

IMF Working Paper

Assessing the Determinants of Interest Rate Transmission Through Conditional Impulse Response Functions

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European Department

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January 2013

Abstract

We employ a structural panel VAR model with interaction terms to identify determinants of effective transmission from central bank policy rates to retail lending rates in a large country sample. The framework allows deriving country specific pass-through estimates broken down into the contributions of structural country characteristics and policies. The findings suggest that industrial economies tend to enjoy a higher pass-through largely on account of their more flexible exchange rate regimes and their more developed financial systems. The average pass-through in our sample increased from 30 to 60 percent between 2003 and 2008, mainly due to positive risk sentiment, rising inflation and increasingly diversified banking sectors. The crisis reversed this trend partly as banks increased precautionary liquidity holdings, non-performing loans proliferated and inflation moderated.

JEL Classification Numbers: F4, E3, E6

Keywords: Interest Rate Pass-Through, Banking Sector, Monetary Policy Transmission

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¹ We would like to thank Erik de Vrijer, Robert Blotvogel, Chris Jarvis, Tam Bayoumi, Sally Chen, Mirko Abbritti, Pascal Towbin, Michal Andrle, Bertrand Gruss, Alexis Meyer-Cirkel and seminar participants at the IMF for their useful comments and suggestions which greatly improved the paper.

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I. INTRODUCTION

Emerging and advanced economies alike are increasingly relying on reference interest rates as their primary monetary policy tools and employ interbank rates as intermediate policy targets. There is a growing consensus that the transparency and predictability of monetary policy making enhances the ability to steer economic activity and anchor inflation expectations. This has boosted the popularity of explicit policy rules that link reference interest rate changes to macroeconomic variables such as growth and inflation (Goodfriend, 2007; Mishra, 2012; Scott, 2009). In such frameworks, the credibility and predictability of monetary policy relies critically upon the degree to which the various channels of transmission are under the policymaker's control. If, for instance, the interest rate channel is impaired and changes in the policy rate cannot, or only imperfectly, steer market rates, policy rate changes become less predictable and less credible as forceful signals of the central bank's monetary policy stance.²

The central objective of this paper is to identify the determinants of interest rate transmission with a focus on the distinction between advanced economies and those in which financial systems and the accompanying institutions and policies are less developed. Identifying the determinants of interest rate transmission is important not only to quantify the expected impact of policy rates on market rates but also to gauge the gains from addressing potential structural weaknesses to make monetary policy more effective. The interest in this research question is not new. Mishra and Montiel (2012) provide an excellent survey of the literature on the effectiveness of monetary policy transmission in developing economies and conclude that monetary policy transmission in such economies tends to be weak at best. At the same time, a variety of studies have examined potential structural explanations for the question why the transmission mechanism is effective in some countries and weak or non-existent in others, mostly with a focus on advanced economies. Cechetti (1999), Cottarelli and Kourelis (1994) and Ehrmann et al (2001), to name a few early contributions, suggest that an economy's financial structure as well as its underlying regulatory and institutional quality are key for the effectiveness of transmission.

The most relevant study for the purposes of the present paper is Mishra et al (2012) who use descriptive evidence to illustrate how far countries at earlier stages of development tend to be behind advanced economies in terms of relevant aspects of financial structure and other factors that have been shown to underpin an effective transmission mechanism. In a second step, the authors use cross-country panel regressions to show that the correlations between

² The focus of this paper is on interest transmission, measured as pass-through from changes in policy rates to retail lending rates. The paper deals with countries with both fixed and flexible exchange rate regimes and thus includes both countries in which policy rate changes represent independent monetary policy actions and those in which monetary policy is not fully autonomous. The paper also includes countries in which the policy rate may not be the main instrument the central bank uses to control liquidity conditions.

policy rates and retail lending rates are indeed conditional upon some of these factors. Medina Cas et al (2011) use a similar framework to identify a wider set of significant determinants of interest rate transmission in a large country sample.

This paper follows this literature in attempting to identify the determinants of interest rate transmission in a large country sample. However, it goes a step further than earlier contributions and explicitly conditions the interest rate transmission mechanism on given country characteristics in a comprehensive framework that allows the joint inclusion of various potential determinants. In particular, we employ a panel VAR with interaction terms that models policy rates and retail lending rates as functions of each other and allows relationships between the endogenous variables to vary with potential determinants of the effectiveness of transmission. The framework can then be used to calculate impulse response functions conditional upon different constellations of country characteristics. We include potential determinants in the model both individually and jointly to disentangle the correlations between the various country characteristics.

Our panel VAR framework has a number of advantages over existing approaches and allows for useful extensions of the analysis. First, it uses monthly instead of annual data to assess how country characteristics affect not only long-run pass-through but also its dynamics over time. Second, our model allows disentangling the correlations between the various potential determinants of transmission to understand which factors dominate. Third, it permits computing country specific pass-through estimates and decomposing these into the respective contributions of the different country characteristics. Finally, since the relationships in our panel VAR are functions of country characteristics, they are time variant and allow deriving the contributions of structural characteristics and policies to the evolution of the average pass-through in our sample over time.

Our analysis begins by identifying a range of country characteristics that have important effects on the effectiveness of interest rate transmission. Across the specifications we use, our results largely confirm the findings of earlier studies on the subject:³ structural characteristics that matter for interest rate transmission are exchange rate flexibility, regulatory quality, financial development and dollarization, inflation and, finally, banking sector related variables such as competition, the ratio of liquid to total assets, and—as an indicator of asset quality—the performance of banks' loan portfolios.⁴ We then proceed to take advantage of our model's capacity to quantify the impact of these factors on pass-through estimates.

³ Most of these potential explanatory variables have been used by other authors in similar contexts.

⁴ The indicator of liquidity we use is the share of liquid assets in total assets. High liquidity ratios could be associated with less effective transmission for at least two reasons which are difficult to distinguish on the basis of the available data: first, a high liquidity ratio could signal excess liquidity in the financial system; second, it might be the result of differences in risk perceptions or a more conservative business model.

The findings suggest that exchange rate flexibility along with banking sector concentration, liquidity ratios as well as non-performing loans (NPL) ratios and financial dollarization are especially important determinants of pass-through. We find that moving from a pegged to a floating exchange rate regime is associated with an increase of between 25 and 50 percentage points of pass-through in our sample, depending on the specification.⁵ An increase in banking sector concentration or the liquidity ratio from the 20th to the 80th percentile is associated with a fall in pass-through of around 20 percentage points. A fall in the share of NPLs in total loans from the 80th to the 20th percentile is associated with an increase in pass-through of between 10–20 percentage points. A drop in the share of foreign currency loans in total loans from the 80th to the 20th percentile increases pass-through by about the same magnitude.

We then proceed to use the model to derive country specific pass-through estimates that are computed as predicted values based on relevant structural characteristics, and decompose these pass-through estimates into the contributions of different structural characteristics. Our results suggest, first, that the country characteristics explain much of the cross-country variation in pass-through estimates and are highly correlated with estimates based on country specific VAR models.

We also find that, in more developed markets, a policy rate change translates almost one for one into changes in retail lending rates. In contrast, the pass-through in developing countries is significantly lower at around 30–45 percent. The main factor that accounts for the higher pass-throughs in more developed economies is the flexibility of their exchange rate regimes. Further key distinguishing factors are lower liquidity and NPL ratios and more developed financial systems. Decomposing the evolution of the average pass-through estimate in our country sample over time, we find that it increased from about 30 percent in 2003 to close to 60 percent in 2008, largely as a result of low liquidity and non-performing loan ratios resulting from positive risk sentiment, increasingly competitive banking sectors and rising inflation. The crisis reversed this trend as inflation moderated, liquidity ratios recovered and non-performing loans proliferated.

The remainder of this paper is organized as follows: Section II describes our econometric approach in detail. Section III discusses the findings of our empirical exercise. Section IV concludes.

⁵ Exchange rate regimes include countries with ‘no separate legal tender’, ‘currency boards’, ‘pre-announced pegs or bands’, and ‘de facto pegs or bands’ for pegs (categories 1–11 of Reinhart and Rogoff, 2004) and ‘managed floats’ and ‘freely floating’ regimes for floats (categories 12–13 of Reinhart and Rogoff, 2004).

II. EMPIRICAL STRATEGY

The central objective of this study is to identify determinants of the effectiveness of interest rate transmission. For this purpose, we employ a panel VAR model with interaction terms that allows relationships between the endogenous variables in the VAR to vary with potential determinants of the effectiveness of transmission. The specification can then be used to calculate impulse response functions that vary with different constellations of such factors. This strategy allows understanding better how the degree of pass-through might change—and by how much—if, for instance, a country successfully implements a de-dollarization strategy, improves its regulatory environment or moves from a fixed exchange rate to a more flexible exchange rate regime. As a cross-check for our results, we also correlate pass-through estimates based on country by country VAR models with the same country characteristics used in the panel VAR model.

Our approach has three main advantages. First, it avoids the small sample bias that may arise in country-by-country estimates of pass-through. Second, it allows analyzing directly the way in which different characteristics affect the response of lending rates to a monetary policy shock. Third, it allows differentiating the effects of structural country characteristics on short-run as opposed to long-run pass-through. The major disadvantage of our approach is that we impose coefficients to be the same across countries which may be problematic to the extent that the characteristics we employ do not fully explain pass-through heterogeneity across countries.

In addition to testing potential determinants of pass-through individually, we also include multiple characteristics in the model at the same time. This approach allows disentangling the correlations between the various potential determinants of transmission and identifying those that remain significant when included alongside others.

Finally, we use panel VAR specifications with all relevant country characteristics to decompose pass-through estimates for individual countries into the contributions of different structural characteristics. In other words, we identify the structural characteristics that are instrumental in lowering or boosting a country's pass-through as well as the magnitude of their impact. Moreover, we use a similar approach to decompose the average pass-through over time into the contributions of different determinants. This allows us to better understand what factors contributed to pass-through developments over time across our country sample.

A. Econometric Approach

The benchmark model used in this paper is based on a panel interaction VAR framework as described in Towbin and Weber (2011).⁶ The framework can be understood as a generalized

⁶ The Matlab toolbox for the interacted Panel VAR procedure is available from: sweber@imf.org.

panel VAR regression that models the dynamic interaction between policy rates and retail lending rates, and in which each right-hand-side variable can vary deterministically with structural country characteristics. In other words, the lending rate is modeled as a function not only of its own lags and the contemporaneous and lagged policy rate, but also of interaction terms between all these regressors with given structural characteristics. The policy rate is modeled as a function of its own lags and the lags of the lending rate. The model is given by:

$$\begin{pmatrix} 1 & 0 \\ \alpha_{21,i,t}^0 & 1 \end{pmatrix} \begin{pmatrix} \Delta i_{i,t}^P \\ \Delta i_{i,t}^R \end{pmatrix} = \sum_{l=1}^3 \begin{pmatrix} \beta_{11}^l & \beta_{12}^l \\ \alpha_{21,i,t}^l & \alpha_{22,i,t}^l \end{pmatrix} \begin{pmatrix} \Delta i_{i,t-l}^P \\ \Delta i_{i,t-l}^R \end{pmatrix} + \begin{pmatrix} \delta_{11} & 0 \\ \delta_{21} & \delta_{22} \end{pmatrix} \begin{pmatrix} I_i \\ X_{i,t} \end{pmatrix} + \begin{pmatrix} v_{i,t} \\ u_{i,t} \end{pmatrix} \quad (\text{II.1})$$

$$\alpha_{pq,i,t}^l = \beta_{pq}^l + \gamma_{pq}^l X_{i,t} \quad (\text{II.2})$$

where $i_{i,t}^P$ is the policy rate, $i_{i,t}^R$ is the retail lending rate, I_i is a set of country fixed effects and $X_{i,t}$ is a matrix that consists of country characteristics chosen as potential determinants of the effectiveness of interest rate transmission. The variables in $X_{i,t}$ are country specific and may vary over time, though potentially at a lower frequency than the interest rate variables.

