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Remittance Inflows and State-Dependent Monetary Policy Transmission in Developing Countries

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Abstract

Remittance inflows from overseas workers are an important source of foreign funding for developing and emerging economies. The literature is inconclusive about the cyclical nature of remittance inflows. To the extent remittances are procyclical they pose a challenge to monetary policy: a tightening of policy will be less effective if at the same time remittances increase strongly. The same is true for a policy easing under exceptionally weak remittance inflows. This paper estimates a series of nonlinear (smooth-transition) local projections to study the effectiveness of monetary policy under different remittance inflows regimes. The model is able to provide state-dependent impulse response functions. We show that for Kenya, Mexico, Colombia and the Philippines monetary policy indeed has a smaller domestic effect under strong inflows of remittances. These results have important implications for the design of inflation targeting in developing countries.

Keywords: Remittance inflows, monetary policy, inflation targeting, smooth-transition model, local projections

JEL classification: E52, E32, O16

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1 Introduction

Inflows of worker remittances are one of the most important sources of external funding for developing and emerging countries. Remittances have a wide array of effects on the recipient economy. They tend to contribute to financial development, affect business cycles and growth, and could lead to a Dutch Disease phenomenon, among other macroeconomic and microeconomic consequences.[1] In addition, remittance flows are less volatile than other forms of private capital inflows.

To the extent remittances impact income, prices of goods and services, asset prices and the financial system, they also interact, and potentially interfere, with monetary policy. This is particularly true if remittance flows are procyclical with regard to the home economy. The literature on the cyclical properties of inflows is inconclusive: while some papers stress the countercyclical nature of remittances, see Frankel (2011) and Buch and Kuckulenz (2010), others provide evidence for a procyclical behavior, see Lueth and Ruiz-Arranz (2007), or present mixed evidence, see Sayan (2006).[2]

It seems plausible that the cyclical properties are not constant over time. During extraordinary economic stress such as sovereign defaults, severe recessions or natural disasters remittances will serve as an automatic stabilizer and, as a result, are countercyclical.[3] However, to the extent local GDP correlates positively with GDP in the U.S. or in other advanced economies, both remittance outflows from host countries and inflows to home countries are procyclical. Remittances not only respond to business cycles, but also promote a change in the cyclical patterns in developing countries. Barajas et al. (2012) find that remittances contribute to business cycle synchronization between host and home countries, in particular of economic downturns.

Procyclical inflows are particularly relevant for monetary policy: suppose a central bank in a developing country pursues an inflation target and adjusts the short-term interest rate in a way to achieve the target inflation rate. If the economy overheats, that is, if growth is high and inflation is above target, the central bank will raise its policy rate. If this economy at the same time experiences inflows of remittances, that is if remittance inflows are procyclical, the contractionary effect of tighter monetary policy could be dampened and even overturned. Likewise, if the economy is depressed and the central bank lowers the interest rate in order to stimulate activity, a sudden drop in remittance inflows can neutralize this expansionary policy move. Taken together, large swings in remittances can impact the effectiveness of monetary

[1] See Chami et al. (2008) for a useful survey of the evidence.

[2] This literature is further discussed in the next section.

[3] Machasio (2016) studies the stabilizing role of remittance inflows after sovereign defaults.

policy and the strength of monetary policy transmission, respectively. Based on the policy-experience in the Philippines, Bayangos (2012, p. 386) notes

> "...the increase in remittances will make monetary policy less effective. ... the increase in remittance inflows leads to an increase in liquidity in the financial markets and to a downward pressure on the interest rate, leading to the possibility that and monetary policy action will have to be strong to counter these impacts."

This loss in effectiveness of monetary policy under procyclical remittance inflows, which has not yet been formally investigated, is studied in this paper. To analyze this research question, we estimate a series of nonlinear empirical models in order to obtain impulse response functions. These functions show the response of important macroeconomic variables to a change in the short-term interest rate. Importantly, we differentiate between a state with strong remittance inflows and one with weak inflows. We show that the impulse response functions differ significantly across both states.

