Acta Oeconomica, Vol. 66 (4), pp. 639–659 (2016)
DOI: 10.1556/032.2016.66.4.4

OPENNESS AND THE STRENGTH OF MONETARY TRANSMISSION: INTERNATIONAL EVIDENCE

Bruno ĆORIĆ – Lena MALEŠEVIĆ PEROVIĆ – Vladimir ŠIMIĆ

(Received: 20 July 2015; revision received: 6 October 2015; accepted: 13 January 2016)

This study explores cross-country variations in the size of the effects of a monetary policy shock on output using the sample of 48 developed and developing countries. The structural vector autoregression model is used to estimate monetary policy effects for each country separately. Based on the estimated impulse responses, we construct a measure of the short-run monetary policy effect on output, which is used as the dependent variable in a cross-country regression. Our results suggest that the effects of monetary policy shock on output are significantly influenced by trade openness, exchange rate regime, correlation with the US and for European countries with the German economy, and the development of the banking sector.

Keywords: monetary policy effects, exchange rate regime, trade openness, international interdependence

JEL classification indices: E52, F41

Bruno *Ćorić,* corresponding author. Assistant Professor at the University of Split, Faculty of Economics, Split, Croatia. E-mail: bcoric@efst.hr

Lena *Malešević Perović,* Assistant Professor at the University of Split, Faculty of Economics, Split, Croatia. E-mail: lena.malesevic@efst.hr

Vladimir *Šimić,* Assistant Professor at the University of Split, Faculty of Economics, Split, Croatia. E-mail: vladimir.simic@efst.hr

1. INTRODUCTION

The ability of monetary policy to influence output in the short run is broadly accepted in economic theory and well documented by a number of time series analyses. However, the determinants of the size of these effects are not well understood. A better understanding of these determinants is crucial not only for understanding how monetary policy works, but also for the efficient conduct of monetary policy.

In recent years, foreign factors have, due to globalisation, become increasingly important in affecting domestic monetary conditions. Policy-makers should therefore pay special attention to the impact of economic openness, both trade and financial, on domestic monetary policy and, by extension, on output. However, this relationship is not straightforward. Many authors discuss these issues and develop theories explaining the precise mechanisms linking the internationalisation of national economies and responsiveness of output to a monetary policy shock (see, for example Rogoff 2003, 2007; BIS 2006; Bernanke 2007; Mishkin 2009; Woodford 2010; Kamin 2010; Cwik et al. 2011).

In order to provide more empirical insights into this issue, this study explores the cross-country variations in the short-run effects of a monetary policy shock on output, focusing on the impact of trade openness, financial openness, the exchange rate regime, and interdependence between national economies on output responses to a monetary policy shock.

Our research strategy consists of two steps. First, we employ a structural vector autoregression (SVAR) model to estimate the effects of a monetary policy shock for each of the 48 countries in the sample separately. Next, we treat the estimates obtained in the first step as the dependent variable in a cross-section regression analysis, which investigates possible sources of cross-country variations in the responses of output to a monetary policy shock.

Earlier studies concentrated mainly on the impact of the financial structure on output responses to a monetary policy shock (Carlino – DeFina 1998, 1999; Cecchetti 1999; Elbourne – Haan 2006; Owyang – Wall 2009; Aysun et al. 2013), and on the impact of the share of the manufacturing sector on output responses to a monetary policy shock (Carlino – DeFina 1998, 1999; Mihov 2001; Owyang – Wall 2009), thus exploring the importance of the interest rate and credit channel of monetary policy. Hence, the impact of economic openness on the responsiveness of output to a domestic monetary policy remains empirically under-investigated.

The paper is organised as follows. Section 2 provides the theoretical background. Section 3 presents the data and methodology used in both steps of the analysis. Section 4 presents and discusses the most important results. Section 5 provides robustness checks and additional tests. Section 6 concludes.

2. ECONOMIC OPENNESS AND MONETARY TRANSMISSION

In an open economy, the exchange rate is one of the relative prices in the monetary transmission process (Meltzer 1995; Mishkin 1995). A change in the short-term interest rate induced by monetary policy measures influences aggregate demand through its effect on the exchange rate and international trade. This effect is expected to be larger the more open the economy to international trade is and the more flexible its exchange rate is. Recently, Cwik et al. (2011) conducted a formal analysis of the effects of trade openness on monetary policy transmission using a medium-scale, two-country Keynesian dynamic stochastic general equilibrium (DSGE) model. Their counterfactual simulations show that trade openness affects monetary transmission significantly and that the effects of a monetary policy shock on output tend to increase with openness.

Economists have also long recognised that financial openness could affect the responses of output to a monetary policy shock. Mundell (1962) and Fleming (1962) showed that a monetary policy shock can have a different effect on output depending on the choice of exchange rate regime and the size of international capital mobility. According to the Mundell-Fleming model, financial openness increases the effects of a monetary policy shock in the case of a flexible exchange rate and decreases them in the case of a fixed exchange rate. The growing internationalisation of financial markets has recently spurred an active debate on the potential effects of international capital mobility on monetary policy transmission (BIS 2006; Yellen 2006; Bernanke 2007; Gudmundsson 2008; Kamin 2010). This debate highlighted two main reasons as to why international capital mobility can undermine the ability of central banks to affect output. First, international capital mobility can make the short-term nominal interest rate dependent on the supply of global liquidity rather than just on the supply of liquidity by the central bank, and in that way reduce the ability of central banks to influence the short-term nominal interest rate. Second, international capital mobility can make the long-term real interest rates dependent on the balance between global savings and investment rather than on this balance at the national level, and in that way reduce the ability of central banks to influence the long-term real interest rate. A more formal analysis within a standard new Keynesian open economy DSGE model in Woodford (2010) shows that financial openness does not reduce the effects of monetary policy. Most recently, Meier (2013) has extended Woodford's (2010) model showing that in the model with richer financial structure, financial openness can even increase the effects of monetary policy. In particular, Meier (2013) demonstrated that under realistic parameterisations, monetary policy is more, rather than less, effective as the positive impact of a strengthened exchange rate and wealth channels more than offsets the negative impact of weakened interest rate channels. On the other hand, Cetorelli – Goldberg (2012) have recently showed that multinational banks can respond to a domestic liquidity shock by activating a cross-border internal capital market between the head and its foreign offices. Because of this, the lending of these banks is likely to be less affected by domestic liquidity shocks and monetary policy effects, though the bank lending channel can be weakened. Overall, the expected impact of international capital mobility on the strength of monetary policy transmission is theoretically ambiguous. The above issues are explored in this paper empirically.