The pass-through from monetary policy rates to lending rates can thus vary over time and with the characteristics of a given economy. We identify impulse response functions based on a simple Choleski ordering, assuming that policy rates are contemporaneously unaffected by changes in the retail lending rate. We also constrain the impact of the lending rate on the monetary policy rate to be homogeneous.⁷

We illustrate the importance of each of the structural characteristics in $X_{i,t}$ by contrasting cumulative impulse response functions evaluated at the 20th and 80th percentiles of the respective sample distributions. This strategy allows understanding how pass-through estimates would change if, holding the other variables at the median, a country were to move from a low to a high value in terms of a given structural characteristic.

⁷ Relaxing this assumption has very limited implications for the estimated impact of the different country characteristics on interest rate pass-through but comes at the cost of less precise estimates due to the loss of degrees of freedom associated with the implied increase in required coefficient estimates.

B. Data

The analysis uses monthly data and an unbalanced panel over the sample period 2000:M1 to 2011:M12.⁸ The country sample includes all countries for which time series data is available for the variables of interest (see Appendix Table 1).⁹ The key variables used in the analysis are the policy rate and the retail lending rate. We source both the policy rate and the lending rate from the IMF's international financial statistics (IFS).¹⁰ The paper thus only includes countries that report the relevant data to IFS.

In addition, we employ a variety of variables as potential determinants of the effectiveness of interest rate transmission. In principle, pass-through from policy rates to retail lending rates can differ in speed and magnitude across countries. A textbook explanation of pass-through would go along the following lines: the central bank purchases government securities in secondary markets. The resulting increase in commercial bank deposits would increase excess reserves, leading to a fall in the short-term money market rate and relieving price constraints to bank lending.¹¹ As funding costs on the wholesale market adjust, the cost of finance for the non-bank sector falls and both retail lending and deposit rates fall along the yield curve, starting from short maturities.¹² Since central banks operate at the lower end of the yield curve, a change in the policy rate typically translates into an almost immediate change in the interbank rate. Pass-through to retail lending rates, on the other hand, can be delayed and incomplete and may vary substantially across countries (Mishra et al, 2012).

Theory suggests a variety of potential constraints to an effective interest rate transmission mechanism as we describe it here. An economy's financial structure, in particular, is critical in setting the right incentives for banks to pass on policy rate changes to customers, but other structural characteristics such as an economy's overall regulatory environment and its

⁸ The interest rate variables are sourced at monthly frequency. The structural country characteristics are linearly interpolated to monthly frequency when data is available only at a lower frequency. See Appendix for details.

⁹ We exclude countries in currency unions from the analysis as the exchange rate regime indicator could produce misleading results in the analysis.

¹⁰ The policy rate—the discount rate/bank rate—in IFS is defined as the rate at which central banks lend or discount eligible paper for deposit money banks. The lending rate in IFS is defined as the bank rate that typically meets the short- and medium-term financing needs of the private sector.

¹¹ Excess reserves might not increase in cases in which deposits and other liabilities are close substitutes, and banks decide to cut back, e.g. on the issuance of securities to fully offset the increase of deposits.

¹² The actual modus operandi of modern central banks differs somewhat from the textbook explanation, including because monetary policy impulses are typically given through price signals (policy rate changes) and implemented by accommodating banks' demand for reserves (arising largely from the need to fulfill minimum reserve requirements) via refinancing operations to steer short term money market rates.

exchange rate regime and inflation rate are likely to matter as well (Gigineishvili, 2011, Medina Cas et al, 2011; Mishra et al, 2012; Mishra and Montiel, 2012).

- *Regulatory quality:* A poorly functioning *regulatory environment* creates uncertainty in the financial system and can lead to a deformalization of financial transactions and a higher cost of financial intermediation. As a result, bank rates may become less sensitive to changes in the policy rate. In fact, the small size of financial intermediation in many developing economies is likely related to a weak regulatory environment (Mishra et al, 2012). As a proxy for the quality of regulations, the rule of law and overall governance, we use the World Bank regulatory quality index.
- *Financial dollarization:* In highly dollarized financial systems, the central bank has only limited control over interest rates of both foreign and domestic currency instruments. The reason is that the cost of foreign currency funding is linked to external factors that are mostly outside the control of the central bank. To the extent that financial market participants can arbitrage between domestic and foreign currency instruments, the policy rate can thus only partially control market interest rates on domestic currency instruments. Moreover, a high degree of dollarization makes bank balance sheets vulnerable, leading to a fear of floating that can be detrimental for effective interest rate transmission (Leiderman et al, 2006).¹³ We measure the extent of dollarization of the financial system by the share of foreign currency loans in total loans.
- *Financial development:* Developed financial systems typically offer a greater variety of alternative forms of investment. More variety in investment opportunities, in turn, likely leads to increased competition between financial products. Market interest rates—including on wholesale markets - are thus more responsive to policy rate changes because profit margins are constrained (Cottarelli, et al., 1994). A lack of financial development is also an important driver of dollarization (Leiderman et al., 2006). Furthermore, weak interbank markets, a key symptom of a low level of financial development, can result in excess liquidity in the banking system (Mishra et al, 2012). We use the private credit to GDP ratio as a measure of development of the financial system.
- *Liquidity ratio:* Interest rate transmission may be less effective in a financial system in which banks and other financial institutions shore up liquidity because adequate investment opportunities do not exist. Intuitively, policy rate changes are unlikely to cause movements in credit supply – or demand due to changing retail lending rates—when liquidity is abundant. In some sense, liquidity acts as a buffer against market

¹³ Balance sheets could be vulnerable both as a result of currency mismatches and as a result of a large exposure to unhedged borrowers.

fluctuations and monetary shocks (De Graeve, De Jonghe and Vennet, 2007; Kashyap and Stein, 2000). However, a major drawback of the measure we employ is that it could be a symptom not only of excess liquidity—a high liquidity ratio that is caused by a lack of investment opportunities—but also of differences in risk perceptions or business models. Caution is thus in order when interpreting the results based on this measure (Saxegaard, 2006).

- *Banking sector competition:* When banks have substantial market power, policy rate changes may translate into movements in spreads rather than market rates. Imperfectly competitive financial systems are often characterized by a small number of relatively large banks, an important role for government-owned banks or a weak role for nonbank financial intermediaries. As alternative measures of competition in the banking sector, we employ (i) a measure of banking sector concentration as given by the Herfindahl index computed over asset shares of individual commercial banks, and (ii) the banking sector's average return on equity (Sorensen und Werner, 2006).
- *Asset quality:* Banks with weak balance sheets may react to an expansive monetary policy stance by shoring up liquidity rather than extending credit at lower rates. A change in the policy rate may thus have only a limited impact on market rates. In essence, potential new loans are crowded out by the presence of bad loans on balance sheets. Moreover, banks have to comply with regulatory requirements, implying that their capacity to expand lending depends, for instance, on their capital adequacy. We use the share of non-performing in total loans (NPL), gross of provisions, as an indicator of asset quality. In addition, the standard deviation of NPLs across banks is used as a measure of banking sector fragmentation. Intuitively, one might expect a banking sector that is highly fragmented to be less competitive and more prone to excess liquidity.
- *Exchange rate flexibility:* Interest rate transmission can only be effective when policy rate changes are perceived as credible signals for the central bank's monetary policy stance. The central bank's control over market rates is thus likely to be tighter when policy rates are set as part of a transparent and rules-based framework that is largely independent of other influences such as fiscal and exchange rate policy. A lack of exchange rate flexibility, for instance, may signal that the policy rate is not set with the primary purpose of steering an intermediate target of monetary policy such as market interest rates or commercial bank reserves. In our analysis, we thus use exchange rate flexibility as a factor that might determine the effectiveness of central

bank policy signals. We use the classification by Reinhart and Rogoff (2004) as a measure of the rigidity of exchange rate regimes.¹⁴

- Inflation: The *inflation rate* is used to assess whether pass-through is higher in high inflation environments. Intuitively, one might expect that higher inflation ratios lead to more frequent price changes, thus making it more likely that policy rate changes impact market rates in a timely fashion (Cottarelli and Kourelis 1994).

We transform all country characteristics in two steps in an effort to limit the influence of outliers on our results and standardize the variables to facilitate interpretation. In particular, each variable in X is transformed to $x = \ln(1+X)$ to limit the impact of outliers. We also center each variable to start at zero by imposing that $x = \ln(1+X - \min(X))$ if $\min(X) < 0$.

III. RESULTS

The analysis is split into four parts. In the first part, we estimate the panel VAR model both with and without interaction terms to determine the average pass-through across countries and identify determinants of the effectiveness of interest rate transmission, one at a time. Scatter plots between these potential determinants and long-run pass-through estimates based on country-specific VARs are used as a cross check for the results.¹⁵ In the second part, we include all relevant determinants, and the related interaction terms, in the model at the same time. This strategy allows us to identify the variables that are significant both when included individually and when included alongside other potential determinants. In part three, we use the full model with all relevant determinants to decompose the contributions of each country's predicted pass-through (by the PVAR model) into the contributions of the relevant country characteristics. We also test the robustness of these findings to a variety of specification changes. Finally, in part four, we use a similar technique to decompose the evolution over time of the average pass-through in our country sample into the contributions of different country characteristics.

Part 1: Determinants of pass-through

We begin part one by estimating the model in equations II.1 and II.2 in the absence of any country characteristics; in other words $X_{i,t}$ is empty. The set of equations II.1 and II.2 can be estimated jointly by OLS, and impulse response functions are identified by assuming that policy rates are contemporaneously unaffected by changes in retail lending rates. The lag

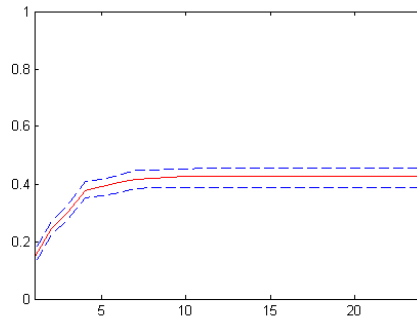
¹⁴ We use a dummy that takes on the value one unless the “fine” classification has the value 12 or 13—corresponding to free floats or managed floats—for the country and time period in question.

