$x_i = x_i^* + e_i, \quad \text{Var}(e_i) = \sigma^2_e, \quad E(e_i) = E(e_i x_i^*) = E(e_i u_i) = 0,$$

(A.18)

with $\text{Var}(x_i) \equiv \sigma_x^2 = \sigma_{x^*}^2 + \sigma_e^2$. Instead of Equation (A.1), the estimated equation is given by

$$y_i^* = \alpha + \beta \cdot x_i + u_i - \beta \cdot e_i = \alpha + \beta \cdot x_i + \delta_i,$$

(A.19)

with $\text{Var}(\delta_i) \equiv \sigma_{\delta}^2 = \beta^2 \sigma_e^2 + \sigma_u^2$. The $R$-squared for the model with measurement error in the explanatory variable in Equation (A.19) is given by

$$R^2_x \equiv 1 - \frac{\hat{\sigma}_\delta^2}{\hat{\sigma}_{y^*}^2}.$$

(A.20)

Due to the non-zero correlation between the composite error $\delta_i = u_i - \beta \cdot e_i$ and the regressor $x_i$, $E(x_i \delta_i) = -\beta \cdot \sigma_e^2 \neq 0$, under measurement error in the explanatory variable the OLS estimates (and therefore residuals and estimated variances) are inconsistent. Consequently, in order to find the probability limit of the $R$-squared of the model with measurement error in the explanatory variable given in Equation (A.19), $R^2_x$, one needs to determine the probability limit of $\hat{\sigma}_\delta^2$. Using
Using the result in Equation (A.21) for the $\mathcal{R}^2$, we have that

\[
\text{plim } \hat{\sigma}_e^2 = \text{plim } \frac{1}{N} \sum_{i=1}^{N} (y_i^* - Z_i \cdot \hat{\gamma})^2
\]

\[
= \text{plim } \frac{1}{N} \sum_{i=1}^{N} [y_i^* - Z_i \cdot \gamma - Z_i \cdot (\hat{\gamma} - \gamma)]^2
\]

\[
= \text{plim } \frac{1}{N} \sum_{i=1}^{N} [\delta_i - Z_i \cdot (\hat{\gamma} - \gamma)]^2
\]

\[
= \text{plim } \frac{1}{N} \sum_{i=1}^{N} \delta_i^2 - 2 \cdot \text{plim } \frac{1}{N} \sum_{i=1}^{N} [\delta_i Z_i \cdot (\hat{\gamma} - \gamma)] + \text{plim } \frac{1}{N} \sum_{i=1}^{N} [Z_i \cdot (\hat{\gamma} - \gamma)]^2
\]

\[
= \sigma_\delta^2 - 2 \cdot \text{plim } \frac{1}{N} \sum_{i=1}^{N} [\delta_i \cdot (\hat{\alpha} - \alpha) + \delta_i x_i \cdot (\hat{\beta} - \beta)] + \text{plim } \frac{1}{N} \sum_{i=1}^{N} [(\hat{\alpha} - \alpha) + x_i \cdot (\hat{\beta} - \beta)]^2
\]

\[
= \sigma_\delta^2 - 2 \cdot \text{plim } (\hat{\alpha} - \alpha) \cdot \text{plim } \frac{1}{N} \sum_{i=1}^{N} \delta_i - 2 \cdot \text{plim } (\hat{\beta} - \beta) \cdot \text{plim } \frac{1}{N} \sum_{i=1}^{N} \delta_i x_i
\]

\[
+ \text{plim } \frac{1}{N} \sum_{i=1}^{N} [(\hat{\alpha} - \alpha)^2 + 2 x_i \cdot (\hat{\alpha} - \alpha)(\hat{\beta} - \beta) + x_i^2 \cdot (\hat{\beta} - \beta)^2]
\]

\[
= \sigma_\delta^2 - 2 \cdot r_x E(x_i) \beta \cdot E(\delta_i) - 2 \cdot (\beta \sigma_e^2) + \text{plim } (\hat{\alpha} - \alpha)^2
\]

\[
= \sigma_\delta^2 - 2 r_x \beta^2 \sigma_e^2 + r_x^2 E(x_i)^2 \beta^2 - 2 r_x^2 E(x_i)^2 \beta^2 + r_x^2 \beta^2 E(x_i^2)
\]

\[
= \sigma_\delta^2 - 2 r_x \beta^2 \sigma_e^2 + r_x^2 \beta^2 \sigma_e^2
\]

\[
= \sigma_\delta^2 - 2 r_x \beta^2 \sigma_e^2 + r_x^2 \beta^2 (\sigma_e^2 + \sigma_x^2)
\]

\[
= \sigma_\delta^2 - 2 r_x \beta^2 \sigma_e^2 + r_x \beta^2 \sigma_e^2
\]

\[
= \sigma_\delta^2 - r_x \beta^2 \sigma_e^2.
\]

(A.21)

Using the result in Equation (A.21) for the R-squared of Equation (A.19) we have

\[
\text{plim } R_x^2 = 1 - \frac{\text{plim } \hat{\sigma}_e^2}{\text{plim } \hat{\sigma}_{y^*}^2} = 1 - \frac{\sigma_\delta^2 - r_x \beta^2 \sigma_e^2}{\sigma_{y^*}^2}.
\]

(A.22)

Asymptotically, the ratio of the R-squareds of the model without any measurement error in Equation (A.11) and the model with measurement error in the explanatory variable in Equation
is given by (using also that $\sigma^2_y = \beta^2 \sigma^2_x + \sigma^2_u$)

$$\text{plim } R^2_{xy} = \frac{(\sigma^2_y - \sigma^2_u)/\sigma^2_y}{(\sigma^2_y - \sigma^2_u + r_x \beta^2 \sigma^2_e)/\sigma^2_y} = \frac{\frac{\beta^2 \sigma^2_y}{\beta^2 \sigma^2_e}}{1 - \frac{\sigma^2_u}{\sigma^2_e} (1 - r_x)} = \frac{1}{1 - r_x} = 1 + \frac{\sigma^2_e}{\sigma^2_e}. \quad (A.23)$$