3. DATA AND RESEARCH METHODOLOGY

3.1. Step 1: SVAR model – impulse response analysis

In the first step of our empirical analysis, we estimate the response of output to a monetary policy shock for each country in our sample. We use a SVAR model, which is the common model used in the literature for identifying the effects of monetary policy.

Our starting point is the model used by Kim – Roubini (2000) and Elbourne – Haan (2006). Following them, the variables we include in our model are GDP (Y), consumer price index (CPI), money (M), domestic interest rate (IR), exchange rate (ER), world price of oil (OIL), and the United States federal funds rate (FFR). The first four are well-known variables in the monetary business cycle literature and therefore we do not elaborate on them specifically. The next variable, the exchange rate, is included in the model since it plays an important role in affecting the whole economy in a world of liberalised goods and capital markets. The world price of oil serves as a proxy for aggregate supply shocks, while the United States (US) federal funds rate approximates the foreign interest rate and, similarly to the world price of oil, captures exogenous monetary policy changes.

The indicators included in our model are as follows. For the GDP variable, we use the index of GDP volume where possible; otherwise, the index of industrial production was used. As for CPI, we use the consumer price index where available and the GDP deflator otherwise. M1 monetary aggregate is used for money where possible; otherwise, we use a broader aggregate (M2 or M3). As for IR, we use the money market rate as our first choice and the deposit rate as the second one in cases where the money market rate was unavailable. The nominal effective exchange rate index (based in 2005) is used for ER; if unavailable, we use the official US dollar exchange rate. Finally, for OIL we use petroleum prices in US dollars per barrel (PETROLEUM: UK BRENT). The FFR variable is the US federal funds rate. All the variables, apart from the interest rate, are transformed into logarithms. Following Kim – Roubini (2000), Mihov (2001), and Elbourne – Haan (2006), we use the data in levels.[1]

Quarterly data on all the variables are obtained from the IFS database (International Monetary Fund, International Financial Statistics database), which contains the data for 190 countries from 1940. However, due to data limitations, our analysis is restricted to those countries for which the data is available for all the variables specified in our preferred model for at least 50 consecutive quarterly observations. Overall, we managed to construct a database of 48 lower-middle, upper-middle, and high-income countries. As a measure of trade openness, we use the sum of imports and exports to GDP from the Penn World Table 7.0 (PWT) database.

The p-th order SVAR model that we use is as follows:

$$Ay_t = \Gamma_1 y_{t-1} + \Gamma_2 y_{t-2} + \ldots + \Gamma_p y_{t-p} + B\varepsilon_t \tag{1}$$

where y_t is a (m*1) vector of m endogenous variables, A represents a (m*m) matrix of instantaneous relations between the left-hand-side variables, Γ_js are structural form parameter (m*m) matrices, ε_t is a (m*1) structural form error that is a zero mean white noise process, and B is a (m*m) matrix of contemporaneous relationships among the structural disturbances ε_t. A reduced form of our p-th order SVAR model, then, is:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + e_t \tag{2}$$

where y_t is a (m*1) vector of m endogenous variables, A represents a (m*m) matrix of reduced-form parameters, and e_t is the reduced-form disturbance term. Since the error terms in the reduced SVAR (e_t) are a complicated mixture of the underlying structural shocks, they are not easy to interpret directly unless a direct link can be made with the structural shocks. The system should therefore be restricted so as to recover structural disturbances, ε_t, from observed values of e_t, as $Ae_t = B\varepsilon_t$. In order to identify the structural model, it is therefore necessary to impose at least $m^2 - m(m+1)/2$ restrictions on the structural model, m being the number of endogenous variables. Following Elbourne – Haan (2006), the identification scheme we use in SVAR is given as:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & a_{16} & 0 \\ a_{21} & 1 & 0 & 0 & 0 & a_{26} & 0 \\ a_{31} & 0 & 1 & a_{34} & 0 & 0 & 0 \\ 0 & 0 & a_{43} & 1 & a_{46} & a_{46} & a_{47} \\ a_{51} & 0 & a_{53} & a_{54} & 1 & a_{56} & a_{57} \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & a_{76} & 1 \end{bmatrix} \begin{bmatrix} e_Y \\ e_{CPI} \\ e_M \\ e_{IR} \\ e_{ER} \\ e_{OIL} \\ e_{FFR} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} \end{bmatrix} \begin{bmatrix} \varepsilon_Y \\ \varepsilon_{CPI} \\ \varepsilon_M \\ \varepsilon_{IR} \\ \varepsilon_{ER} \\ \varepsilon_{OIL} \\ \varepsilon_{FFR} \end{bmatrix} \tag{3}$$

[1] All indices are constructed on 2005=100 basis.

where e_Y is an output shock, e_{CPI} is a price level shock, e_M is a money demand shock, e_{IR} is a domestic interest rate shock, e_{ER} is an exchange rate shock, e_{OIL} is an oil price shock, and e_{FFR} is the foreign interest rate (federal funds rate) shock.

This identification scheme has the following justification. Given that oil is a crucial input for most economic sectors, the price of oil is assumed to affect prices and the real sector contemporaneously. Additionally, prices are affected by the current value of output. A usual money demand function is assumed; the demand for real money balances depends on real income (nominal income and prices) and the nominal interest rate. The interest rate is assumed to be set after the monetary authority observes the current value of money, the exchange rate, the world price of oil, and the federal funds rate, but not the current values of output and the price level. These two variables are assumed not to be available to monetary authorities within the current time period.[2] As for the exchange rate, since it is a forward-looking asset price, we assume that all the variables have a contemporaneous effect on the exchange rate. Finally, the world price of oil is assumed to be contemporaneously exogenous to all the variables in the domestic economy, while the federal funds rate is assumed to be contemporaneously exogenous to all variables apart from the oil price.