The impulse response functions are derived from local-projections following Jordà (2005). One of the major advantages of local-projections over competing models, among them vector autoregressions, is that they can easily accomodate state-dependent coefficients and, hence, state-dependent impulse-response functions, even for relatively small sample sizes. We estimate two versions of the state-dependent model: in the first the states are separated by appropriately defined dummy variables which reflect whether remittances growth is above the median growth rate or not. In the extension, our second model, we allow for a smooth transition between states driven by the growth rate of remittances.[4] This is a generalization of the first model since we do not impose an abrupt switch from one state to the other.

The models are estimated for four countries (Kenya, Mexico, Colombia and the Philippines), all of which receive large and volatile inflows of remittances as important sources of foreign financing. Although there are countries for which remittances play an even more important role, i.e. Armenia or El Salvador, these countries typically lack the macroeconomic data we need for this study.

We show that indeed the effect of monetary policy on inflation and output is different under strong remittance inflows. In particular, a monetary policy tightening has significantly smaller effects on inflation and output in a state with high remittance inflows. Likewise, a restrictive monetary policy shock leads to a larger appreciation

[4] Smooth transition local projection models have recently been applied by Tenreyro and Thwaites (2016) and others to study whether the effects of monetary policy shocks depend on the state of the business cycle.

of the currency if, at the same time, remittances pour into the economy. The same shock leads to a smaller increase in long-term bond yields under strong inflows of workers' remittances. Hence, we find that the transmission of monetary policy is muted under exceptionally strong inflows.

A set of counterfactuals is constructed in order to exclude alternative explanations of our findings. We show that the results are not due to the U.S. business cycle, which drives remittances and affects the cycle in small open economies. Likewise, we exclude an explanation based on the domestic business cycle. The results are different from a model in which the effects of monetary policy are allowed to differ between periods with growth rates being above or below the median.

The two papers closest to this study are Mandelman (2013) and Barajas et al. (2016). The first author presents a general equilibrium model with a large variety of frictions, among them credit constrained households. Based on Philippine data he shows that remittance flows smooth the consumption path of credit constrained households. He shows that a flexible exchange rate regime is preferable. While he outlines the normative consequences of remittances for the design of policy regimes, he does not directly address our empirical question. The second paper, Barajas et al (2016), uses a reduced-form model to show that remittances lead to a decoupling of monetary policy rates and credit conditions and this affect the transmission of monetary policy.

The remainder of this paper is organized as follows. Section two links our research to major strands of the literature. Section three introduces linear and nonlinear local projections. The data used in this study is explained in section four. The results and a couple of robustness checks are discussed in section five. Section six generalizes the model to a smooth-transition model and section seven draws policy conclusions from our results.

2 Related literature

There are various strands of the literature which explore the relationship between remittances and domestic macroeconomic variables. Our paper is particularly related to three of these branches.

First, as mentioned in the introduction, a number of papers evaluate the effect of remittances on business cycles. The evidence as regards the cyclical properties of remittance inflows is mixed. Econometric results obtained by Frankel (2011) show that remittances are countercyclical with respect to the income in workers' country of origin and procyclical with respect to income earned in the host country. According

to these results, remittances constitute a particularly valuable component of balance of payments in domestic downturns or when international investors flee the country. Similarly, Buch and Kuckulenz (2010) support the notion of the countercyclical nature of remittance inflows.

This conclusion, however, is not generally shared in the literature. On the flip side, Lueth and Ruiz-Arranz (2007) report the correlation between detrended global remittances and detrended GDP and find that remittances are procyclical, albeit to a lesser extent than exports, official aid and portfolio investment. Supporting mixed evidence, Sayan (2006) studies 12 developing and emerging countries and does not find general countercyclicality of remittance flows. Ruiz and Vargas-Silva (2010) show that the cyclical properties of remittance inflows change over time. Based on data from Mexico they conclude that there is no general cyclical pattern of remittance inflows. Model-based evidence provided by Durdu and Sayan (2010) is also inconclusive as the relative size of opposite effects on the cyclical nature is unclear.