Thus,

$$\text{plim } R^2 = \left(1 + \frac{\sigma^2_e}{\sigma^2_e}\right) \cdot \text{plim } R^2_{xy}. \quad (A.24)$$

### A.2.3 Measurement Error in both $y^*_i$ and $x^*_i$

Suppose we want to estimate Equation (A.1) but we have inaccurate measures of both the dependent and the explanatory variable, that is

$$y_i = y^*_i + w_i, \quad \text{Var}(w_i) = \sigma^2_w, \quad E(w_i) = E(w_i y^*_i) = E(w_i u_i) = 0, \quad (A.25)$$

$$x_i = x^*_i + e_i, \quad \text{Var}(e_i) = \sigma^2_e, \quad E(e_i) = E(e_i x^*_i) = E(e_i u_i) = 0, \quad (A.26)$$

Instead of Equation (A.1), the estimated equation is given by

$$y_i = \alpha + \beta \cdot x_i + u_i - \beta \cdot e_i + w_i$$

$$= \alpha + \beta \cdot x_i + \delta_i, \quad (A.27)$$

with $\text{Var}(\delta_i) \equiv \sigma^2_\delta = \beta^2 \sigma^2_e + \sigma^2_u + \sigma^2_w$. The $R$-squared for the model with measurement error in the explanatory variable in Equation (A.27) is given by

$$R^2_{xy} \equiv 1 - \frac{\sigma^2_\delta}{\sigma^2_y}. \quad (A.28)$$

Suppose the measurement errors of the dependent and the explanatory variables are uncorrelated, $E(e_i w_i) = 0$. Then, as measurement error in the dependent variable does not introduce

\[ \text{If they are correlated, this only affects the magnitude of the error variance, } \sigma^2_\delta, \text{ but leaves the derivations of the effects of measurement error on the } R\text{-squared unchanged.} \]

29
any inconsistency but only increases the variance of the regression error, $\sigma^2_\delta$, the effects of measurement error in the dependent and explanatory variable on the goodness of fit are independent of each other. Consequently, asymptotically it holds that the ratio of the $R$-squareds of the model without any measurement error in Equation (A.1) and the model with measurement error in both the dependent and the explanatory variable in Equation (A.27) is given by

$$plim \frac{R^2}{R^2_{xy}} = \left(1 + \frac{\sigma^2_e}{\sigma^2_{e^*}}\right) \cdot \left(1 + \frac{\sigma^2_w}{\sigma^2_{w^*}}\right), \quad (A.29)$$

so that

$$plim R^2 = \left(1 + \frac{\sigma^2_e}{\sigma^2_{e^*}}\right) \cdot \left(1 + \frac{\sigma^2_w}{\sigma^2_{w^*}}\right) \cdot plim R^2_{xy}. \quad (A.30)$$

Notice that this does not imply that for sufficiently small signal-to-noise ratios the true $R$-squared is larger than unity, as lower signal-to-noise ratios imply lower values of $R^2_{xy}$. To see this, for the model with measurement error in the dependent variable notice that $R^2_y \to 0$ for the case when $\frac{\sigma^2_w}{\sigma^2_{w^*}} \to \infty$ since Equation (A.15) can be rewritten as

$$plim R^2_y = 1 - \frac{1 + \frac{\sigma^2_w}{\sigma^2_{w}}}{1 + \frac{\sigma^2_e}{\sigma^2_{e^*}} + \beta^2 \frac{\sigma^2_{e^*}}{\sigma^2_{e}}}. \quad (A.31)$$

For the model with measurement error in the explanatory variable, observe that upon substitution, Equation (A.22) can be rewritten as

$$plim R^2_x = 1 - \frac{\frac{\sigma^2_e}{\sigma^2_{e^*}} + (1 - r_x)\beta^2}{\frac{\sigma^2_e}{\sigma^2_{e^*}} + \beta^2 \frac{\sigma^2_{e^*}}{\sigma^2_{e}}}. \quad (A.32)$$

As measurement error becomes stronger, that is as $\frac{\sigma^2_w}{\sigma^2_{w^*}} \to 0$ implying $r_x \to 1$, for fixed $\beta$ it holds that $R^2_x \to 0$. 

30
B Constructing Generalized Impulse Response Functions with Monte Carlo Integration

Following Koop et al. (1996), I integrate out the history dependence of the impulse responses implied by the PCHVAR model while preserving the cross-sectional spread in the impulse responses by repeating the following steps in country-specific Monte Carlo experiments:

1. Pick an initial observation $\tilde{z}_{i1}$ by drawing randomly from the actual data $\{z_{it}\}_{t=1,2,\ldots,T_i}$ of country $i$.

2. Generate a simulated time series $\{\tilde{z}_{it}\}_{t=1,2,\ldots,H}$ of the conditioning variable of country $i$ by iterating on
   \[ \tilde{z}_{ijt} = \tilde{\phi}_0 + \tilde{\phi}_1 \cdot \tilde{z}_{ij,t-1} + u_{ijt}, \]  
   \[ \text{for } j = 1, 2, 3 \] and where $u_{ijt} \overset{i.i.d.}{\sim} N(0, \hat{\sigma}^2_{ij})$ and $\tilde{\phi}_0$, $\tilde{\phi}_1$, $\hat{\sigma}^2_{ij}$ are OLS estimates.\textsuperscript{21}

3. Calculate history-dependent impulse responses using the simulated values of the conditioning variable obtained in steps 1. and 2. in Equation (11).

4. Repeat steps 1. to 3. 250 times and store the impulse responses in each replication.

5. Calculate the average of the impulse responses obtained in step 4.

The intuition for this approach is the following: The impulse response at horizon $h$ is a random variable,

\[ ir^{(PCHVAR)}(h) = E[y_{i,t+h}|u_{it}, Y_{it}, \mathbf{Z}_{i,t+h}^{(h)}] - E[y_{i,t+h}|Y_{it}, \mathbf{Z}_{i,t+h}^{(h)}], \]  

where $\mathbf{Z}_{i,t+h}^{(h)}$ is a random variable (for example countries’ structural characteristics) of which $\mathbf{Z}_{i,t+h}$ is a realization, and $Y_{it} \equiv [y_{it}, y_{i,t-1}, \ldots, y_{i,t-p}]$. To integrate out the history dependence, calculate

\[ E \left[ ir^{(PCHVAR)}(h, u_{it}, Y_{it}, \mathbf{Z}_{i,t+h}^{(h)}) \right], \]  

where the expectation is taken with respect to $\mathbf{Z}_{i,t+h}^{(h)}$.