In choosing the order of SVAR, we are led by the autocorrelation Lagrange multiplier (LM) test, and we use a minimum of 4 lags for each country. In cases where the LM statistics suggests that the null of no correlation can be rejected at 4 lags, we increase the number of lags until the problem is solved. In the interest of parsimony, our starting point is to use the same model for each country. However, as noted by Dornbusch et al. (1998), VARs that use the same explanatory variables can be misleading because countries have different economic structures and possibly different reaction functions. According to economic theory, we expect the reaction of output to a contractionary monetary policy shock to be negative. Therefore, where the results appear to be implausible, the model is somewhat modified. These modifications include increasing the number of lags, adding a trend, using the German interest rate instead of the US federal funds rate for European countries, and/or adding dummy variables that take account of a change in the exchange rate regime. Using the above specified model, we estimate the im-

2 We follow Clarida – Gertler (1997), Kim – Roubini (2000), Elbourne – Haan (2006), and Sims – Zha (2006) in assuming that it is information delays that do not allow monetary policy to respond within the current period (one quarter in our data) to price level and output developments. While it could be argued that central banks use CPI and output projections for conducting their monetary policy, literature on the topic typically assumes that the information on CPI and output is not available within the current period, and hence their contemporaneous effect on interest rate is non-existent in the SVAR identification scheme.

Table 1. List of countries and average impulse response estimates

High Income Country (period)	AROMPS	High Income Country (period)	AROMPS	Upper-Middle Income Country (period)	AROMPS	Lower-Middle Income Country (period)	AROMPS
Australia (75Q1–09Q3)	–0.1649	Japan (75Q1–09Q3)	–0.1317	Brazil (95Q1–09Q4)	–0.1005	Bolivia (95Q1–09Q3)	–0.0924
Austria (75Q1–97Q4)	0.0954	Korea, Rep. (76Q4–08Q4)	–0.1325	Chile (85Q1–09Q3)	–0.0096	India (71Q1–92Q4)	0.0013
Belgium (80Q1–98Q3)	–0.0265	Netherlands (81Q1–97Q4)	–0.1921	Colombia (95Q1–09Q4)	–0.0113	Jordan (92Q3–09Q3)	0.0809
Canada (75Q1–09Q3)	–0.0504	New Zealand (94Q1–09Q3)	–0.4128	Lithuania (96Q4–09Q4)	–0.1896	Morocco (94Q1–09Q1)	–0.7100
Croatia (94Q2–09Q2)	–0.2075	Norway (79Q1–04Q3)	0.1126	Mexico (85Q4–09Q3)	–0.0466	Philippines (81Q1–06Q3)	–0.2178
Cyprus (96Q1–07Q4)	–0.3240	Poland (96Q4–09Q4)	–0.0338	Peru (91Q1–09Q2)	0.0547	Senegal (76Q1–03Q4)	–0.2788
Czech Republic (94Q1–09Q4)	–0.2102	Portugal (79Q4–98Q4)	–0.0728	Russia (95Q2–09Q3)	–0.0498	Thailand (97Q1–09Q4)	–0.3158
Denmark (91Q1–09Q4)	–0.2272	Singapore (84Q3–09Q4)	–1.7007	South Africa (75Q1–09Q4)	–0.1204	Tunisia (93Q1–09Q4)	–0.3007
Estonia (93Q4–09Q3)	–0.6805	Slovenia (94Q1–06Q4)	0.1604	Turkey (87Q1–09Q4)	–0.0806		
Finland (78Q1–98Q4)	–0.2939	Spain (75Q1–98Q4)	–0.0915				
France (77Q4–98Q4)	–0.1992	Sweden (75Q1–04Q3)	–0.0779				
Germany (75Q1–98Q4)	–0.3506	Switzerland (84Q4–09Q4)	–0.1749				
Hungary (95Q1–09Q4)	–0.1655	Trinidad and Tobago (91Q1–08Q1)	–0.0277				
Ireland (82Q4–98Q4)	–0.1920	United Kingdom (75Q1–09Q4)	–0.2381				
Israel (83Q4–08Q3)	–0.0582	United States (75Q1–09Q4)	–0.1235				
Italy (80Q1–98Q4)	–0.1690						

Note: Countries are categorised based on the World Bank's 2011 income group classification. AROMPS refers to the average effect of a monetary policy shock on output over 8 quarters.

pulse response functions. *Table 1* reports the average responses for the countries included in our sample as well as the time periods available for estimation.[3]

The plots of the estimated impulse responses, a precise description of the model estimated for each country, and the data definitions and sources are provided in an appendix, which is available upon request.

Based on the estimated impulse responses, we construct a measure of the short-run monetary policy effect on output. Consistent with the previous studies of cross-sectional differences in monetary policy effects (Carlino – DeFina 1998, 1999; Mihov 2001; Elbourne – Haan 2006), this measure is constructed as an average response to a monetary policy shock (one percentage point increase in the interest rate) over the first 8 quarters. We use the average rather than the maximum (negative) response to a monetary policy shock, which is used in some studies (Cecchetti 1999; Elbourne – Haan 2006; Aysun et al. 2013), to reduce the possible effects of extreme point estimates on the results of our subsequent analysis of cross-section variations in monetary policy effects. Note, however, that the maximum (negative) responses to a monetary policy shock will be also used as a robustness check.[4] The time span of 8 quarters is employed in the present study because theoretical models usually imply monetary policy transmission lags of similar length (Taylor – Wieland 2012). Eight quarters are also a proximate period that policy-makers commonly assume is necessary for monetary policy changes to have their full impact on the economy (Bank of England, 1999; European Central Bank, 2010). The average responses to a monetary policy shock over longer time spans are subsequently used as robustness checks.

[3] *Table 1* reveals that the average response to a monetary policy shock for 6 countries is positive. In 4 out of these 6 countries (Austria, Norway, Slovenia, and Jordan), the initial response of output to a monetary policy shock is negative and then turns to mainly positive values. In 2 countries (India and Peru), initial response of output to a monetary policy shock is positive and then swings around zero from negative to positive values. Such results are similar to the results of recent studies of the monetary policy transmission in India and Peru (see Acosta-Ormaechea – Coble 2011; Bhattacharya et al. 2011), which suggest that the apparent lack of the standard effect of a monetary policy shock on output in these two countries can be explained by large dollarisation, the small size of the financial sector and the large size of the informal sector, which does not use the official financial sector for financing.