¹⁵ The country specific VAR models use the same two variables (policy rate and lending rate), lag length, and Choleski ordering as the panel VAR.

length is chosen to be three in the benchmark specification. Figure 1 presents the cumulative impulse responses of retail lending rates to a 1 percentage point increase in the policy rate, estimated on the basis of the full sample of countries and constraining the coefficient estimates to be homogeneous across countries. We also draw 90 percent confidence bands around the point estimates that are calculated based on bootstrapping techniques.¹⁶

The chart illustrates that the average pass-through in our sample reaches about 45 percent in the long-run.¹⁷ About 90 percent of the long-run pass-through materializes after four months, and the full pass-through essentially materializes after seven months. This result is broadly in line with other studies on the subject that also used cross-country samples, yet with differing country coverage and sample periods.¹⁸

Figure 1: Average Impulse Response of Lending Rate to Policy Rate Shock



An important question that arises with respect to the PVAR specification we have chosen is whether the model is complex enough to allow identifying a policy rate shock adequately. While equivalent specifications have been used frequently in the literature, an omitted variable bias could in principle arise, thus affecting the pass-through estimates. This would be of concern for this study to the extent that a bias in the pass-through estimate would translate into a significant bias in the coefficients on the interaction terms that determine the extent to which country characteristics condition pass-through estimates. In order to gain a

¹⁶ The procedure can be described as follows: 1) (II.1) by OLS; 2) Draw errors from the sample distribution of residuals; 3) Use the draw, the initial observations of the sample, and the coefficient estimates to simulate the dependent variable recursively. The artificial sample is then used to re-estimate the coefficients of (II.1), which are used to compute the impulse response function.

¹⁷ The long run is defined to be 24 months after the impact of the shock to allow for cases in which it takes longer to materialize than is the case on average in our sample.

¹⁸ Medina Cas et al. calculate pass-through estimates in a sample of 70 countries and find that the average pass-through is about 0.55. Mishra et al (2012) use a sample of 94 countries and find that the correlation between policy rates and lending rates in the long term is 0.35 for advanced economies, 0.61 for emerging economies and 0.29 for LICs.

better understanding of whether this concern is warranted, we experiment with a variety of model changes, including by augmenting the specification used in equation II.1 by two additional variables, namely industrial production and inflation. The findings of this exercise are presented in Figure 5 which suggests that notable differences in pass-through estimates only arise when the country sample is altered, but not when additional variables of potential relevance are included.¹⁹ We are thus reasonable confident that the impact of a potential omitted variable bias in our results will be rather small.

Relatedly, a range of papers in the literature have used Autoregressive Distributed Lag (ADL) models to capture the dynamic impact of the policy rate on the retail lending rate (e.g. Medina Cas et al, 2011). In our opinion, an ADL type specification is not appropriate in our setup as feedback from the policy rate to movements in the retail lending rate exists. Indeed, we find that the lags of the retail lending rate are jointly significant in the entire variety of model specifications we estimated, including those presented in Figure 5. We thus see a strong case in favor of allowing for feedback from retail lending rates to policy rates in our model.

We proceed to add one variable at a time to $X_{i,t}$ and estimate the model in equations II.1 and II.2 separately for each specification. The definition of the conditional coefficient estimates in II.2 implies that II.1 models each interest rate as a function not only of its own lags and the other interest rate along with its respective lags, but also of interaction terms between all these regressors and the structural characteristics in $X_{i,t}$. Thus the transmission from the policy rate to the lending rate and its dynamics are a function of the country characteristics in $X_{i,t}$. In order to assess whether the respective characteristic has an important impact on pass-through, we contrast cumulative impulse response functions evaluated at the 20th and the 80th percentile of its sample distribution. We also test whether the two impulse response functions are statistically different from each other.²⁰ Figure 2 illustrates the two impulse response

¹⁹ Figure 5 in the Appendix shows that comparing the more complex model that includes industrial production and inflation (model 4) with the simple two equation model yields no significant differences in pass-through estimates as long as identical sample periods are employed (model 2). This conclusion is also invariant to different orderings for the variables in model 4. Similarly, a model that includes only one additional variable—the inflation rate—also yields a very similar pass-through estimate (model 3). Major differences in average pass-through estimates only arise when the country sample is altered, e.g. by including inflation and IP. This can be seen by comparing the interest rate pass-through estimate under model 4, model 2 and 2*, where the difference between 2* and 2 is that the sample in the latter is identical to the sample in model 4. The estimates for model 4 and 2 are close to identical, while the estimate for model 2* is different.

²⁰ The procedure to derive the confidence intervals is adjusted to account for the use of interaction terms and may be described as follows: (1) estimate the equation system (II.1 and II.2) by OLS; (2) draw errors from the sample distribution of residuals; (3) use the draw, the dependent variable in the previous period (or the initial observations of the sample for the first observation), the interaction terms, and the coefficient estimates to simulate the dependent variable recursively; (4) after the period is simulated for all variables in the system, interact the endogenous variables with the interaction terms; and (5) repeat steps 2 to 4 as many times as there

(continued)

functions along with the difference between them and presents both point estimates and 90 percent confidence intervals around them. Figure 6 shows simple correlations between the country characteristics and country-specific VAR estimates of pass-through in order to put the results into perspective.²¹ The results suggest the following:

- *Regulatory quality* appears to be a relevant determinant of the effectiveness of interest rate transmission. The impulse response functions suggest that countries with low (20th percentile) regulatory quality attain a long run pass-through of about 35 percent while countries with high (80th percentile) regulatory quality attain a substantially higher pass-through of about 50 percent. The difference between the two is highly significant at all points of the impulse response function. The result is further confirmed by the positive correlation between pass-through estimates based on country specific VAR models and the regulatory quality measure (Figure 6).
- *Financial dollarization* has a significant and sizable influence on pass-through. Countries with high dollarization have a long-run pass-through of about 30 percent while countries with low dollarization have a pass-through of 50 percent. Moreover, the difference is statistically different from zero at all points of the response horizon. Similarly, Figure 6 shows that, based on country-specific estimates, there is a negative correlation between loan dollarization and pass-through.
- *Financial development*—proxied for by the ratio of private credit to GDP—exerts a significant and large influence on the effectiveness of interest rate transmission, with pass-through for low financial development 30 percentage points lower than that of countries at a high stage of financial development. Once again the difference is highly significant along the response horizon. Similarly, based on the country-specific models we find that the correlation between pass-through and private credit is positive.
- The *liquidity ratio* also has a substantial impact on pass-through.²² The results suggest that countries with low excess liquidity have a pass-through of about 55 percent,

are errors. The artificial sample, together with the interaction variables, is then used to re-estimate the coefficients in II.1 and II.2.

²¹ The country-specific VAR models use the same endogenous variables, lag length and Choleski ordering as in the PVAR. The only difference is that no country characteristics or interaction terms enter the model. We use the cumulative impulse response of the retail rate to a 1 percentage point increase in the policy rate after 24 months as the relevant long-run pass-through estimate in Figure 6. Extending the horizon has no impact on the values, as the long-run value is typically reached within a year's time.

²² In particular, the share of liquid assets in total assets does not necessarily reflect excess liability to the extent that different economic environments and business models across countries and time may require different optimal liquidity ratios (Saxegaard, 2006).

compared to 35 percent in the case of those with high excess liquidity. In contrast, in the case of the country-by-country estimations we do not find evidence of a negative correlation between pass-through and excess liquidity.

- *Banking sector competition* matters notably for pass-through if indicators of banking sector concentration are used. In countries with a low concentration of the banking sector, as measured by the Herfindahl index, long run pass-through reaches 55 percent while it reaches only 35 percent for countries with a high concentration. The difference is large and statistically significant as well as confirmed by the negative correlation in Figure 6. When measuring competition via the return on equity, the results are not significant. The reason might be that the return on equity is not a very precise measure of banking sector competition since a high return on equity could be both the result of weak competition and of a very profitable banking sector. In fact, we find evidence in favor of a positive correlation between pass-through and the return on equity in the country specific analysis.
- *Asset quality*, as measured by the banking sector's NPL share in total loans is also an important determinant of pass-through, as predicted by theory. Countries with low NPLs have a long term pass-through that is 10 percentage points higher than that of countries with high NPLs. The difference is also significant throughout the response horizon. Indeed, the country-specific estimations confirm that there is a negative correlation between NPL ratios and pass-through. We could not, however, find evidence that the fragmentation of the banking sector, as measured by the standard deviation of NPLs across banks matters much as suggested by the negative correlation in Figure 6. A possible explanation is that banking sector fragmentation only affects competition and efficiency in the banking sector once it reaches a critical threshold.
- *Exchange rate flexibility* is among the determinants of interest rate transmission with the largest impact. Countries with rather rigid exchange rate regimes have a long run pass-through of about 40 percent whereas those with flexible rates have one of 65 percent. The difference is significant at all points of the response horizon. The relationship is confirmed by the correlations between the indicator of exchange rate flexibility and the country-specific VAR estimates.
- *Inflation* does not appear to be an important determinant of pass-through in our model. The difference between the point estimates in low and high inflation environments is not statistically significant. Similarly, there does not seem to be a strong correlation between inflation and country-by-country estimates of long-run pass-through.