\textsuperscript{21}I smooth the simulated time series $\{\tilde{z}_{it}\}_{t=1,2,\ldots,H}$ using the Hodrick-Prescott filter before moving to step 3. Moreover, I drop a replication if the simulated time series exceeds unity or declines below zero, as in the estimation of the PCHVAR model I enter re-scaled structural characteristics that fall in $[0, 1]$, see Section 4.4.
Table 1: Countries Included, Periods Covered and Variables Used

<table>
<thead>
<tr>
<th>Country</th>
<th>Period Covered</th>
<th>Variables</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1995:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Austria</td>
<td>1995:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Belgium</td>
<td>1995:1-2009:10</td>
<td>Log CPI (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Canada</td>
<td>1995:1-2009:10</td>
<td>Log CPI (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1998:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Denmark</td>
<td>1995:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>France</td>
<td>1995:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Germany</td>
<td>1998:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Hungary</td>
<td>1995:3-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Ireland</td>
<td>1995:1-2009:10</td>
<td>Log CPI (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Italy</td>
<td>1995:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Korea</td>
<td>1995:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>New Zealand</td>
<td>1996:12-2009:10</td>
<td>Log CPI (nat. sources, q)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Poland</td>
<td>1995:4-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Portugal</td>
<td>1995:1-2009:10</td>
<td>Log CPI (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Spain</td>
<td>1995:1-2009:10</td>
<td>Log CPI (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Sweden</td>
<td>1995:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1995:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1995:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
<tr>
<td>United States</td>
<td>1999:1-2009:10</td>
<td>Log GDP Deflator (OECD)</td>
<td>Log Real GDP (OECD)</td>
</tr>
</tbody>
</table>

Note: The table provides a list of the countries included, the time period covered for each country and the variables used. The GDP and deflator figures are taken from the OECD'S Quarterly National Accounts. The CPI figures are taken from the OECD's Prices Database in the Main Economic Indicators and from Statistics New Zealand. The figures are seasonally adjusted. The GDP figures are expressed in US dollars using fixed PPP weights. The short-term interest rate is taken from the Financial Indicators in the OECD’s Main Economic Indicators and usually is either the three month interbank offer rate or the rate associated with Treasury bills, Certificates of Deposit or comparable instruments, each of three month maturity. The immediate interest rate is the official discount rate or overnight call-money rate.
<table>
<thead>
<tr>
<th>Study</th>
<th>Approach</th>
<th>Countries</th>
<th>Finding</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gerlach and Smets (1995)</td>
<td>country-specific VAR models with mix of long- and short-run restrictions; one standard deviation shock and 100 basis points shock over eight quarters</td>
<td>CAN, FRA, DEU, ITA, JPN, GBR, USA</td>
<td>“The estimates of the effects of monetary policy provide little evidence of large differences in the monetary transmission between countries, particularly not when estimated confidence bands are taken into account.” (p. 39)</td>
<td></td>
</tr>
<tr>
<td>Barran et al. (1996)</td>
<td>identical, country-specific VAR models with recursive identification; one standard deviation shock</td>
<td>AUT, DEU, DK, ESP, FIN, FRA, ITA, NLD, GBR</td>
<td>“[European countries] were similar in the sense of responses and lags [to a monetary policy shock]. However, the magnitudes involved seem different.” (p. 21)</td>
<td></td>
</tr>
<tr>
<td>Ramaswany and Slok (1998)</td>
<td>country-specific VAR models with recursive identification; 100 basis points shock</td>
<td>AUT, BEL, DEU, DK, ESP, FIN, FRA, GBR, ITA, NLD, PRT, SWE</td>
<td>“there appear to be marked differences in the real effects of monetary policy among EU countries.” (p. 383)</td>
<td></td>
</tr>
<tr>
<td>Dornbusch et al. (1998)</td>
<td>Estimate country-specific monetary policy reaction function and dynamic output equations, so that they can simulate a currency union-wide shock</td>
<td>DEU, ESP, FRA, ITA, SWE, GBR</td>
<td>“the impact effect on output is always significant, but different across countries” (p. 40)</td>
<td>Perform Wald tests for cross-country asymmetries in monetary transmission.</td>
</tr>
<tr>
<td>Kieler and Saarenheimo (1998)</td>
<td>identical, country-specific VAR models; compare impulse responses obtained from rotations of orthogonalized reduced form shocks and impose plausibility windows;</td>
<td>DEU, FRA, GBR</td>
<td>“once the uncertainty involved in the structural identification is accounted for, no statistically significant differences in monetary transmission can be found for a group of three large EU countries.” (p. 4)</td>
<td></td>
</tr>
<tr>
<td>Kim (1999)</td>
<td>identical, country-specific structural VAR models; one standard deviation shock</td>
<td>CAN, DEU, FRA, GBR, ITA, JPN, USA</td>
<td>“the output responses [to a monetary policy shock] are very similar across countries.” (p. 399)</td>
<td></td>
</tr>
<tr>
<td>Ehrmann (2000)</td>
<td>country-specific and different VAR models; restrictions on the cointegrating properties; ten basis points shock</td>
<td>AUT, BEL, DEU, DK, FIN, FRA, IRL, ITA, NLD, PRT, ESP, SWE, GBR</td>
<td>“considerable differences in the monetary transmission mechanism” (p. 78)</td>
<td></td>
</tr>
<tr>
<td>Clements, Kontolemis and Levy (2001)</td>
<td>country-specific VAR models with recursive identification; 100 basis points shock</td>
<td>AUT, BEL, DEU, FIN, FRA, IRL, ITA, NLD, PRT, ESP</td>
<td>“[the effects of monetary policy] on economic activity are likely to differ across EMU countries” (p. 1)</td>
<td></td>
</tr>
<tr>
<td>Mihov (2001)</td>
<td>country-specific VAR models with recursive identification; 100 basis points shock</td>
<td>AUS, AUT, CAN, DEU, FRA, GBR, ITA, JPN, NLD, USA</td>
<td>“monetary policy transmission mechanisms were quite heterogeneous across EMU members.” (p. 372)</td>
<td></td>
</tr>
<tr>
<td>Mojon and Peersman (2001)</td>
<td>country-specific, structural VAR models; one standard deviation shock</td>
<td>AUT, BEL, DEU, FIN, FRA, GRC, IRL, ITA, NLD, ESP</td>
<td>“the overall pattern for output and prices is quite similar across countries” (p. 17)</td>
<td></td>
</tr>
<tr>
<td>Sala (2002)</td>
<td>Dynamic factor model to investigate currency-union wide shock to monetary policy</td>
<td>AUS, BEL, DEU, ESP, FRA, ITA, NLD, PRT</td>
<td>“European countries (...) are characterized by quantitatively different responses [of output to a monetary policy shock].” (p. 1)</td>
<td></td>
</tr>
<tr>
<td>Dedola and Lippi (2005)</td>
<td>country-specific VAR models with recursive identification; one standard deviation shock</td>
<td>DEU, FRA, GBR, ITA, USA</td>
<td>“hardly detectable cross-country variability.” (p. 1543)</td>
<td>Perform Wald tests for cross-country asymmetries in monetary transmission (controlling for industry effects).</td>
</tr>
</tbody>
</table>
Table 2: An Overview of the Literature on Cross-Country Asymmetries in Monetary Transmission (continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Approach</th>
<th>Countries</th>
<th>Finding</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciccarelli and Rebucci (2006)</td>
<td>Approach similar to Dornbusch et al. (1998) with reaction functions and output equations, but allow for time variation</td>
<td>DEU, ESP, FRA, ITA</td>
<td>“cross-country differences in the effects of [monetary policy] shocks have not decreased over time.” (p. 737)</td>
<td></td>
</tr>
</tbody>
</table>