[4] Note, also, that our measure of the short-run monetary policy effect on output (expressed as an average) is equivalent to a cumulative response to a monetary policy shock, which is also used in some studies since it is obtained as a cumulative response divided by eight.

3.2. Step 2: Cross-country analysis

Estimates of the average response of output to a monetary policy shock over the first 8 quarters are used as the dependent variable in the following model:

$$Y_j = Int + \sum X_{jk}\alpha_k + u_j \quad (4)$$

where Y_j represents the estimated effect of a monetary policy shock on output, *Int* stands for the intercept term, and X_{jk} stands for *k* explanatory variables; α_k are coefficients to be estimated, u_j is the regression residual, $j = 1, \ldots$, n indexes the countries, and $k = 1, \ldots$, m indexes the explanatory variables.

As the estimated impulse responses in the previous section represent the average effects of a monetary policy shock during the sample period under consideration for each country, all of the explanatory variables are constructed as averages over these periods.

To empirically explore the relationship between foreign factors and the effects of a monetary policy shock on output, our set of explanatory variables includes indicators for trade openness, financial openness, and the exchange rate regime.

A proxy for financial openness is constructed as a sum of total foreign assets and liabilities to GDP, using Lane – Milesi-Ferretti's (2007) estimates of foreign assets and liabilities.[5] The exchange rate regime is another variable that can be important in determining the effects of a domestic monetary policy shock on output. Admittedly, the identification of the exchange rate regime is not an easy task. The problem is the existence of mismatches between the officially reported exchange rate regimes to the IMF, and the actually prevailing exchange rate regimes. In order to circumvent this problem, we use Ilzetzki et al.'s (2008) classification, which distinguishes between 14 unified exchange rate systems. They assign one number on the 1 to 14 scale to each category of unified exchange rate systems, where the least flexible exchange rate arrangements are assigned the lowest values. We merge the last two categories – free floating (number 13) and free falling (number 14) – into a single category to which we assign number 13.[6] Our proxy for the exchange rate regime is then constructed as an average value of the exchange rate categories over the considered sample periods.

5 Lane – Milesi-Ferretti's (2007) data unfortunately do not cover the period after 2004, hence, the proxy for financial openness is constructed using observations only for periods before 2005.

6 There is no clear reason to assume that the free falling exchange rate is a more flexible exchange rate regime than the free floating. The free floating and free falling categories are merged into one to obtain an exchange rate classification in which the most flexible exchange rate arrangements are assigned the highest value.

In addition to these variables, we also consider whether output responsiveness to a monetary policy shock is systematically related to the size and development of the banking sector. The traditional interest rate channel of monetary policy suggests that a change in the short-term interest rate induced by monetary policy measures leads to a change in various long-term interest rates. A change in long-term interest rates affects economic agents' spending decisions depending on the extent of credit usages in the economy. Therefore, the short-run monetary policy effect on output can be determined by the size and development of the banking sector. To consider the possible relationship between variations in the size and development of countries' banking sector and cross-country variations in output responses to a monetary policy shock, we use the following variables: the ratio of deposit money bank assets to GDP, private credit by deposit money banks to GDP, bank deposits to GDP, liquid liabilities to GDP, and the ratio of bank credit to bank deposits. The mentioned variables are constructed using Beck et al.'s (2010) database. These variables are traditionally employed in the literature as indicators of the size and importance of financial intermediation in the economy.

The interest rate channel also implies that monetary policy effects can be related to the differences in the share of interest-sensitive sectors in the economy. These differences can arise because of varying interest sensitivities in the demand for different kinds of products. Housing, cars, and other durable manufacturing goods have historically been more responsive to interest rate changes than other goods. In a similar way, differences in an industry's response may depend on whether its output constitutes a necessity or a luxury (Carlino – DeFina 1999). The findings of Carlino – DeFina (1998, 1999), Mihov (2001), and Owyang – Wall (2009) show that the effect of a monetary policy shock on output is on average larger in regions/countries with a larger share of manufacturing and smaller in regions with a larger share of extractive industries. Due to data limitations, we are not able to include variables for the share of particular sectors of industry in our model. Notwithstanding this limitation, to control for the effect of the economic structure on output responses to a monetary policy shock, we include the share of industry in GDP among the set of explanatory variables.[7] With respect to missing data, two general principles are adopted in the construction of the dataset. In those countries where less than 20 percent of observations are missing for a certain variable, the average values of that variable are still calculated. In cases where more than 20 percent of observations are missing, the country is excluded from the analysis.

[7] This variable is calculated from World Development Indicators (WDI) data on the shares of industry value added in a country's GDP. The industry value added corresponds to ISIC divisions 10–45 and includes value added of mining, manufacturing, construction, electricity, water, and gas. Thus, the share of industry used in our analysis comprises both the interest-sensitive sectors and interest-insensitive sectors.

4. RESULTS

Table 2 reports the results of our cross-country analysis. Because variance inflation analysis displays evidence of substantial multicollinearity when all financial variables are simultaneously included into the regression, we report the models that include only two financial variables at a time (one of which is always bank credit to deposit ratio, which does not lead to multicollinearity problems). The results of the standard diagnostic tests and investigative procedures (available on request) reveal that the reported models are well specified with respect to multicollinearity, normality, heteroscedasticity, and functional form. According to the standard criteria, the variance inflation analysis suggests that collinearity does not pose a problem, either for individual variables or for the model as a whole. Cameron-Trivedi's test is unable to reject the null hypothesis of no non-normal skewness or kurtosis. Moreover, further tests (the Cameron-Trivedi and the Breusch-Pagan test) suggest that there is no problem with heteroscedasticity of residuals. The Ramsey RESET test is unable to reject the null of no omitted variables or to correct functional form at conventional levels of significance. Finally, the quantile regression estimates provide qualitatively similar results, suggesting that the reported results are not driven by outliers.