Figure 2: Cumulative Conditional Impulse Response Functions: Adding One Country Characteristic at a Time

Figure 2.1: Impulse Response Function: Variation with Regulatory Quality

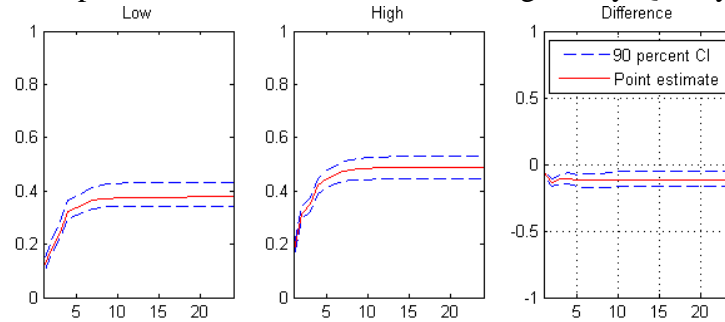


Figure 2.2: Impulse Response Function: Variation with Loan Dollarization

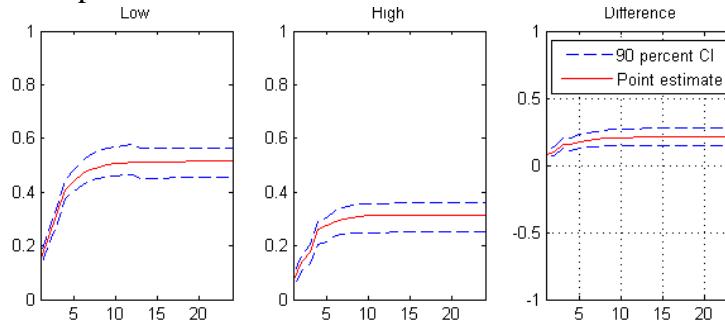


Figure 2.3: Impulse Response Function: Variation with Private Credit to GDP Ratio

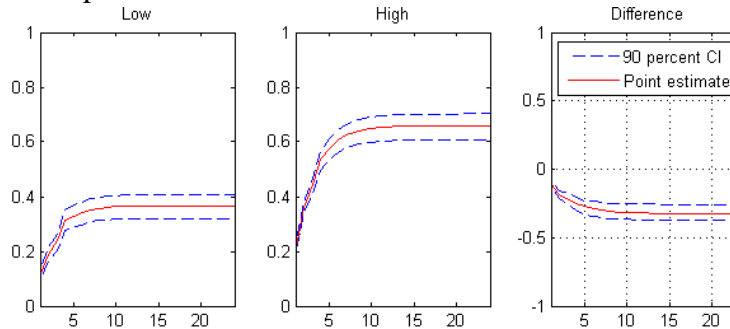


Figure 2.4: Impulse Response Function: Variation with Ratio of Liquid Reserves to Assets

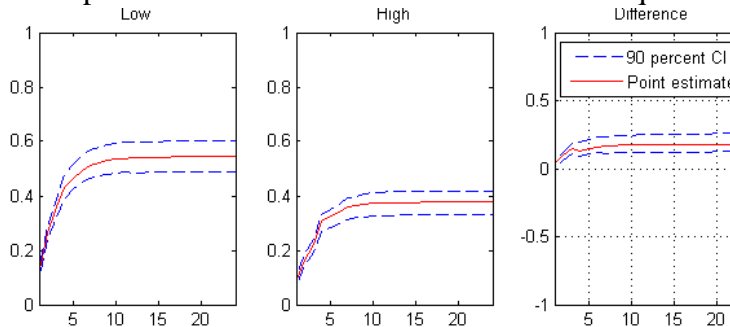


Figure 2.5: Impulse Response Function: Variation with Banking Sector Concentration

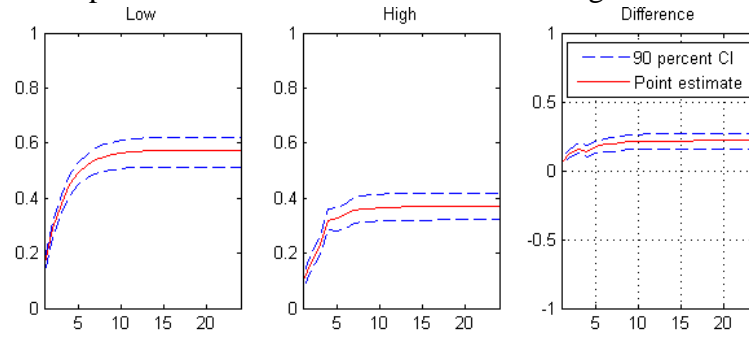


Figure 2.6: Impulse Response Function: Variation with Return on Equity

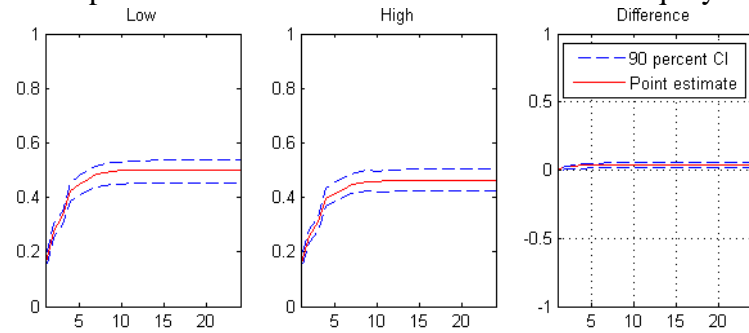


Figure 2.7: Impulse Response Function: Variation with NPL Ratio

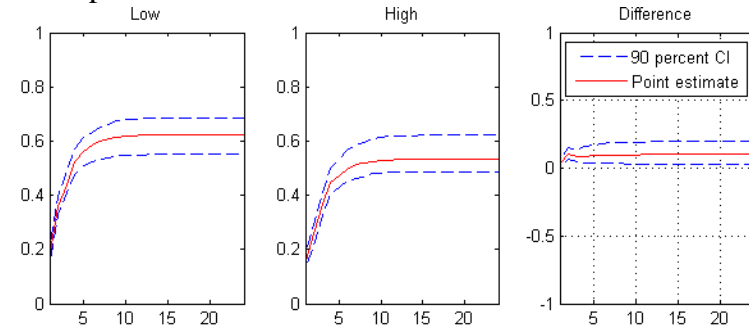


Figure 2.8: Impulse Response Function: Variation with Standard Deviation of NPL Ratio

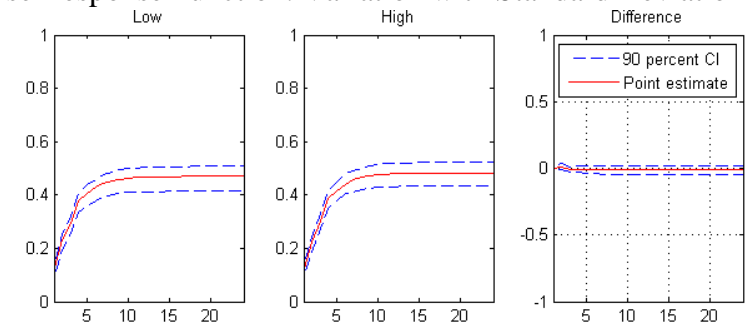


Figure 2.9: Impulse Response Function: Variation with Exchange Rate Flexibility

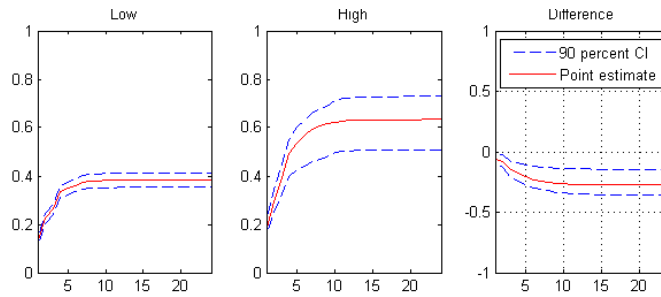
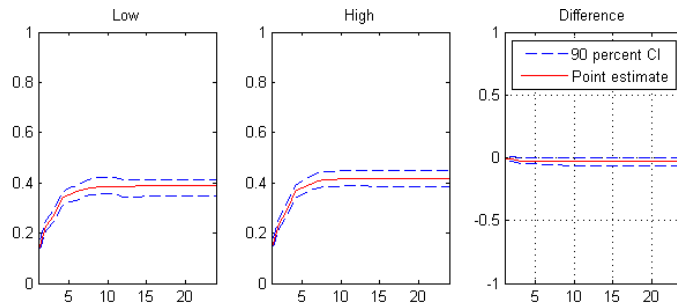


Figure 2.10: Impulse Response Function: Variation with Inflation Rate



* The Figure shows how the cumulative impulse response function of the retail lending rate to a cumulative one percentage point shock to the policy rate varies with different country characteristics which are included, one at a time, in separate specifications. The left sub-chart shows the impulse response function for low values for the respective country characteristic while the middle sub-chart shows the impulse response function for high values. The right sub-chart depicts the difference between the two. The red line is the point estimate while the blue lines are the bootstrapped 90 percent confidence bands. The vertical axis shows the pass-through as a share of the cumulative shock. The horizontal axis shows the months after the shock.

Part 2: Disentangling correlations between determinants

For the second part of the analysis, we proceed to include the most relevant proxies for each of the dimensions of country characteristics jointly in the model in an effort to disentangle possible correlations between the variables that may have affected results in the previous section. We thus estimate equations II.1 and II.2 by including the following regressors jointly in $X_{i,t}$: the Herfindahl measure of bank concentration, the NPL ratio, the regulatory quality index, the inflation rate, the exchange rate regime variable, the loan dollarization variable, the credit to GDP ratio and the liquid reserves to total assets ratio.²³ The impulse response functions are evaluated at the 20th and 80th percentiles of the distributions of each respective country characteristic while holding the other variables constant at their median.

²³ We include all country characteristics tested in the previous section but the standard deviation of NPLs and the return on equity as the NPL ratio itself and the measure of banking sector concentration, respectively, were shown to be better proxies of the respective dimensions.

The joint inclusion of these eight variables implies a significant reduction in the number of observations in the sample and a substantial loss of degrees of freedom. Nevertheless, the results presented in Figure 7 show that confidence bands generally remain reasonably tight, and most variables that had a significant influence on pass-through when included separately continue to have a statistically significant impact in this setup. In particular, the magnitude of the effects of private credit, the liquidity ratio, banking sector concentration and the NPL ratio on pass-through remain broadly unchanged although confidence bands widened somewhat compared to the results in part 1, as expected.

A variable that now has a substantially larger impact than previously is the exchange rate regime indicator. Countries with highly flexible exchange rates tend to have a pass-through of close to 95 percent—if all other determinants are at their respective medians—while pass-through in countries with rather rigid regimes is only about 45 percent. The finding confirms that exchange rate flexibility is highly relevant in the context of interest rate transmission, reflecting the importance of monetary policy independence from exchange rate objectives. Similarly, the impact of inflation on pass-through, previously close to zero, is now sizable, with countries in low inflation environments achieving a pass-through of about 45 percent that is about 10 percentage points below that achieved in high inflation environments.

In the case of the regulatory quality index, it remains the case that high regulatory quality is associated with higher pass-through than low regulatory quality, but the difference is no longer significant. Part of the loss in precision in our estimates is likely due to the dramatic reduction in degrees of freedom when including all variables at the same time. In particular, including eight country characteristics, as opposed to one, in our model implies having to estimate an additional 56 ($=7 \times 4 + 7 \times 3 + 7$) coefficients. It is also worth pointing out that regulatory quality shows similarly sizable effects as in Part 1 in smaller models that omit one or two country characteristics at a time (not reported). In other words, the reason why the two indicators were not significant in the full model may partly be explained by the diminished degrees of freedom.

An important question is how the panel VAR framework results compare to the country-by-country VAR estimates of long-run pass-through we already used in part 1.²⁴ Figure 8 shows that the correlation between the two sets of estimates is relatively high, at about 45 percent.²⁵ Moreover, in a regression of one set of results on the other we cannot, at standard levels of significance reject the hypothesis that the slope is equal to one. In other words, there is no

²⁴ Country-by-country estimates suffer from a small sample bias while the panel approach potentially suffers from a slope heterogeneity bias.

²⁵ We exclude all estimates from the country-by-country estimation that imply a negative pass-through or one above 200 percent.

systematic difference between the two sets of results.²⁶ This suggests that the country characteristics employed in the analysis do a reasonably good job at explaining the variation in country specific pass-through estimates although some measures may be imperfect, and although the specifications do not take all variables into account that might determine pass-through in reality.