Note: The table presents an overview of papers on cross-country asymmetries in monetary transmission.
Table 3: Cross-Country Rankings of Statistics of the Responses of Output to a Monetary Policy Shock from Individual Country VAR Models

<table>
<thead>
<tr>
<th>Maximum Response</th>
<th>Mean Response</th>
<th>Response at Horizon $H = 48$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poland</td>
<td>-0.003</td>
<td>Poland</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>-0.004</td>
<td>Czech Republic</td>
</tr>
<tr>
<td>Hungary</td>
<td>-0.005</td>
<td>United States</td>
</tr>
<tr>
<td>Australia</td>
<td>-0.005</td>
<td>Australia</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>-0.005</td>
<td>Hungary</td>
</tr>
<tr>
<td>Canada</td>
<td>-0.005</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>United States</td>
<td>-0.006</td>
<td>Canada</td>
</tr>
<tr>
<td>Germany</td>
<td>-0.008</td>
<td>Germany</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.008</td>
<td>Switzerland</td>
</tr>
<tr>
<td>New Zealand</td>
<td>-0.008</td>
<td>Italy</td>
</tr>
<tr>
<td>France</td>
<td>-0.009</td>
<td>France</td>
</tr>
<tr>
<td>Italy</td>
<td>-0.011</td>
<td>New Zealand</td>
</tr>
<tr>
<td>Portugal</td>
<td>-0.012</td>
<td>Portugal</td>
</tr>
<tr>
<td>Denmark</td>
<td>-0.014</td>
<td>Denmark</td>
</tr>
<tr>
<td>Sweden</td>
<td>-0.016</td>
<td>Korea</td>
</tr>
<tr>
<td>Austria</td>
<td>-0.016</td>
<td>Sweden</td>
</tr>
<tr>
<td>Spain</td>
<td>-0.016</td>
<td>Spain</td>
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<tr>
<td>Korea</td>
<td>-0.017</td>
<td>Belgium</td>
</tr>
<tr>
<td>Belgium</td>
<td>-0.017</td>
<td>Austria</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.019</td>
<td>Ireland</td>
</tr>
</tbody>
</table>

| Mean             | -0.010        | Mean                          | -0.006                    | Mean                         | -0.006 |
| Std.             | 0.005         | Std.                          | 0.004                     | Std.                         | 0.005 |

Note: The table provides the country rankings of the maximum, mean and the values at horizon $H = 48$ of the responses of output to a monetary policy shock derived from the country VAR models in Equation (1). For each of these statistic, the table also provides the mean and the standard deviation across countries.
Table 4: Cross-Country Rankings of Statistics of the Responses of Prices to a Monetary Policy Shock from Individual Country VAR Models

<table>
<thead>
<tr>
<th>Maximum Response</th>
<th>Mean Response</th>
<th>Response at Horizon $H = 48$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>-0.002</td>
<td>Australia</td>
</tr>
<tr>
<td>Sweden</td>
<td>-0.002</td>
<td>-0.000</td>
</tr>
<tr>
<td>New Zealand</td>
<td>-0.003</td>
<td>Italy</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.003</td>
<td>Poland</td>
</tr>
<tr>
<td>Poland</td>
<td>-0.003</td>
<td>Switzerland</td>
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<tr>
<td>United Kingdom</td>
<td>-0.003</td>
<td>France</td>
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<tr>
<td>United States</td>
<td>-0.003</td>
<td>New Zealand</td>
</tr>
<tr>
<td>Hungary</td>
<td>-0.003</td>
<td>United States</td>
</tr>
<tr>
<td>Germany</td>
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<td>United Kingdom</td>
</tr>
<tr>
<td>France</td>
<td>-0.004</td>
<td>Hungary</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>-0.004</td>
<td>Hungary</td>
</tr>
<tr>
<td>Korea</td>
<td>-0.005</td>
<td>Austria</td>
</tr>
<tr>
<td>Austria</td>
<td>-0.005</td>
<td>Ireland</td>
</tr>
<tr>
<td>Italy</td>
<td>-0.005</td>
<td>Korea</td>
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<tr>
<td>Denmark</td>
<td>-0.007</td>
<td>Czech Republic</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.007</td>
<td>Canada</td>
</tr>
<tr>
<td>Canada</td>
<td>-0.008</td>
<td>Denmark</td>
</tr>
<tr>
<td>Portugal</td>
<td>-0.008</td>
<td>Portugal</td>
</tr>
<tr>
<td>Spain</td>
<td>-0.010</td>
<td>Spain</td>
</tr>
<tr>
<td>Belgium</td>
<td>-0.010</td>
<td>Belgium</td>
</tr>
</tbody>
</table>