As a consequence of our two-step research strategy for the dependent variables, we use the estimated rather than the observed values. In such cases, variations in the error of the estimations of the dependent variable induce heteroscedasticity in the second step of the analysis. Lewis – Linzer's (2005) Monte Carlo simulations demonstrated that in these circumstances, the bootstrapping procedure produces conservative but efficient standard errors. Therefore, in our results, we report the bootstrapped standard errors for each model.

Our dependent variable measures output responses to a monetary policy shock (one percentage point increase in the interest rate), and these responses are expected to be negative. A negative coefficient on a certain explanatory variable therefore suggests that a particular country characteristic, captured by that variable, is, on average, related to a larger (negative) effect of monetary policy. A positive coefficient, on the other hand, suggests that a particular country characteristic is, on average, related to a smaller (negative) monetary policy effect.

Table 2 reports the results for our baseline specifications (models). Each reported regression is significant at the conventional levels of statistical significance. The reported regressions explain about 63 percent of cross-country variation in the average output responses to a monetary policy shock. The number of observations used in most specifications is 47 instead of 48 because the data for the share of industry in GDP is missing for Israel (the results for models without

Table 2. The results of cross-country regressions (baseline specifications**)**

Dependent variable	Average effect on output			
	(1)	(2)	(3)	(4)
Deposit money bank assets	–0.0006 (0.0007)			
Private credit		–0.0010 (0.0009)		
Bank deposits			–0.0009 (0.0009)	
Liquid liabilities				–0.0010 (0.0012)
Bank credit to deposits ratio	–0.0020* (0.0012)	–0.0018 (0.0012)	–0.0023** (0.0011)	–0.0021** (0.0011)
Exchange rate	–0.0287** (0.0148)	–0.0278* (0.0149)	–0.0283** (0.0145)	–0.0269* (0.0141)
Trade openness	–0.0044*** (0.0016)	–0.0044*** (0.0016)	–0.0044*** (0.0016)	–0.0045*** (0.0015)
Financial openness	0.0003 (0.0003)	0.0003 (0.0003)	0.0003 (0.0003)	0.0004 (0.0003)
Share of industry	0.0158*** (0.0064)	0.0158*** (0.0064)	0.0157*** (0.0064)	0.0149*** (0.0061)
Constant	0.1075 (0.2468)	0.0889 (0.2525)	0.1448 (0.2377)	0.1340 (0.2404)
No. of observations	47	47	47	45
R^2	0.63	0.63	0.63	0.65
Wald χ^2 test	0.04	0.04	0.03	0.02

Note: *,**, and *** indicate the 10%, 5%, and 1% levels of significance.

the share of industry, in which all 48 countries are included in the analysis, are qualitatively similar and are available on request).

The coefficients on financial variables are negative across all specifications. three out of 4 coefficients on bank credit to deposit ratio are significant at conventional levels of statistical significance. The results for financial variables, in general, suggest that in the countries with more developed banking sector, a monetary policy shock has, on average, a larger effect on output. These results are in line with Cecchetti's (1999) and Mihov's (2001) findings on the importance of the financial sector in monetary policy transmission. More precisely, the results in *Table 2* indicate that a 10 percentage point increase in bank credit to deposit ratio leads to an increase in the effect of a monetary policy shock on output of about 0.02 percentage points.

The results in *Table 2* also point towards the importance of international links for the responsiveness of output to a domestic monetary policy shock. In particular, the coefficient on the exchange rate regime is negative and statistically significant at conventional levels in all specifications. Since our measure of the exchange rate regime is constructed in such a manner that the least flexible exchange rate arrangements are assigned the lowest values, the negative coefficients on this variable suggest that in countries with more flexible exchange rates, a monetary policy shock has, on average, a larger effect. More precisely, an increase in exchange rate flexibility by one category leads to an increase in the effect of a monetary policy shock on output of about 0.03 percentage points. These results are consistent with the exchange rate channel of monetary policy transmission. If the exchange rate channel is a functioning channel of monetary policy transmission then, *ceteris paribus,* the effects of monetary policy on output should be weaker in countries with fixed exchange rates compared to countries with flexible exchange rates.

The coefficients on trade openness are negative and statistically significant in all models, suggesting that in countries with a larger share of international trade in GDP, a monetary policy shock has, on average, a larger effect. More precisely, a 10 percentage point increase in openness leads to an increase in the effect of a monetary policy shock on output of about 0.04 percentage points. These results, again, point to the importance of the exchange rate channel in monetary policy transmission. Namely, if a monetary policy shock affects aggregate demand through the effect of exchange rate on imports and exports, then monetary policy effects should be closely related to the share of imports and exports in GDP.

The coefficients on the share of industry appear to be significantly positive. Note, however, that our industry variable comprises both interest-sensitive and interest-insensitive sectors. While the obtained estimates suggest that industry structure matters for monetary policy transmission, it seems that interest-insensitive sectors that reduce the effect of monetary policy on output dominate in our variable.

Finally, coefficients on financial openness appear to be positive, but statistically insignificant across all specifications. These results suggest that the negative effect of financial openness on the strength of the interest rate channel of monetary policy is empirically offset by the positive effect of financial openness on the strength of the exchange rate and wealth channels. In other words, our empirical results suggest that possible negative and positive effects of financial openness cancel each other, leaving the overall strength of monetary policy transmission unchanged.

5. ROBUSTNESS CHECKS AND ADDITIONAL TESTS

In order to check the robustness of our findings, we ran several sensitivity checks. We used the average response to a monetary policy shock over the first 8 quarters as a dependent variable in our benchmark models, because theoretical models usually imply monetary policy transmission lags of similar length. However, Havranek – Rusnak (2013) recently argued that empirical studies suggest that these lags are, on average, longer. Hence, we use the average response to a monetary policy shock over the first 16 quarters as the dependent variable. The estimates (available on request) show that our main findings are robust with respect to different time spans used to construct our dependent variable. In particular, coefficients on exchange rate and trade openness remain negative and statistically significant. Coefficients on financial variables keep the same sign, but lose statistical significance.