Part 3: Decomposing pass-through estimates

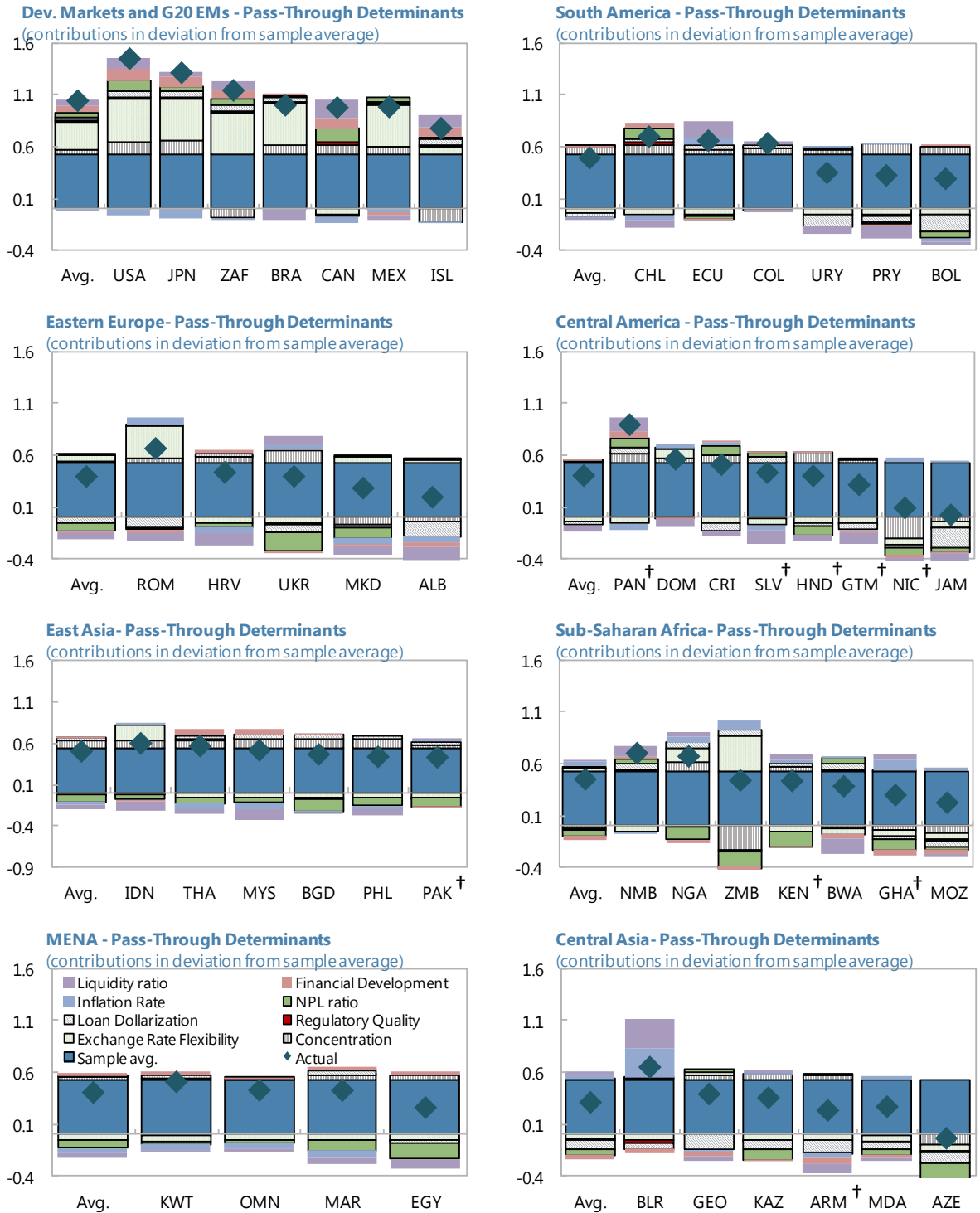
In Part 3 of the analysis, we use the estimation results of the full model with eight country characteristics to decompose pass-through estimates into the contributions of the various country characteristics. The aim of this exercise is to better understand which factors are most important for the heterogeneity of pass-through estimates across countries and regions. We check the robustness of our findings to a variety of specification changes.

We employ a two step procedure to calculate the decomposition based on counter-factual analysis. First, we calculate the average pass-through that results when all country characteristics are held at their respective sample means. Second, for each country i , we calculate how the average pass-through would change if a given country characteristic in $X_{i,t}$ were to change from the sample mean to the value attained in country i . We perform step two for all countries and country characteristics.²⁷ This strategy provides us with the contribution of each country characteristic to the deviation of country i 's pass-through from the average.

²⁶ The sample of countries in Figure 8 is small due to different data limitations affecting the two approaches.

²⁷ Analytical solutions cannot be obtained due to the non-linearity of the model, which precludes disentangling the contribution of single variables in second order terms. For the same reason, the decompositions calculated based on counter-factual analysis are not exact. However, counter-factual analysis provides a very close estimate of the true decomposition based on the model since the second order terms are small and thus play only a limited role for long run pass-through estimates. Hence, while the sum of the contributions in the short run can deviate somewhat from the actual pass-through estimate, in the long-run the difference is marginal.

Figure 3: Pass-Through Decompositions Predicted by the Model with the Full Set of Interaction Terms*



Source: IMF staff calculations

* The Figure depicts decompositions for average pass-through estimates in each country as well as their decomposition into the various country characteristics. The left vertical axis shows the pass-through estimate as a fraction of the cumulative policy rate increase. The dark blue part of each column

is the average pass-through in the country sample employed while the differently colored building blocks depict how the country-specific pass-through estimate deviates from the sample average due to each respective country characteristic.

† Countries that have a † next to the three letter code have information on all interaction terms but not sufficient information on the interest rates and, thus, do not contribute to the estimated coefficients .

In order to facilitate a useful comparison of the results, we group countries into eight regions. This strategy allows us to assess whether pass-through decompositions have similarities at the regional level. The groupings are; (i) East Asia; (ii) Central Asia; (iii) Sub-Saharan Africa; (iv) Middle East and Northern Africa (MENA); (v) South America; (vi) Central America; (vii) Eastern Europe; and (viii) Developed Markets and G20 Economies. Six main conclusions can be derived from the findings presented in Figure 4:

- First, we find that developed markets and G20 economies have the highest average pass-through of about 100 percent. The runner-ups are South American countries and East Asia (both 50 percent), followed by Eastern Europe, Central America, MENA, Sub-Saharan Africa (around 40 percent), and Central Asia (30 percent). The average pass-through in the sample is 52 percent.²⁸ The main reason why developed countries and G20 economies have a higher average pass-through is that their exchange rate regimes tend to be more flexible. Other reasons are their low liquidity and NPL ratios and their high level of financial development.
- Second, while there is heterogeneity of pass-through estimates within regional groupings, including particularly among developed countries and G20 emerging market economies, the heterogeneity within groups, especially in East Asia and MENA, is limited compared to the variation we observe across country groups.
- Third, the similarity in pass-through estimates within groupings is not necessarily due to similar combinations of country characteristics. For instance, Ghana and Mozambique have roughly the same pass-through estimate but Ghana's value is largely due to the high level of NPLs, while Mozambique's pass-through is lower than average mainly due to high levels of dollarization and concentration in its banking sector.
- Fourth, in Eastern European, East Asian and MENA economies, high liquidity and NPL ratios are typically the dominant drags on pass-through. Additional factors that notably weaken the transmission mechanism are loan dollarization in Eastern Europe

²⁸ The average pass-through calculated here differs from part one of this section because data availability reduces the number of observations used when all country characteristics are included in the model at the same time.

and rigid exchange rate regimes in MENA. In East Asia, relatively diversified banking sectors are important mitigating factors.

- Fifth, in South America, Central Asia, and Central America, loan dollarization and exchange rate rigidity are important factor accounting for lower pass-through. However the most important drag on the transmission mechanism in Central America is high liquidity ratios. While banking sector diversification boosts pass-through in South America, this is not the case for Central America.
- Sixth, pass-through in Sub-Saharan African economies is often low because of high NPLs in banking sectors and low levels of financial development. Relatively low liquidity ratios are a mitigating factor in some cases.

In order to understand how robust these findings are, Figure 9 shows how the baseline estimates of average pass-throughs by region change with relevant changes in our specification. More precisely, first, we extend the number of lags to 6 in order to test whether the lag length chosen in our baseline specification matters for our results. Second, we drop all countries that have a hard exchange rate peg in place. We do so because these countries should, by definition, not be able to conduct an independent monetary policy. Since the exchange rate matters so much as a determinant of pass-through in our results, it appears relevant to determine whether our results change as a result of this.²⁹ Third, we drop all observations following the onset of the global crisis, as dated to September 2008, to test whether we can identify a structural break in the effect of any of our country characteristics on pass-through. Fourth, we include inflation as an additional endogenous variable in the model in order to test whether the change in identification of the monetary shock has an impact on the results.³⁰ Fifth, we use the money market rate in place of the policy rate in our model for two reasons: (i) to test whether the factors that limit transmission do so mainly at the stage of pass-through from money market to retail lending rates and (ii) to account for the fact that some countries implement their monetary policy stance by limiting or increasing quantities in open market operations rather than changing the policy rate.

Figure 9 shows that the first two robustness tests have no major implications for the results, indicating that changing the lag length or dropping out countries with hard pegs does not impact our findings in a significant way. When excluding post-crisis observations from the sample, the dollarization variable becomes somewhat less important as a determinant of pass-through. When adding the inflation rate to the model or using the money market rate in place

²⁹ Thus the exchange rate regime ranges now from ‘de facto peg’ to ‘moving band’ for pegs and ‘managed floats’ and ‘freely floating’ regimes for floats. We hence exclude countries with no separate legal tenders or any pre-announced peg or band from the analysis (categories 1-3 of Reinhart and Rogoff, 2004).

³⁰ The Choleski ordering we employ for this purpose is the same as in Figure 5.

of the policy rate, the only noteworthy change in the results is that regulatory quality gains a more prominent role in conditioning pass-through estimates. First and foremost, this suggests that most of the determinants of interest pass-through we identify mainly exert an impact on the transmission from interbank to retail lending rates rather than from policy rates to interbank rates. A surprising finding is that, in the model that uses the money market rate, the sign of the effect of financial development on pass-through appears to be reversed. A lower relevance of financial development is well in line with our expectations since the depth of the financial system is particularly relevant for a close link between the policy rate and the money market rate. However, a reversal in the sign is not intuitive and may reflect a correlation with omitted variables that limit pass-through from money market to lending rates.³¹ Overall, our results appear robust to a variety of significant specification changes.