Mean       -0.005 | Mean       -0.002 | Mean       -0.004 |
Std.       0.003  | Std.       0.002  | Std.       0.002  |

Note: The table provides the country rankings of the maximum, mean and the values at horizon $H = 48$ of the responses of prices to a monetary policy shock derived from the country VAR models in Equation (1). For each of these statistic, the table also provides the mean and the standard deviation across countries.
### Table 5: Cross-Country Differences in Structural Characteristics

<table>
<thead>
<tr>
<th>Country</th>
<th>Financial Structure Index</th>
<th>Strictness of Employment Protection</th>
<th>Share of Manufacturing Durable Components</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Australia</td>
<td>0.57</td>
<td>0.64</td>
<td>0.51</td>
</tr>
<tr>
<td>Austria</td>
<td>0.58</td>
<td>0.60</td>
<td>0.52</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.57</td>
<td>0.59</td>
<td>0.52</td>
</tr>
<tr>
<td>Canada</td>
<td>0.60</td>
<td>0.69</td>
<td>0.52</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>0.51</td>
<td>0.53</td>
<td>0.49</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.59</td>
<td>0.87</td>
<td>0.42</td>
</tr>
<tr>
<td>France</td>
<td>0.58</td>
<td>0.63</td>
<td>0.52</td>
</tr>
<tr>
<td>Germany</td>
<td>0.60</td>
<td>0.64</td>
<td>0.56</td>
</tr>
<tr>
<td>Hungary</td>
<td>0.41</td>
<td>0.48</td>
<td>0.34</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.67</td>
<td>0.82</td>
<td>0.52</td>
</tr>
<tr>
<td>Italy</td>
<td>0.54</td>
<td>0.64</td>
<td>0.50</td>
</tr>
<tr>
<td>Korea</td>
<td>0.64</td>
<td>0.68</td>
<td>0.52</td>
</tr>
<tr>
<td>New Zealand</td>
<td>0.64</td>
<td>0.71</td>
<td>0.53</td>
</tr>
<tr>
<td>Poland</td>
<td>0.40</td>
<td>0.48</td>
<td>0.35</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.63</td>
<td>0.74</td>
<td>0.50</td>
</tr>
<tr>
<td>Spain</td>
<td>0.59</td>
<td>0.73</td>
<td>0.51</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.62</td>
<td>0.72</td>
<td>0.52</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.65</td>
<td>0.68</td>
<td>0.53</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.63</td>
<td>0.71</td>
<td>0.54</td>
</tr>
<tr>
<td>United States</td>
<td>0.62</td>
<td>0.67</td>
<td>0.57</td>
</tr>
<tr>
<td>Mean</td>
<td>0.58</td>
<td>0.66</td>
<td>0.50</td>
</tr>
<tr>
<td>Std.</td>
<td>0.07</td>
<td>0.10</td>
<td>0.06</td>
</tr>
<tr>
<td>Max</td>
<td>0.67</td>
<td>0.87</td>
<td>0.57</td>
</tr>
<tr>
<td>Min</td>
<td>0.40</td>
<td>0.48</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Note: The table provides the mean, maximum and minimum values of the financial structure index, strictness of employment protection indicator, and the share of durable goods manufacturing for every country in the sample and the time periods displayed in Table 1. The table also provides the mean, maximum and minimum values as well as the standard deviation across all countries of the country-specific figures.
Table 6: Regressing Statistics of Country VAR Model Impulse Responses of Output on Countries’ Structural Characteristics

<table>
<thead>
<tr>
<th></th>
<th>max. IR</th>
<th>mean IR</th>
<th>IR at H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Structure Index</td>
<td>−0.019*** (0.005)</td>
<td>−0.013*** (0.004)</td>
<td>−0.016*** (0.005)</td>
</tr>
<tr>
<td>Strictness of Employment Protection</td>
<td>−0.010** (0.004)</td>
<td>−0.007** (0.003)</td>
<td>−0.004 (0.004)</td>
</tr>
<tr>
<td>Share of Manufacturing Durable Components</td>
<td>−0.003 (0.004)</td>
<td>−0.000 (0.003)</td>
<td>−0.000 (0.003)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.42</td>
<td>0.42</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Note: The table displays the estimates $\hat{b}$ from Equation (2). Standard errors of point estimates are reported in parentheses. * (**, ****) represents statistical significance at the 10% (5%, 1%) significance level. Standard errors are heteroskedasticity-consistent.

Table 7: Regressing Statistics of Country VAR Model Impulse Responses of Prices on Countries’ Structural Characteristics

<table>
<thead>
<tr>
<th></th>
<th>max. IR</th>
<th>mean IR</th>
<th>IR at H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Structure Index</td>
<td>−0.003 (0.002)</td>
<td>−0.002 (0.002)</td>
<td>−0.003 (0.002)</td>
</tr>
<tr>
<td>Strictness of Employment Protection</td>
<td>−0.005** (0.002)</td>
<td>−0.003* (0.002)</td>
<td>−0.006*** (0.002)</td>
</tr>
<tr>
<td>Share of Manufacturing Durable Components</td>
<td>0.002 (0.002)</td>
<td>0.001 (0.002)</td>
<td>0.003* (0.002)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.23</td>
<td>0.15</td>
<td>0.40</td>
</tr>
</tbody>
</table>

Note: The table displays the estimates $\hat{b}$ from Equation (2). Standard errors of point estimates are reported in parentheses. * (**, ****) represents statistical significance at the 10% (5%, 1%) significance level. Standard errors are heteroskedasticity-consistent.
Table 8: Rank Correlations Between Statistics of the Country VAR Model and the PCHVAR Model Impulse Responses