We also tested for the robustness of our results with respect to alternative orders of SVAR models used to construct our dependent variable. We re-estimate the SVAR models, described in Section 2.1, using 2 and 8 lags for each country. The average responses to a monetary policy shock obtained from models with 2 and 8 lags are then used separately to construct dependent variables. The results obtained by using these dependent variables (available on request) remain similar to the benchmark results reported in *Table 2.* In particular, coefficients on financial variables and trade openness remain negative and statistically significant in both cases. Coefficients on exchange rate also remain negative, but lose statistical significance.

As explained earlier, we used the average rather than the maximum (negative) response to a monetary policy shock in our benchmark models to reduce the possible effects of extreme point estimates on the results. To check the robustness of our results, we constructed maximum (negative) responses to a monetary policy shock and employ them as the dependent variable. The quantile regressions results indicate that when extreme points estimates of maximum (negative) responses to a monetary policy shock are taken into account, coefficients on financial variables and trade openness remain similar to those reported in *Table 2*. Coefficients on exchange rate remain negative, but lose statistical significance.

There is an ongoing debate in the profession whether the VAR model should be estimated in levels or growth rates. Hence we re-estimated our SVAR model for each country using data in growth rates. That is, we used the log differences of the data for the GDP, consumer price index, money, domestic interest rate, exchange rate, world price of oil, and the United States federal funds rate described in Section 3.1 to estimate our SVAR models. All the data are obtained from the IFS database. The results of cross-country analysis obtained by using these estimates are similar to our benchmark results. In short, coefficients on trade openness, exchange rate regime, and financial variables keep the same sign and remain statistically significant.

We also considered a number of additional explanatory variables. As our sample includes heterogeneous countries, we controlled for the possible relationship between the variations in economic size and development level, and cross-country variations in the response of output to a monetary policy shock. The indicator of economic size was calculated as the average value of the ratio of a country's real GDP to the world's real GDP over the considered sample period for each country, using GDP in constant 2000 USD from WDI database. The indicator of the level of development was calculated as the average value of the ratio of the country's real GDP per capita to the world's real GDP per capita over the considered sample period for each country, using GDP per capita in constant 2000 USD from WDI. The results (available upon request) suggest that the effects of a monetary policy shock are not related to cross-country variations in economic size or development. We also employed the World Bank's classification of the world's economies to create dummy variables for low-middle, upper-middle, and high income groups of countries. The results show that monetary policy effects do not differ among these income groups. To check for other possible unobserved characteristics that might influence monetary policy transmission, we introduce dummies for Anglo-Saxon countries, South American countries, European countries, Far East countries, Scandinavian countries, and Eastern European countries. The results, once again, do not reveal significantly different effects of monetary policy in any of these groups.

Shares of aggregate consumption, investment, and government consumption in GDP were employed to check whether it is different structures of aggregate demand across countries (due to possible differences in interest rate elasticity of aggregate demand components) that are systematically related to variations in the effects of monetary policy. All the variables are calculated using PWT's 7.0 data as the average value of the share of considered aggregate in a country's GDP over the considered sample period. Again, the results (available upon request) do not reveal any significant relationship between the shares of different aggregate demand components and monetary policy effects.

We, furthermore, employed Chinn – Ito's (2006) *de jure* measure of financial openness (for which the data in the updated authors' database is available up to 2009) as an alternative to our *de facto* measure based on Lane – Milesi-Ferretti's (2007) estimates of foreign assets and liabilities (for which the data is available up to 2005). In particular, we used the average value of the Chin-Ito index (KAOPEN) over the considered sample period for each country. We also used alternative measures of the exchange rate regime. In particular, we constructed the exchange rate regime measure analogous to the one employed in *Table 2,* only this time using Ilzetzki et al.'s (2008) "coarse" classification instead of the "fine" one. Using each of these classifications, we also construct new measures of the exchange rate regime, calculating the average value of the original exchange rate categories over the considered sample periods (i.e. without merging the free floating and the free falling regime into a single category as we did before). The regression analyses with these alternative measures (available upon request) do not reveal any noteworthy discrepancy with respect to the above reported results on financial openness and exchange rate regime *(Table 2).*

Recent empirical studies suggest substantial international spillovers and interdependence between national money, bonds and equity markets, and exchange rates (Ehrmann – Fratzscher 2009; Hausman – Wongswan 2011; Ehrmann et al. 2011). These studies stress the US markets as the main driver of global financial markets. In addition, Baxter – Kouparitsas (2005) and Imbs (2006) showed that cross-country correlations in the short-run output fluctuations rise with the level of financial and trade integration. The growing internationalisation of economic activities has made the impact of foreign factors on the ability of monetary policy to influence output in the short run one of the most important issues for policy-makers. This gives impetus to the question of whether the responsiveness of output to a domestic monetary policy shock is systematically related to interdependence between national economies. We therefore also tested whether cross-country variations in monetary policy effects can be related to differences in the correlation of national economies with the large world economies. In particular, for European economies, together with Turkey and Jordan, we calculated and used the correlation coefficients of national GDP growth with the German GDP growth over the considered sample periods. For other economies, the correlation coefficients with the US GDP growth were used. All the coefficients were calculated using WDI's annual percentage growth rate of GDP at market prices expressed in at constant local currency. The results in *Table 3* indicate that all the coefficients on correlation of national economies with the US or Germany are positive and statistically significant at the 5 percent level, suggesting that the effect of a monetary policy shock on output is, on average, smaller in countries that are more correlated with the US or German economy. This suggests that growing international interdependence can increase the importance of foreign factors in the determination of domestic output and, in turn, undermine the ability of national monetary policy to influence domestic output in the short run.