Part 4: Decomposing the average pass-through over time

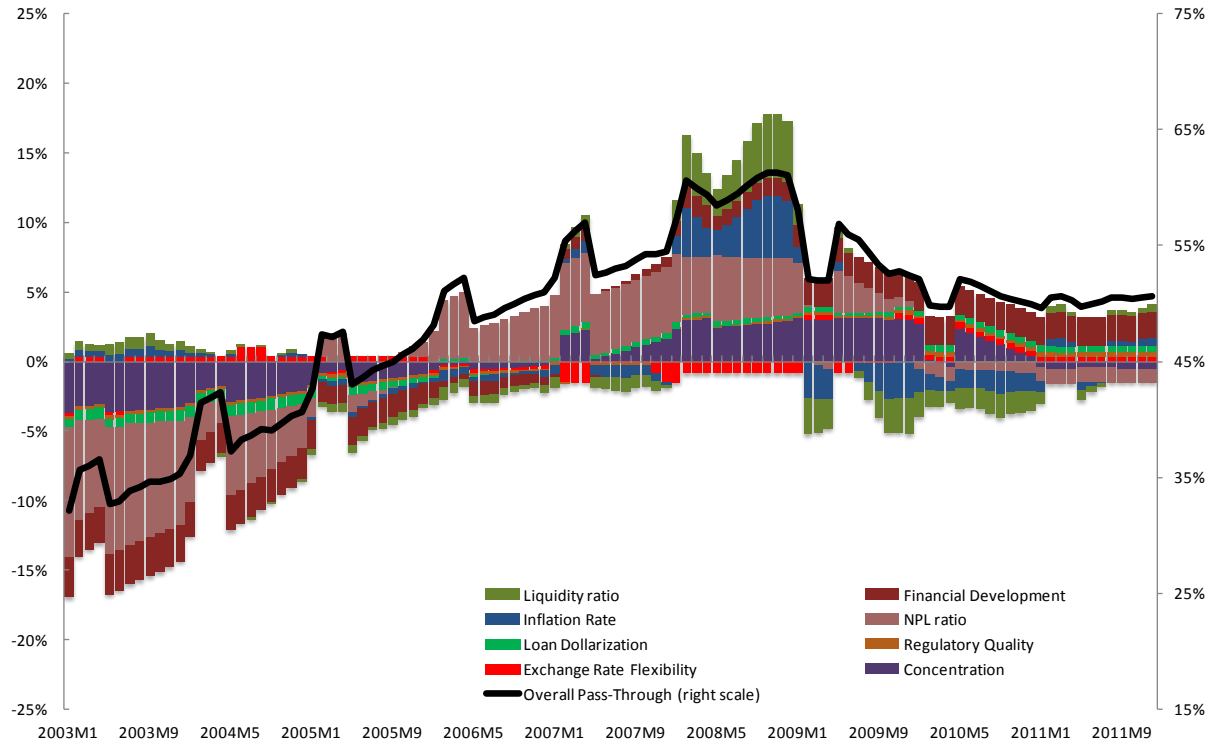
As a final empirical exercise, we analyze how and why pass-through has changed over time in our country sample as a whole. We decompose the sample average pass-through estimate into its determinants based on the estimated coefficients from the model with all interaction terms. The decomposition is performed in much the same way as in the previous part except that, instead of decomposing country-specific pass-through estimates into the contributions of time-invariant country characteristics, we now focus on the average pass-through across countries but allow it to vary over time along with the contributions of the country characteristics.

Figure 4 illustrates that growing and well performing loan portfolios in the banking sector were important factors that boosted pass-through in the run-up to the global crisis, reflecting positive risk sentiment in financial markets during the boom. With tight liquidity ratios and rapidly expanding loan portfolios, NPL ratios fell largely due to increases in the denominator while masking the actual quality of loan portfolios. Greater competition in the banking sector and higher inflation also contributed to more effective transmission during this period.

When the crisis hit, deteriorating risk sentiment and the resulting deleveraging of major banks—as reflected in increasing liquidity ratios—lead to a decline in the average pass-through. The deteriorating loan portfolios in banking sectors around the globe, and in particular in more developed countries, became an additional drag on the transmission mechanisms as the crisis went on. Interestingly, while exchange rate flexibility, and financial dollarization represent important determinants of cross-country variation in pass-through estimates, they contributed only modestly to the average change in pass-through over time.

³¹ A closer analysis of the differential effect of the various determinants on the transmission from policy to money market and then from money market to lending rates is an interesting extension which however is beyond the scope of this paper.

Figure 4: Average Pass-Through Over Time Predicted by the Model with the Full Set of Interaction Terms*



Sources: Authors' calculations

* The Figure depicts the average pass-through estimate in the sample over time as predicted by the PVAR model. The right vertical axis shows the average pass-through. The differently colored blocks of the respective columns show the contribution of each country characteristic to the deviation from the average at each point in time. The respective contribution is measured on the left vertical axis.

IV. CONCLUSION

Developing and emerging market economies have increasingly relied on interest rates as their primary policy variable, often as part of increasingly transparent and rules-based monetary policy frameworks that employ commercial bank reserves or money market interest rates as intermediate policy targets. The functioning of the monetary transmission mechanism in these economies is rooted in the predictability and credibility of central bank operations which, in turn, are conditional upon the effectiveness of the various channels of transmission. Identifying the determinants of effective interest rate transmission—an important channel of the monetary transmission mechanism—is thus important not only to quantify the expected impact of policy rates on market rates but also to gauge the gains, in terms of a more effective monetary policy, from addressing potential structural weaknesses.

This paper identifies determinants of the effectiveness of interest rate transmission using a panel VAR framework with interaction terms that allows the relationships between the endogenous variables in the VAR to vary with potential determinants of the effectiveness of transmission. We identify a range of country characteristics that have important effects on the effectiveness of interest rate transmission, including indicators of regulatory quality, inflation, financial development and dollarization, exchange rate flexibility, as well as banking sector competition, asset quality and liquidity.

Using the estimated panel VAR model to derive and decompose country-specific pass-throughs, we find that in more developed countries a policy rate change translates almost one for one into changes in retail lending rates. In contrast, pass-through is much lower in developing countries among which Central Asian achieves the lowest pass-through of around 30 percent. The main factor that accounts for the higher pass-throughs in more developed economies is the flexibility of their exchange rate regimes. Additional distinguishing factors are lower liquidity ratios, better asset quality and more developed financial systems. Decomposing the evolution of the average pass-through estimate in our country sample over time, we find that it increased from about 30 percent in 2003 to close to 60 percent in 2008, largely as a result of increasingly competitive banking sectors, rising inflation and low liquidity and non-performing loan ratios resulting from positive risk sentiment. The crisis reversed this trend as inflation dropped, liquidity ratios recovered and non-performing loans proliferated.

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Appendix

Table 1: Variable Definitions and Sources

Variable	Frequency	Source
Policy interest rate	Monthly	Discount rate/bank rate in International Financial Statistics
Retail lending rate	Monthly	Lending rate in International Financial Statistics
Interbank rate	Monthly	Money market rate in International Financial Statistics
CPI inflation	Monthly	International Financial Statistics
Industrial Production	Monthly	International Financial Statistics
Loan dollarization (percent total total loans)	Monthly	International Financial Statistics
Exchange rate flexibility	Monthly	Reinhart and Rogoff (2004) and updates
Regulatory quality	Annual	World Bank Governance Indicators
Private credit to GDP	Annual	World Development Indicators
Liquid reserves to total assets	Annual	World Development Indicators
Non-performing loans (percent total loans)	Annual	World Development Indicators
Banking sector concentration (Herfindahl)	Annual	Bank Scope