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Output</th>
<th>Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Response</td>
<td>0.87***</td>
<td>0.57**</td>
</tr>
<tr>
<td>Mean Response</td>
<td>0.83***</td>
<td>0.24</td>
</tr>
<tr>
<td>Response at $H$</td>
<td>0.64***</td>
<td>0.72***</td>
</tr>
</tbody>
</table>

Note: The table reports rank correlations between impulse response statistics from the country VAR models and the PCHVAR model. * (**, *** ) represents statistical significance at the 10% (5%, 1%) significance level.
Table 9: Correlation of Country VAR Model Impulse Responses Between Baseline and Alternative Specifications

<table>
<thead>
<tr>
<th>Robustness Check</th>
<th>Maximum Responses</th>
<th>Responses at H=48</th>
<th>Mean Responses</th>
<th>All Horizons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange Rate</td>
<td>0.90, 0.91</td>
<td>0.88, 0.88</td>
<td>0.88, 0.94</td>
<td>0.95, 0.95</td>
</tr>
<tr>
<td>Money</td>
<td>0.86, 0.70</td>
<td>0.44, 0.40</td>
<td>0.72, 0.86</td>
<td>0.84, 0.84</td>
</tr>
<tr>
<td>Overnight Rate</td>
<td>0.93, 0.92</td>
<td>0.96, 0.92</td>
<td>0.95, 0.96</td>
<td>0.97, 0.96</td>
</tr>
<tr>
<td>p=9</td>
<td>0.93, 0.88</td>
<td>0.93, 0.88</td>
<td>0.91, 0.88</td>
<td>0.94, 0.90</td>
</tr>
<tr>
<td>q=3</td>
<td>0.89, 0.87</td>
<td>0.92, 0.87</td>
<td>0.86, 0.83</td>
<td>0.96, 0.90</td>
</tr>
<tr>
<td>Euro Area Aggregates</td>
<td>0.77, 0.59</td>
<td>0.50, 0.37</td>
<td>0.71, 0.51</td>
<td>0.80, 0.81</td>
</tr>
<tr>
<td>Financial Structure</td>
<td>0.92, 0.76</td>
<td>0.76, 0.71</td>
<td>0.88, 0.81</td>
<td>0.88, 0.82</td>
</tr>
<tr>
<td>Share of Manufacturing Durable Components</td>
<td>0.72, 0.78</td>
<td>0.76, 0.66</td>
<td>0.74, 0.84</td>
<td>0.93, 0.84</td>
</tr>
<tr>
<td>Strictness of Employment Protection</td>
<td>0.87, 0.86</td>
<td>0.87, 0.78</td>
<td>0.81, 0.94</td>
<td>0.89, 0.86</td>
</tr>
</tbody>
</table>

Note: The table reports the correlations between the impulse responses of the baseline country VAR model and the robustness checks described in Section 6. For each robustness check and each impulse response statistic, the first correlation refers to the impulse responses of output and the second to those of prices.
<table>
<thead>
<tr>
<th>Country</th>
<th>Inflation Target</th>
<th>Policy Rate/Operating Target</th>
<th>Operating Framework</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia: Reserve Bank of</td>
<td>Full-fledged. Target is 2 to 3% in the medium term.</td>
<td>Target for Cash Rate/Cash Rate (overnight money market rate).</td>
<td>The RBA uses open market operations on a day-to-day basis to keep the Cash Rate close to target. The RBA offers a standing marginal lending facility 25 basis points above the Cash Rate.</td>
<td></td>
</tr>
<tr>
<td>Australia (RBA).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada: Bank of Canada (BoC).</td>
<td>Full-fledged. Target is 1 to 3% over the next six to eight quarters.</td>
<td>Bank Rate/overnight money market rate.</td>
<td>The BoC maintains an interest rate corridor. The upper bound is the Bank Rate, the rate for the standing marginal lending facility; the implicit target for the money market rate is 25 basis points below the Bank rate, and 25 basis points above the rate of the standing deposit facility. The BoC uses open market operations on a day-to-day basis to keep the money market rate close to target.</td>
<td></td>
</tr>
<tr>
<td>Czech Republic: Czech National</td>
<td>Full-fledged. The target is 2% (since 2005).</td>
<td>Repo Rate/overnight money market rate.</td>
<td>The CNB maintains an interest rate corridor. The CNB conducts repo auctions every two weeks.</td>
<td></td>
</tr>
<tr>
<td>Bank (CNB).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark: Danmark Nationalbank</td>
<td>Eclectic. Exchange rate target.</td>
<td>Lending Rate/overnight money market rate.</td>
<td>The DNB conducts weekly repo auctions in which it grants seven-day loans to counterparties at the Lending Rate. The overnight money market rate is to be close to the Lending Rate. Counterparties can also deposit funds overnight at the Current Account Rate, but may not lend funds overnight. In case of liquidity shortage, the DNB intervenes by open market operations.</td>
<td>Denmark maintains a fixed-exchange-rate policy vis-a-vis the Euro Area.</td>
</tr>
<tr>
<td>(DNB).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euro Area: European Central Bank</td>
<td>Eclectic. Price stability is defined as a year-on-year increase in Euro Area consumer prices of below 2%.</td>
<td>Repo Rate/overnight money market rate.</td>
<td>The ECB maintains an interest rate corridor. The ECB conducts weekly repo auctions.</td>
<td>From 1995 to 2007, the Forint was tied to a crawling basket of currencies (US$, DM and Euro, respectively, only Euro since 2000). Since 2008, the Forint is floating vis-a-vis the Euro. Inflation targeting was adopted in 2001. The inflation target has been varying.</td>
</tr>
<tr>
<td>(ECB).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary: Magyar National Bank</td>
<td>Full-fledged. The target is 3% (since 2007) in the medium term.</td>
<td>MNB-Bill Rate/three-month money market rate.</td>
<td>The MNB maintains an interest rate corridor. The MNB conducts weekly repo auctions.</td>
<td></td>
</tr>
<tr>
<td>(MNB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Korea: Bank of Korea (BoK)</td>
<td>Full-fledged. The target is 3% over the next three years.</td>
<td>BoK Base Rate/overnight money market rate.</td>
<td>The BoK maintains an interest rate corridor. The BoK conducts weekly repo auctions.</td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>Inflation Target</td>
<td>Policy Rate/Operating Target</td>
<td>Operating Framework</td>
<td>Comments</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>--------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>New Zealand: Reserve Bank of New Zealand (RBNZ).</td>
<td>Full-fledged. The target is 1 to 3% (since 2008) over the medium term.</td>
<td>Official Cash Rate/overnight money market rate.</td>
<td>The RBN maintains an interest rate corridor. The RBN conducts open market operations on a day-by-day basis to keep the overnight money market rate close to the Official Cash Rate. The RBN switched to targeting the overnight money market rate instead of settlement cash balances in 1999.</td>
<td></td>
</tr>
<tr>
<td>Poland: National Bank of Poland (NBP).</td>
<td>Full-fledged. The target is 2.5% (since 2004) for the next year.</td>
<td>Reference Rate/overnight money market rate.</td>
<td>The NBP maintains an interest rate corridor. The NBP conducts weekly repo auctions.</td>
<td>Inflation targeting was adopted in 1999.</td>
</tr>
<tr>
<td>Sweden: Sveriges Riksbank (SRB).</td>
<td>Full-fledged. The target is 2%.</td>
<td>Repo Rate/overnight money market rate.</td>
<td>The SRB maintains an interest rate corridor. The SRB conducts weekly repo auctions.</td>
<td>-</td>
</tr>
<tr>
<td>Switzerland: Swiss National Bank (SNB).</td>
<td>Eclectic. The SNB equates price stability with a rise in consumer prices of less than 2% per year.</td>
<td>Repo Rate/three-month money market rate.</td>
<td>The SNB maintains an interest rate corridor. The SNB conducts weekly repo auctions.</td>
<td>-</td>
</tr>
<tr>
<td>United Kingdom: Bank of England (BoE).</td>
<td>Full-fledged. The target is 2%.</td>
<td>BoE Base Rate/overnight money market rate.</td>
<td>The BoE maintains an interest rate corridor. The BoE conducts weekly repo auctions.</td>
<td>The operational framework of the BoE was reformed in 2006.</td>
</tr>
<tr>
<td>United States: Federal Reserve System (Fed).</td>
<td>Eclectic. The Fed is to promote maximum sustainable output and employment and to promote stable prices, with no explicit inflation targeting.</td>
<td>Fed Funds Rate target/overnight money market rate.</td>
<td>The Fed conducts open market operations on a day-by-day basis to keep the Fed Funds Rate close to its target. The Fed also provides a standing marginal lending facility.</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Central banks with an eclectic inflation-targeting regime feature an implicit price stability anchor and are not fully transparent and accountable with respect to an inflation target. In contrast, central banks with full-fledged inflation-targeting clearly commit to their inflation target, and institutionalize this commitment in the form of a transparent monetary framework that fosters accountability of the central bank to the target. See Carare and Stone (2006).
D Figures