Negative and significant coefficients on trade openness in *Table 2* point to the importance of international trade for monetary policy transmission. This potential effect of trade openness on monetary policy transmission depends on exchange rate flexibility. In order to additionally test these findings, we create a dummy

Table 3. Robustness checks: Regressions with correlation with US/Germany and exchange rate interaction term

Dependent variable	Average effect on output							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Deposit money bank assets	–0.0015*				–0.0003			
	(0.0009)				(0.0008)			
Private credit		–0.0020*				–0.0006		
		(0.0011)				(0.0009)		
Bank deposits			–0.0017				–0.0006	
			(0.0011)				(0.0009)	
Liquid liabilities				–0.0015				–0.0007
				(0.0013)				(0.0012)
Bank credit to deposit ratio	–0.0021**	–0.0017	–0.0026***	–0.0024***	–0.0017	–0.0016	–0.0019*	–0.0018*
	(0.0011)	(0.0012)	(0.0010)	(0.0010)	(0.0011)	(0.0012)	(0.0011)	(0.0011)
Exchange rate	–0.0233*	–0.0224*	–0.0239*	–0.0237*	0.0011	0.0013	0.0011	0.0004
	(0.0126)	(0.0129)	(0.0126)	(0.0127)	(0.0114)	(0.0113)	(0.0112)	(0.0118)
Trade openness	–0.0048***	–0.0048***	–0.0047***	–0.0047***	–0.0021**	–0.00212**	–0.0022**	–0.0025***
	(0.0014)	(0.0015)	(0.0014)	(0.0014)	(0.0010)	(0.0010)	(0.0010)	(0.0010)
Financial openness	0.0004	0.0004	0.0003	0.0004	0.0002	0.0002	0.0002	0.0003
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Share of industry	0.0175***	0.0176***	0.0175***	0.0167***	0.0119**	0.0119**	0.0118**	0.0114**
	(0.0062)	(0.0062)	(0.0062)	(0.0059)	(0.0053)	(0.0054)	(0.0054)	(0.0053)
Corr. with US or Germany	0.2861**	0.2821**	0.2705**	0.2376**				
	(0.1262)	(0.1231)	(0.1218)	(0.1109)				
Flex. exchange rate dummy					–0.0025*	–0.0025*	–0.0025*	–0.0023*
x Trade openness					(0.0014)	(0.0014)	(0.0014)	(0.0013)
Constant	0.0055	–0.0424	0.0585	0.0637	–0.1778	–0.1844	–0.1465	–0.1242
	(0.2431)	(0.2577)	(0.2311)	(0.2347)	(0.2301)	(0.2283)	(0.2208)	(0.2257)
No. of observations	46	46	46	44	47	47	47	45
R^2	0.70	0.70	0.70	0.71	0.69	0.69	0.69	0.71
Wald χ^2 test	0.00	0.00	0.00	0.00	0.04	0.04	0.03	0.03

Note: *,**, and *** indicate the 10%, 5%, and 1% levels of significance.

variable for countries with more flexible exchange rates and construct an interaction variable between this dummy and the trade openness variable.[8] When this interaction term was included in the model, the results (*Table 3,* columns 5–8) reveal that the effect of trade openness on output responsiveness to a monetary policy shock is significantly different for economies with flexible exchange rates. In particular, the negative and statistically significant coefficients on trade openness suggest that in countries with a larger share of international trade in GDP, a monetary policy shock has, on average, a larger effect on output. The negative and statistically significant coefficients on the interaction variable suggest that this hypothesised effect between the share of international trade and output responsiveness to a monetary policy shock is larger for countries with more flexible exchange rates. These results underpin the previous findings in *Table 2* regarding the importance of the exchange rate channel in monetary policy transmission.

6. CONCLUSION

This paper contributes to the better understanding of cross-country variations in the effects of a monetary policy shock on output. We used a structural vector autoregression (SVAR) model to estimate the effects of a monetary policy shock for each country in the sample separately. Next, we treated the estimates obtained in the first step as the dependent variable in a cross-section regression analysis that investigates possible sources of cross-country variations in the output responses to a monetary policy shock.

The main contribution of the paper includes novel empirical evidence on the importance of the exchange rate channel and the interdependence between national economies for monetary policy transmission.

In particular, our results on the exchange rate regime and trade openness are consistent with the exchange rate channel of monetary policy. A positive impact of exchange rate flexibility on monetary policy effects on output suggests that the size of these effects is larger in countries with more flexible exchange rates. In line with the exchange rate channel of monetary policy, we also find that a monetary policy shock has, on average, a larger effect on output in economies with a higher openness to international trade. Moreover, our results indicate that

[8] The dummy variable takes the value of 1 for countries for which the average value of the exchange rate categories over the considered sample period was 11 or higher, and 0 otherwise. Exchange rate categories are defined using Ilzetzki et al.'s (2008) classification and procedure as described in Section 3.2.

the estimated relationship between trade openness and output responsiveness to a monetary policy shock is larger for countries with more flexible exchange rates.

The results on the correlation (of non-European economies) with the US and (of European economies) with the German economy point towards the importance of the interdependence between economies for monetary policy transmission. Namely, we find a negative impact of this correlation term on the effect of monetary policy. This suggests that a larger correlation of national economies with the dominant world economies undermines the ability of national monetary policies to influence output in the short run. This is consistent with the view that growing international interdependence may have increased the importance of foreign factors in the determination of domestic output and, in turn, reduced the ability of national monetary policy to influence domestic output in the short run.

With respect to the issues analysed by the previous literature, our results on financial variables support the findings of Cecchetti (1999) and Mihov (2001) regarding the importance of the banking sector in the monetary policy transmission. Our results indicate that a monetary policy shock has, on average, a larger effect on output in countries with a larger and more developed banking sector.

REFERENCES

Acosta-Ormaechea, S. – Coble, D. (2011): Monetary Transmission in Dollarized and Non-Dollarized Economies: The Cases of Chile, New Zealand, Peru and Uruguay. *IMF Working Paper*, WP/11/87.

Aysun, U. – Brady, R. – Honig, A. (2013): Financial Frictions and the Strength of Monetary Transmission. *Journal of International Money and Finance*, Vol. 32(C), pp. 1097–1119.

Bank for International Settlements (2006): *76th Annual Report.* Basel, Bank for International Settlements.

Bank of England (1999): *The Transmission Mechanism of Monetary Policy*. The Monetary Policy Committee, Bank of England.

Baxter, M. – Kouparitsas, M. A. (2005): Determinants of Business Cycle Co-Movement: A Robust Analysis. *Journal of Monetary Economics*, 52(1): 113–157.