A second, very small strand of the literature studies the relationship between remittances and monetary policy. According to model proposed by Vacaflores (2012), higher levels of remittances alter the effectiveness of monetary policy. The typical monetary injection leads to a decline in the nominal interest rate that raises investment but because it generates a wealth effect that initially reduces work effort, it creates an initial drop in output before experiencing the typical hump-shaped improvement. Higher levels of remittances accentuate the liquidity effect arising from the monetary shock, increasing investment and capital, but also enable the household to increase its leisure time. This negative effect on labor is large enough to depress output over time. Using data for the Philippines, Mandelman (2013) develops and estimates a heterogeneous agent model to analyze the role of monetary policy in a small open economy subject to sizable remittance fluctuations. His findings reveal that in a purely deterministic framework, a fixed exchange rate regime avoids a rapid real appreciation and performs better for recipient households facing an increasing trend for remittances. A flexible floating regime is therefore preferred in the Philippine case when unanticipated shocks driving the business cycle are considered. Bayangos (2012) is the only paper that touches explicitly on the effectiveness of monetary policy. The author provides simulation results for the Philippines suggesting that the monetary policy pass-through tends to moderate once the impact of large remittance flows is taken into account.

The third strand addresses monetary policy in developing economies in general. In evaluating monetary policy in remittance dependent economies, remittance inflows

have been identified as interest-insensitive private transfers across international borders and that they expand balance sheets in the recipient countries directly.
However, given the challenging institutional, informational and high risk environment prevailing in these countries, banks prefer to invest the additional funds in safe and liquid assets, including lending to government. As a result, liquidity in banks becomes ample and their marginal cost of loanable funds becomes delinked from movements in the policy rate, thereby weakening a major channel through which changes in the policy rate are transmitted to the lending rate and lending behavior by banks (Barajas et al, 2016). According to Mbutor (2010) while evaluating the role of monetary policy in enhancing remittances for economic growth in Nigeria, he posits that developing countries mostly require full package for growth enhancement because fiscal and monetary policies are inextricable except in terms of instruments and implementing authorities. Nevertheless, monetary policy appears more potent in correcting short term macroeconomic maladjustments because of the frequency in applying and altering the policy tools, relative ease of its decision process and the sheer nature of the financial system.

3 Local projections

In this paper we derive impulse response functions from local projections as suggested by Jordà (2005). Rather than estimating a full dynamic model for several endogenous variables such as a vector autoregressive (VAR) model, our method rests on a single equation model. The interpretation of an impulse response function in terms of the response of a forecast of a variable h periods ahead to a shock in t is identical in both modelling approaches. We will introduce the linear local projection first followed by the nonlinear model, which is our main tool in this paper.

3.1 Linear model

We start with a series of regressions of a dependent variable dated $t+h$ on a driving variable dated t as well as a set of control variables. Our estimated model is the following

$$y_{t+h} = \alpha_h + \beta_h R_t + \gamma_h' \sum_{s=1}^{q} \mathbf{x}_{t-s} + \delta_h' \sum_{s=1}^{q} \mathbf{z}_{t-s} + \varepsilon_{t+h}, \tag{1}$$

where y_t is the dependent variable, $\mathbf{x}_t$ is a vector of domestic variables that potentially drive y_t and $\mathbf{z}_t$ is a vector of foreign variables. We include up to q lags of domestic and foreign control variables. The measure of monetary policy, which in

our case is the short term interest rate, is denoted by R_t. Hence, the coefficient β_h measures the impact of a change in policy at t on the dependent variable h periods ahead. Plotting β_h as a function of h results in an impulse response function.

The model is estimated for Kenya, Mexico, Colombia and the Philippines. These countries have been chosen because they are known to be strongly affected by remittance inflows from abroad. We use four alternative dependent variables: the log of real GDP, the log of the CPI, the log of the exchange rate against the U.S. dollar and the yield on long-term government bonds. These variables are assumed to characterize the transmission process of monetary policy.

The domestic control variables are real GDP, CPI, and the exchange rate. All models other than the model for bond yields include the log of U.S. real GDP, the log of global food prices and the log of remittance inflows as a foreign control variable. All three foreign control variables reflect the high dependency of developing and emerging countries on the global business cycle as well as the importance of global food prices for domestic inflation. We include only one lag of the control variables, that is, we set $q = 1$.[5] Due to the fact that the dependent variable is h periods ahead, the error terms will exhibit serial correlation. We therefore apply a Newey-West correction to our estimation errors, which we use to construct a confidence band around the estimated series of β_h coefficients. As suggested by Jordà (2005), the maximum lag for the Newey-West correction is set to $h + 1$.