Figure 1: Countries’ Responses to a Monetary Policy Shock

Note: The figure displays the responses of output and prices of all countries in the sample to a 100 basis points monetary policy shock derived from the country VAR models in Equation (1). The upper panel combines the responses of output of all countries in the sample, and the lower panel combines the responses of prices.
Figure 2: Countries’ Output Responses to Monetary Policy Shock

Note: The figure displays the responses of output to a 100 basis points monetary policy shock derived from the country VAR models in Equation (1). In each panel, the solid line depicts the point estimate of the impulse response and the shaded area represents asymptotic (bootstrap, dark shaded area) 95% confidence bands.
Figure 3: Countries' Price Level Responses to Monetary Policy Shock

Note: The figure displays the responses of prices to a 100 basis points monetary policy shock derived from the country VAR models in Equation (1). In each panel, the solid line depicts the point estimate of the impulse response and the shaded area represents asymptotic (bootstrap, dark area) 95% confidence bands.
Figure 4: Cross-Country Differences in Structural Characteristics

Note: The figure displays the financial structure index, the Strictness of Employment Protection indicator and the share of durable goods manufacturing in total output. In the left-hand side panels, the time averages of the structural characteristics are depicted. In the right-hand side panels, the evolution of the structural characteristics over time is depicted. The solid lines represent the evolution for each country, and the dashed line the country average. The financial structure index is bounded between zero and one, and larger values reflect financial systems in which bank credit is more important and in which the banking sector competitive pressures are stronger. The Strictness of Employment protection indicator is bounded between zero and four, and larger values reflect more rigid labor markets.
Figure 5: Summary of Country VAR Model Output Responses to a Monetary Policy Shock

Note: The figure displays the output responses to a 100 basis points monetary policy shock obtained from the country VAR models in Equation (1) and the PCHVAR model in Equation (13). In each panel, the solid line depicts the response obtained from the country VAR model and the dotted line depicts the responses obtained from the PCHVAR model.
Figure 6: Summary of Country VAR Model Price Level Responses to a Monetary Policy Shock

Note: The figure displays the price level responses to an exogenous 100 basis points monetary policy shock obtained from the country VAR models in Equation (1) and the PCHVAR model in Equation (13). In each panel, the solid line depicts the response obtained from the country VAR model and the dotted line depicts the responses obtained from the PCHVAR model.
Figure 7: The Relationship Between Country VAR Model and PCHVAR Model Impulse Responses of Output at Different Horizons

Note: The top panel depicts the evolution of the $R^2$ over response horizons $h = 0, 1, 2, \ldots, H$ for the model in Equation (14) for output. The horizontal line represents the average of the $R^2$ over all response horizons. The bottom left-hand side panel depicts the evolution of the intercept estimate of Equation (14) (solid line) together with 95% confidence bands (dashed lines). The bottom right-hand side panel depicts the evolution of the slope of Equation (14) (solid line) together with 95% confidence bands (dashed lines).
Figure 8: The Relationship Between Country VAR Model and PCHVAR Model Impulse Responses of Prices at Different Horizons