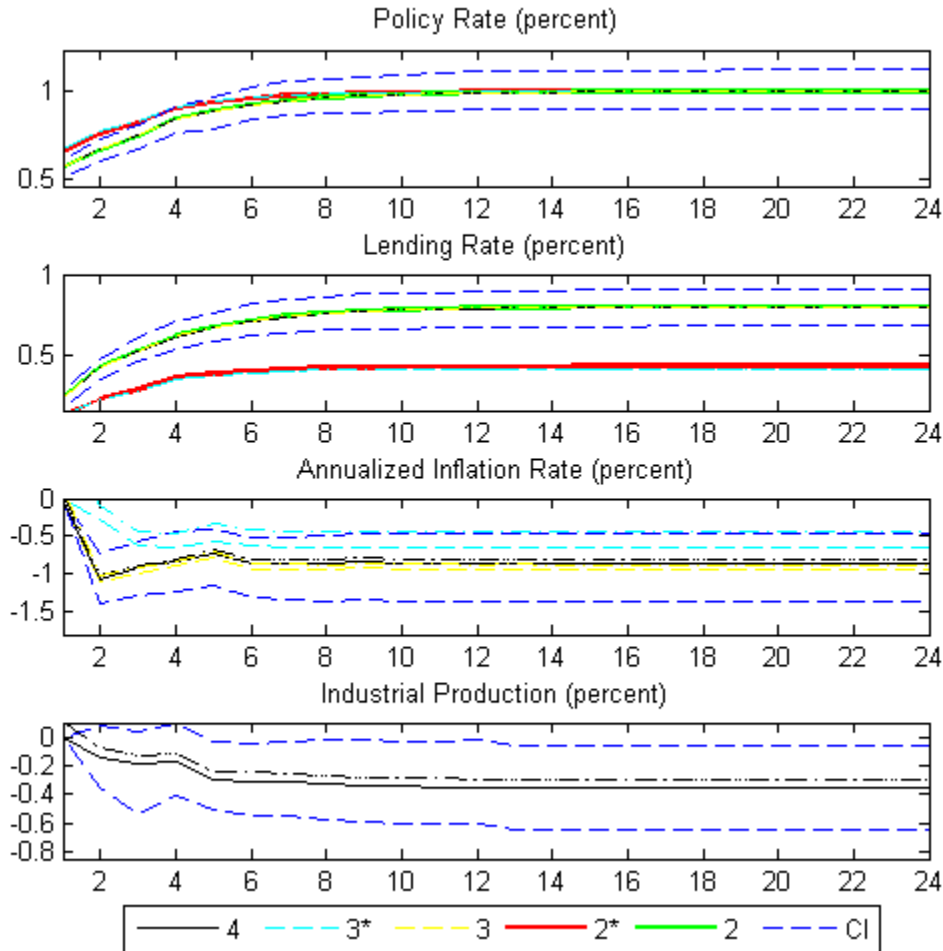
Table 2: Country Sample³²

Albania (ALB), Algeria (DZA[†]), Angola (AGO[†]), Armenia (ARM*), Aruba ([†]), Australia (AUS[†]), Azerbaijan (AZE), Bahamas (BHS[†]), Bahrain (BHR[†]), Bangladesh (BGD), Barbados (BRB[†]), Belarus (BLR), Belize (BLZ[†]), Bolivia (BOL), Botswana (BWA), Brazil (BRA), Bulgaria (BGR[†]), Burundi (BDI[†]), Canada (CAN), Cape Verde (CPV[†]), Chile (CHL), China (CHN[†]), Colombia (COL), Comoros (COM[†]), Dem Rep of Congo (COD[†]), Costa Rica (CRI), Croatia (HRV), Cyprus (CYP[†]), Czech Republic (CZE[†]), Dominican Republic (DOM*), Ecuador (ECU), Egypt (EGY), El Salvador (SLV*), Fiji (FJI[†]), The Gambia (GMB[†]), Georgia (GEO), Ghana (GHA*), Guatemala (GTM*), Guinea (GIN[†]), Guyana (GUY[†]), Honduras (HND*), Hungary (HUN[†]), Iceland (ISL), India (IND[†]), Indonesia (IDN), Iran (IRN[†]), Iraq (IRQ[†]), Israel (ISR[†]), Jamaica (JAM*), Japan (JPN), Jordan (JOR[†]), Kenya (KEN*), Korea (KOR[†]), Kuwait (KWT), Lao (LAO[†]), Latvia (LVA[†]), Lebanon (LBN[†]), Lesotho (LSO[†]), Libya (LBY[†]), Lithuania (LTU[†]), Macedonia (MKD), Madagascar (MDG[†]), Malawi (MWI[†]), Malaysia (MYS), Maldives (MDV[†]), Malta (MLT[†]), Mauritania (MRT[†]), Mexico (MEX), Moldova (MDA), Mongolia (MNG[†]), Morocco (MAR), Mozambique (MOZ), Myanmar (MMR[†]), Namibia (NMB), Nepal (NPL[†]), Netherlands Antilles (ANT[†]), New Zealand (NZL[†]), Nicaragua (NIC*), Nigeria (NGA), Norway (NOR[†]), Oman (OMN), Pakistan (PAK*), Panama (PAN*), Papua New Guinea (PNG[†]), Paraguay (PRY), Peru (PER[†]), Philippines (PHL), Poland (POL[†]), Qatar (QAT[†]), Romania (ROM), Russia (RUS[†]), Rwanda (RWA[†]), Sao Tome and Principe (STP[†]), Serbia (SRB[†]), Seychelles

³² Countries with a [†] after the three letter code in brackets are part of the baseline estimation without interaction terms but lack sufficient information on all country characteristics to be in the model with all interaction terms. Countries that have a * next to the three letter code have information on all country characteristics but do not sufficient information on the interest rate variables and are thus not part of any estimation. We do, however, compute decompositions for these countries based on the estimated coefficients.

(SYC[†]), Singapore (SGP[†]), Slovak Republic (SVK[†]), Slovenia (SVN[†]), South Africa (ZAF), Sri Lanka (LKA[†]), Swaziland (SWZ[†]), Sweden (SWE[†]), Switzerland (CHE[†]), Syria (SYR[†]), Tanzania (TZA[†]), Thailand (THA), Trinidad and Tobago (TTO[†]), Uganda (UGA[†]), Ukraine (UKR), United Kingdom (GBR[†]), United States (USA), Uruguay (URY), Vanuatu (VUT[†]), Venezuela (VEN[†]), Vietnam (VNM[†]), Yemen (YEM[†]), Zambia (ZMB), Zimbabwe (ZWE[†])

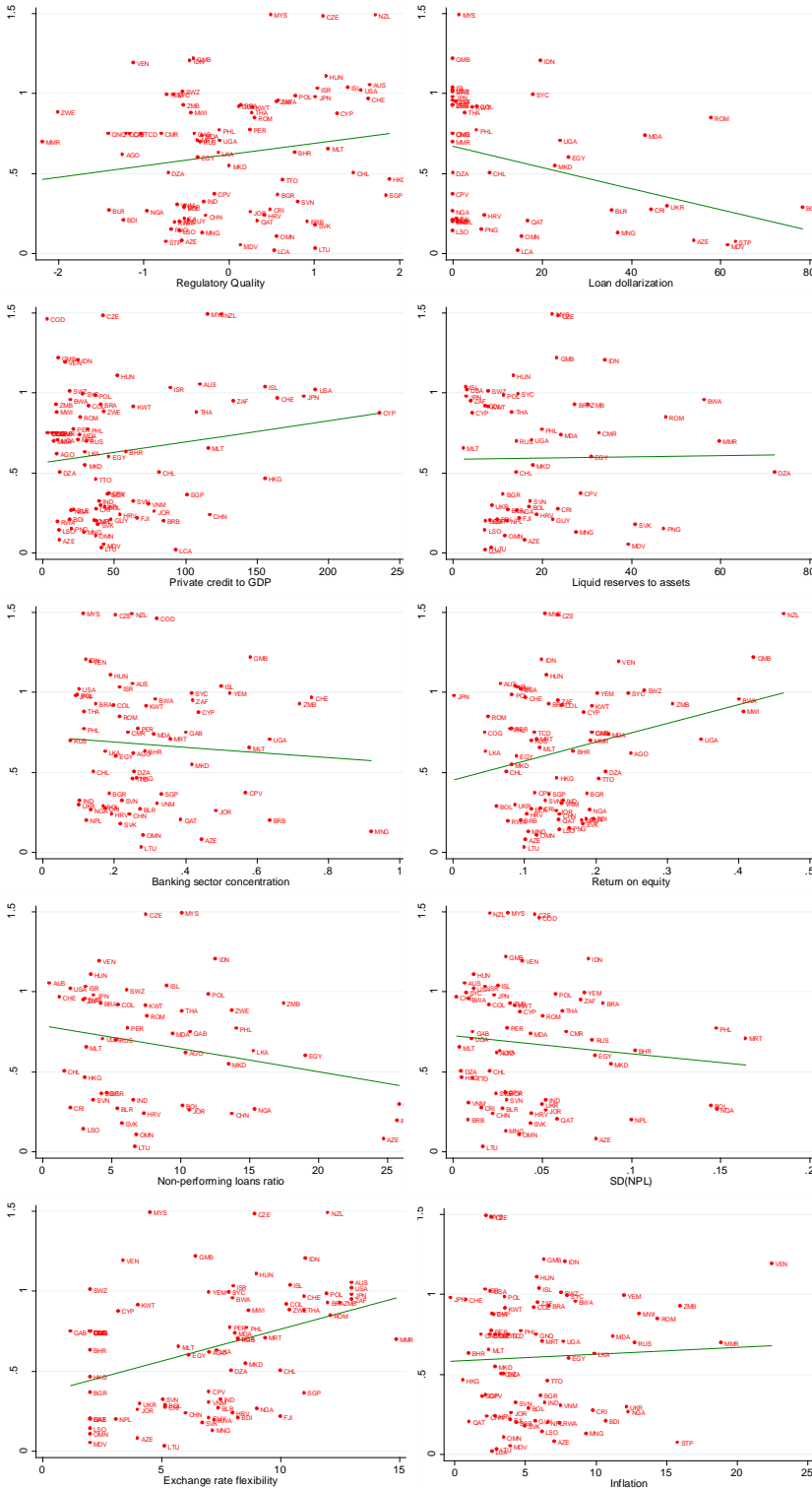
Figure 5: Average Impulse Response to Policy Rate Shock in Different Model Specifications



* The Figure shows how the impulse response functions of the retail lending rate, inflation, industrial production and the policy rate to a permanent one percentage point shock to the policy rate vary with specification changes. The horizontal axis shows the period after the shock. The vertical axis shows the response of the respective variable to the policy rate shock. The blue lines are the bootstrapped 90 percent confidence bands for the full model 4 which includes policy and retail lending rates as well as industrial production and inflation. The black solid line corresponds to the impulse response under this model when the ordering is given by inflation, industrial production, policy rate, and, lastly, the lending rate. Three alternative orderings are shown (black dashed, dotted, and dash-dot line). Notable differences in the impulse response functions are, however, only visible in the case of industrial production, while the impulse response functions in all other cases are identical and no separate line is detectable. The yellow 3 and light blue 3* lines correspond to models that include the two interest rates and the inflation rate only. The difference between models 3 and 3* is

that the former is estimated on the same sample as the full model 4 while the latter includes all observations (i.e. also those for which IP is not available). Once again, we employ different orderings which only seem to matter for the inflation response but not the retail lending rate response. Model 3 shows an interest rate pass through estimate that is almost identical to the one under the full model 4. Hence dropping IP affects the interest rate pass-through estimate due to the change in the sample (moving from model 3 to 3* but not because one includes additional variables and the other does not. Finally, the green 2 and red 2* line reflect the model that includes the policy and lending rate only. As before, model 2 which restricts the sample to include only those observations that were also used in the full model 4 implies a nearly identical interest rate pass-through estimate. Model 2* instead implies an interest rate pass-through estimate in line with the estimate from model 3*.

Figure 6: Scatter Plots of Country Characteristics vs Pass-Through Estimates in Country-Specific VARs



* The Figure plots pass-through estimates for each country based on country-specific two-variable VARs against country characteristics. The vertical axis shows the pass-through estimate while the horizontal shows the

respective country characteristics. Countries with pass-through estimates above 1.5 or below zero are excluded, as are those with large outliers on the country characteristics.

Figure 7: Cumulative conditional Impulse Response Functions Using the Full Model

Figure 7.1: Impulse Response Function: Variation with Regulatory Quality

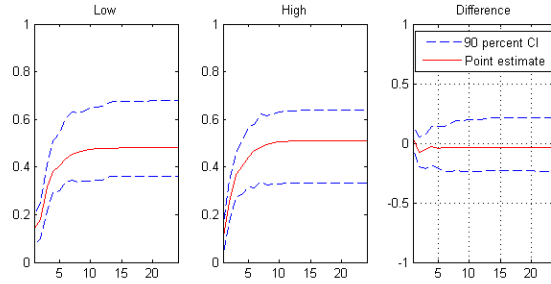


Figure 7.2: Impulse Response Function: Variation with Loan Dollarization

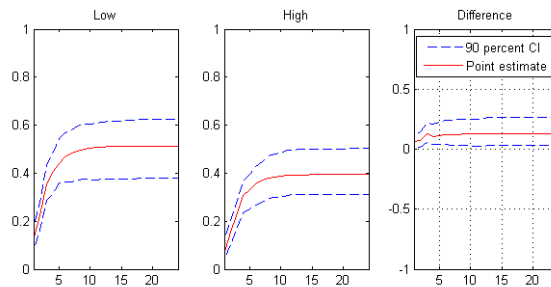


Figure 7.3: Impulse Response Function: Variation with Private Credit to GDP Ratio

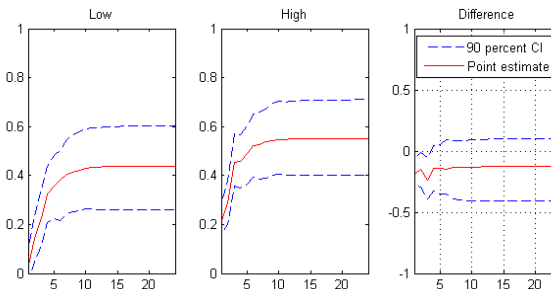


Figure 7.4: Impulse Response Function: Variation with Ratio of Liquid Reserves to Assets