Beck, T. – Demirgüç-Kunt, A. – Levine, R. (2010): Financial Institutions and Markets across Countries and Over Time: The Updated Financial Development and Structure Database. *World Bank Economic Review*, 24(1): 77–92.

Bernanke, B. S. (2007): *Globalization and Monetary Policy*. Speech at the Fourth Economic Summit, Stanford Institute for Economic Policy Research.

Bhattacharya, R. – Patnaik, I. – Shah, A. (2011): Monetary Policy Transmission in an Emerging Market Setting. *IMF Working Paper,* WP/11/5.

Carlino, G. A. – DeFina, R. (1998): The Differential Regional Effects of Monetary Policy. *Review of Economics and Statistics*, 80(4): 572–587.

Carlino, G. A. – DeFina, R. (1999): The Differential Regional Effects of Monetary Policy: Evidence from the U.S. States. *Journal of Regional Science*, 39(2): 339–358.

Cecchetti, S. G. (1999): Legal Structure, Financial Structure, and Monetary Policy Transmission Mechanism. *FRBNY Economic Policy Review*, July: 9–28.
Cetorelli, N. – Goldberg, L. S. (2012): Banking Globalization and Monetary Transmission. *Journal of Finance*, 67(5): 1811–1843.
Chinn, M. D. – Ito, H. (2006): What Matters for Financial Development? Capital Controls, Institutions, and Interactions. *Journal of Development Economics*, 81(1): 163–192.
Clarida, R. – Gertler, M. (1997): How the Bundesbank Conducts Monetary Policy. In: Romer, C. D. – Romer, D. H. (eds): *Reducing Inflation: Motivation and Strategy.* Chicago: University of Chicago Press. pp. 363–412.
Cwik, T. – Müller, G. J. – Wolters, M. H. (2011): Does Trade Integration Alter Monetary Policy Transmission? *Journal of Economic Dynamics and Control*, 35(4): 545–564.
Dornbusch, R. – Favero, C. A. – Giavazzi, F. (1998): Immediate Challenges for the ECB. *Economic Policy*, 13(26): 15–52.
Ehrmann, M. – Fratzscher, M. (2009): Global Financial Transmission of Monetary Policy Shocks. *Oxford Bulletin of Economics and Statistics*, 71(6): 739–759.
Ehrmann, M. – Fratzscher, M. – Rigobon, R. (2011): Stocks, Bonds, Money Markets, and Exchange Rates: Measuring International Financial Transmission. *Journal Applied Econometrics*, 26(6): 948–974.
Elbourne, A. – de Haan, J. (2006): Financial Structure and Monetary Policy Transmission in Transition Countries. *Journal of Comparative Economics*, 34(1): 1–23.
European Central Bank (2010): *Monthly Bulletin May.* Frankfurt.
Fleming, M. J. (1962): Domestic Financial Policies under Fixed and Floating Exchange Rates. *IMF Staff Papers*, 9(3): 369–379.
Gudmundsson, M. (2008): Financial Globalization: Key Trends and Implications for the Transmission Mechanism of Monetary Policy. *Bank for International Settlements paper,* No. 39, Basel.
Hausman, J. – Wongswan, J. (2011): Global Asset Prices and FOMC Announcements. *Journal of International Money and Finance*, 30(3): 547–571.
Havranek, T. – Rusnak, M. (2013): Transmission Lags of Monetary Policy: a Meta-Analysis. *International Journal of Central Banking*, 9(4): 39–75.
Ilzetzki, E. O. – Reinhart, C. M. – Rogoff, K. (2008): *Exchange Rate Arrangements into the 21st Century: Will the Anchor Currency Hold?* Mimeo: Harvard University.
Imbs, J. (2006): The Real Effect of Financial Integration. *Journal of International Economics*, 68(2): 296–324.
Kamin, S. B. (2010): Financial Globalization and Monetary Policy. *Discussion Paper,* No. 1002*,* Washington, D.C.: Board of Governors of the Federal Reserve System.
Kim, S. – Roubini, N. (2000): Exchange Rate Anomalies in the Industrial Countries: A Solution with a Structural VAR Approach. *Journal Monetary Economics*, 45(3): 561–586.
Lane, P. R. – Milesi-Ferretti, G. M. (2007): The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970–2004. *Journal Monetary Economics*, 73(2): 223–250.
Lewis, J. B. – Linzer, D. A (2005): Estimating Regression Models in Which the Dependent Variable is Based on Estimates. *Political Analysis*, 13(4): 345–364.
Meier, S. (2013): Financial Globalization and Monetary Transmission. *Globalization and Monetary Policy Institute Working Paper,* No. 145, Dallas: Federal Reserve Bank of Dallas.
Meltzer, A. H. (1995): Monetary, Credit and (Other) Transmission Processes: A Monetarist Perspective. *Journal of Economic Perspectives*, 9(4): 49–72.
Mihov, I. (2001): Monetary Policy Implementation and Transmission in the European Monetary Union. *Economic Policy*, 16(33): 371–406.

Mishkin, F. S. (1995): Symposium on the Monetary Transmission Mechanism. *Journal of Economic Perspectives*, 9(4): 3–10.

Mundell, R. A. (1962): The Appropriate Use of Monetary and Fiscal Policy for Internal and External Stability. *IMF Staff Papers*, 9(1): 70–79.

Owyang, M. T. – Wall, H. J. (2009): Regional VARs and the Channels of Monetary Policy. *Applied Economics Letters*, 16(12): 1191–1194.

Sims, C. – Zha, T. (2006): Does Monetary Policy Generate Recessions? *Macroeconomic Dynamics*, 10(2): 231–272.

Taylor, J. B. – Wieland, V. (2012): Surprising Comparative Properties of Monetary Models: Results from a New Model Database. *Review of Economics and Statistics*, 94(3): 800–816.

Woodford, M. (2010): Globalization and Monetary Control. In: Gali, J. – Gertler, M. (eds): *International Dimension of Monetary Policy.* University of Chicago Press, pp. 13–77.

Yellen, J. L. (2006): *Monetary Policy in a Global Environment.* Presentation at the "Euro and the Dollar in a Globalized Economy" Conference, Santa Cruz: University of California Santa Cruz.