Note: The top panel depicts the evolution of the $R^2$ over response horizons $h = 0, 1, 2, \ldots, H$ for the model in Equation (14) for prices. The horizontal line represents the average of the $R^2$ over all response horizons. The bottom left-hand side panel depicts the evolution of the intercept estimate of Equation (14) (solid line) together with 95% confidence bands (dashed lines). The bottom right-hand side panel depicts the evolution of the slope of Equation (14) (solid line) together with 95% confidence bands (dashed lines).
Figure 9: The Relationship Between Country VAR Model and PCHVAR Model Impulse Responses of Output at Different Horizons - Contributions

Note: The figure depicts the evolution of the $R^2$ over response horizons $h = 0, 1, 2, \ldots, H$ for the model in Equation (14) for output. The solid line represents the results from the baseline specification with all three structural characteristics considered jointly. The dash-dotted line represents the results for considering only financial structure, the dashed line those for labor market rigidities, and the dotted line those for industry mix. In order to reduce the impact of outlier observations on the $R^2$-squareds for the three latter cases, at each response horizon I drop that observation which is farthest away from the fit.
Figure 10: The Relationship Between Country VAR Model and PCHVAR Model Impulse Responses of Prices at Different Horizons - Contributions

Note: The figure depicts the evolution of the $R^2$ over response horizons $h = 0, 1, 2, \ldots, H$ for the model in Equation (14) for prices. The solid line represents the results from the baseline specification with all thee structural characteristics considered jointly. The dash-dotted line represents the results for considering only financial structure, the dashed line those for labor market rigidities, and the dotted line those for industry mix. In order to reduce the impact of outlier observations on the $R$-squareds for the three latter cases, at each response horizon I drop that observation which is farthest away from the fit.
Figure 11: Output Responses to a Monetary Policy Shock, Exchange Rates and Money Added

Note: The figure displays for all countries the output responses to a 100 basis points monetary policy shock obtained from the baseline country VAR models in Equation (1) (solid lines) together with the responses from the country VAR models augmented by the exchange rate (dash-dotted lines) or money (dotted lines); the figure also displays impulse responses for country VAR models with a lag order of nine (dashed lines), and impulse responses with the lag order of the commodity price index increased to three (plus lines).
Figure 12: Price Level Responses to a Monetary Policy Shock, Exchange Rates and Money Added

Note: The figure displays for all countries the price level responses to a 100 basis points monetary policy shock obtained from the baseline country VAR models in Equation (1) (solid lines) together with the responses from the country VAR models augmented by the exchange rate (dash-dotted lines) or money (dotted lines); the figure also displays impulse responses for country VAR models with a lag order of nine (dashed lines), and impulse responses with the lag order of the commodity price index increased to three (plus lines).
Figure 13: Output Responses to a Monetary Policy Shock, Alternative Lag Orders

Note: The figure displays for all countries the output responses to a 100 basis points monetary policy shock obtained from the baseline country VAR models in Equation (1) (solid lines) together with the responses from the country VAR models augmented by the exchange rate (dash-dotted lines) or money (dotted lines); the figure also displays impulse responses for country VAR models with a lag order of nine (dashed lines), and impulse responses with the lag order of the commodity price index increased to three (plus lines).
Figure 14: Price Level Responses to a Monetary Policy Shock, Alternative Lag Orders

Note: The figure displays for all countries the price level responses to a 100 basis points monetary policy shock obtained from the baseline country VAR models in Equation (1) (solid lines) together with the responses from the country VAR models augmented by the exchange rate (dash-dotted lines) or money (dotted lines); the figure also displays impulse responses for country VAR models with a lag order of nine (dashed lines), and impulse responses with the lag order of the commodity price index increased to three (plus lines).
Figure 15: Output Responses to a Monetary Policy Shock, Country VAR Models with Euro Area Aggregates

Note: The figure displays for all countries the output responses to a 100 basis points monetary policy shock obtained from the baseline country VAR models in Equation (1) estimated from 1996 (solid lines) together with the responses from the country VAR models augmented by the logarithms of Euro area real GDP and the HICP (dash-dotted lines).
Figure 16: Price Level Responses to a Monetary Policy Shock, Country VAR Models with Euro Area Aggregates

Note: The figure displays for all countries the price level responses to a 100 basis points monetary policy shock obtained from the baseline country VAR models in Equation (1) estimated from 1996 (solid lines) together with the responses from the country VAR models augmented by the logarithms of Euro area real GDP and the HICP (dash-dotted lines).
Figure 17: Country VAR Model Output Responses to a Monetary Policy Shock with the Structural Characteristics as Additional Endogenous Variables

Note: The figure displays for all countries the output responses to a 100 basis points monetary policy shock obtained from the baseline country VAR models in Equation (1) (solid lines) together with the responses from the country VAR models augmented by the structural characteristics financial structure (dash-dotted lines), labor market rigidity (dashed lines) and industry mix (dashed lines) as additional endogenous variables one at a time. For the countries that do not feature any time-series variation in employment protection the corresponding impulse response can not be estimated and is therefore missing.
Figure 18: Country VAR Model Price Level Responses to a Monetary Policy Shock with the Structural Characteristics as Additional Endogenous Variables

Note: The figure displays for all countries the price level responses to a 100 basis points monetary policy shock obtained from the baseline country VAR models in Equation (1) (solid lines) together with the responses from the country VAR models augmented by the structural characteristics financial structure (dash-dotted lines), labor market rigidity (dashed lines) and industry mix (dashed lines) as additional endogenous variables one at a time. For the countries that do not feature any time-series variation in employment protection the corresponding impulse response can not be estimated and is therefore missing.
Figure 19: The Relationship Between Country VAR Model and PCHVAR Model Impulse Responses at Different Horizons

Note: The figure displays the evolution of the $R^2$ over response horizons $h = 0, 1, 2, \ldots, H$ for the model in Equation (14) of the baseline country VAR and PCHVAR model specifications together with the corresponding results for the PCHVAR model impulse responses constructed using Monte Carlo integration along the lines of Koop et al. (1996) (dash-dotted lines).