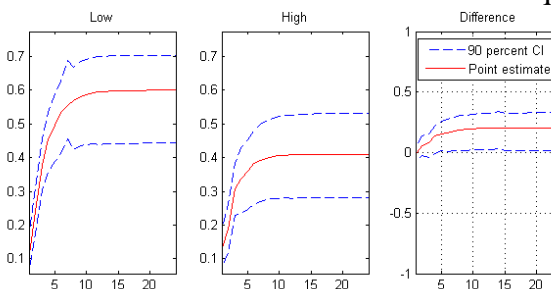


Figure 7.5: Impulse Response Function: Variation with Banking Sector Concentration

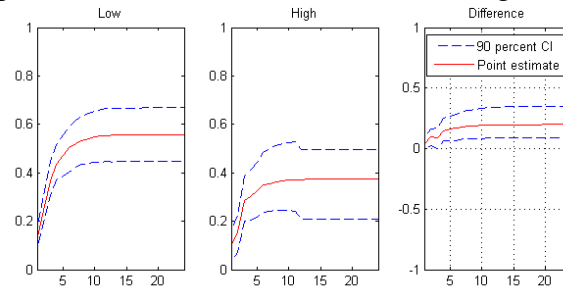


Figure 7.6: Impulse Response Function: Variation with NPL Ratio

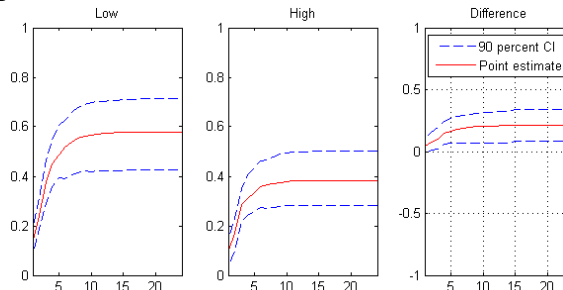


Figure 7.7: Impulse Response Function: Variation with Exchange Rate Flexibility

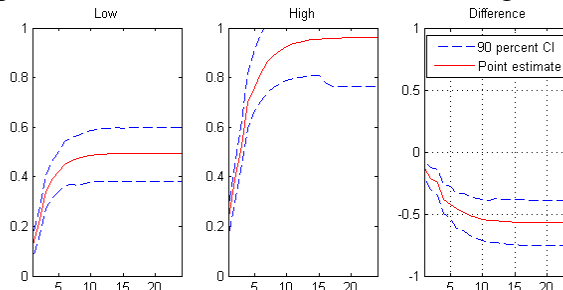
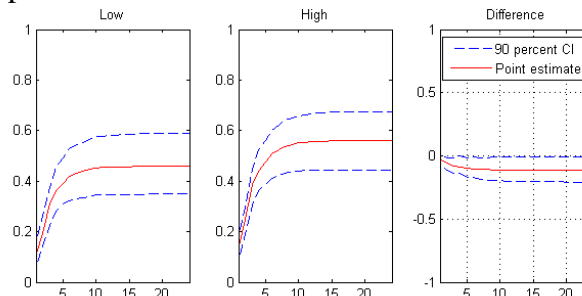
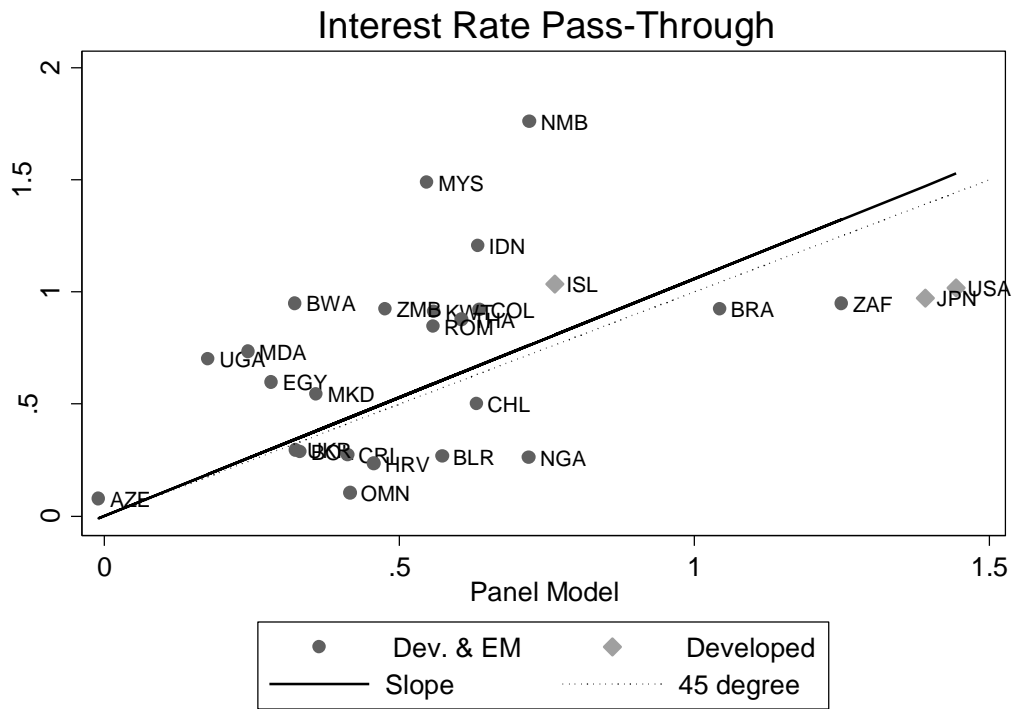


Figure 7.8: Impulse Response Function: Variation with Inflation Rate



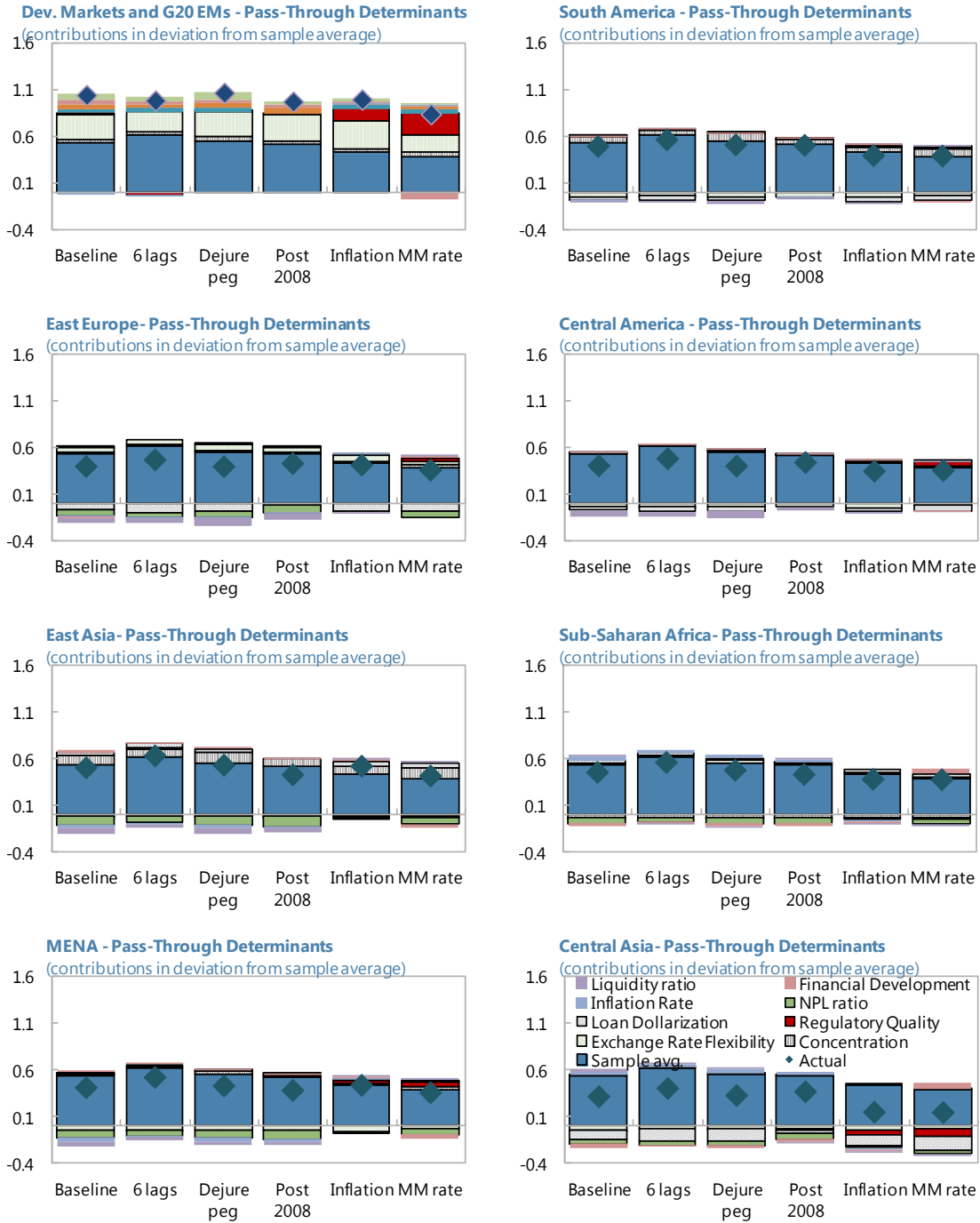
* The Figure shows how the impulse response function of the retail lending rate to a one percentage point shock to the policy rate varies with different country characteristics in the full model which incorporates all relevant country characteristics and the respective interaction terms at the same time. The left sub-chart shows the impulse response function for low values on the respective country characteristic while the middle sub-chart shows the impulse response function for a high value. The right sub-chart depicts the difference between the two. The red line is the point estimate while the blue lines are the bootstrapped 90 percent confidence bands. The vertical axis shows the pass-through as a share of the cumulative shock. The horizontal axis shows the period after the shock.

Figure 8: Pass-Through Estimates Predicted by PVAR vs. Estimates Based on Country-Specific VARs*



* The Figure shows a scatter plot of pass-through estimates predicted by the PVAR model with all country characteristics and interaction terms vs. pass-through estimates based on simple country-specific VARs. The former are on the horizontal axis while the latter are on the vertical axis.

Figure 9: Robustness: Pass-Through Decompositions Predicted by the Baseline Model Compared with Different Specifications*



Source: IMF staff calculations

* The Figure depicts decompositions for average pass-through estimates in each region as well as their decomposition into the various country characteristics. The left vertical axis shows the average pass-through in percent. The different columns in each sub-chart reflect different PVAR model specifications: *6 lags* is the baseline model estimated with 6 lags; *De jure peg* is the baseline specification estimated on the sample which excludes countries with hard pegs; *Post 2008* is the baseline specification estimated on a sample excluding all

observations after September 2008; *Inflation* is the baseline specification with inflation as an additional endogenous variables; *MM rate* is the baseline specification in which the policy rate is replaced by the money market rate. The dark blue part of each column is the average pass-through in the country sample employed in the respective models while the differently colored blocks depict how the pass-through estimate deviates from the sample average due to each respective country characteristic in the model.