Our measure of R_t is the short-term interest rate. The short-term interest rate should summarize the overall policy stance. In all four countries the zero lower bound on nominal interest rate is not a binding constraint. As a matter of fact, a change in the short-term rate is not necessarily a policy shock as this change could have been anticipated based on the knowledge of the state of the economy and the central bank's reaction function. However, we do not believe this is a large problem for our analysis as (1) the policy frameworks of all four central banks included in our study are less transparent than in advanced economies such that anticipating policy moves is more difficult and (2) the macroeconomic control variables at least to some extent capture the endogenous response of monetary policy to the state of the economy.

There are several advantages of local projections as compared to VAR models: (1) The model requires estimating only a handful of parameters. Thus, it is particularly suited for a situation in which the length of available time series is short such as in developing countries. (2) Since we do not need to estimate a complete system, the model is more robust with regard to model uncertainty. This should result in more

[5] The model for real GDP and the CPI also includes a time trend.

robust estimates.

3.2 Nonlinear model

Another key advantage of local projections over competing VAR models is that they allow us to study non-linearities in the monetary transmission process easily.[6]
Suppose there are two observable regimes, I and II, that govern the impact of monetary policy. We construct a dummy variable, I_t, which is one if the economy is in regime I and zero if the economy is in regime II. For $I_t = 1 \ \forall \ t$ the model collapses to the linear benchmark.
The model can easily be generalized to encompass regime-dependent dynamics

$$\begin{aligned} y_{t+h} &= I_{t-1}\left[\alpha_h^I + \beta_h^I R_t + \left(\gamma_h^I\right)' \sum_{s=1}^{q} \mathbf{x}_{t-s}\right] \\ &\quad + (1 - I_{t-1})\left[\alpha_h^{II} + \beta_h^{II} R_t + \left(\gamma_h^{II}\right)' \sum_{s=1}^{q} \mathbf{x}_{t-s}\right] + (\delta_h)' \sum_{s=1}^{q} \mathbf{z}_{t-s} + \varepsilon_{t+h}. \end{aligned} \tag{2}$$

In this regression model, the constant, the coefficient on the monetary policy variable and the coefficient on the domestic control variables are allowed to be regime-specific. The foreign control variables are assumed to have a regime-invariant effect in order to maintain a relatively parsimonious model.[7]
In our case let regime I be a state of the world with remittance growth above the median. In contrast, regime II exhibits below-mean inflows of remittances. Hence, both regimes are observable, which differentiates the model from models of unobservable regimes such as Markov-switching models. We assess whether the impact of monetary policy is different in regimes with high growth rates of remittances. Hence, the two regimes are the following

$$I_t = \begin{cases} I & \text{if } v_t > \tau \\ II & \text{if } v_t \leq \tau, \end{cases}$$

where τ is the country-specific median of the year-on-year growth rate of remittance inflows, v_t. Hence, β_h^I reflects the impact of monetary policy on the endogenous variables in a regime with high remittance inflows and β_h^{II} stands for the effect of

[6]Nonlinear local projections have among others, been applied by Ramey and Zubairy (2014) in their study of fiscal multipliers in booms and recessions, by Nodari (2015) in order to estimate the effect of credit supply shocks in different stages of the business cycle and by Caselli and Roitman (2016) who study the nonlinear interest rate pass-through.

[7]As in Ramey and Zubairy (2014) and others we use the lagged indicator function, I_{t-1}, in this model. Using I_t instead would not change our results.

monetary policy if remittance inflows are subdued.[8] While we use the median of the growth rate of remittances as a critical value to separate regimes, the critical value could also be set differently. The higher the critical value, the more extreme are the remittance inflows scenarios captured and the larger is the difference in the estimated β_h coefficients across regimes.

As mentioned by Ramey and Zubairy (2014), the procedure for calculating impulse responses involves no iterations. For each horizon h a new regression is estimated. In contrast to other kinds of regime-dependent impulse response functions, such as the ones obtained from Markov Switching models, we do not need to assume that a given regime prevails for the entire duration of the response.

4 Data

We investigate nonlinear monetary policy transmission in the presence of remittances in four developing countries which are known to be strongly affected by remittance inflows. We estimate the model for Kenya, Mexico, Colombia and the Philippines during the period 2000Q1-2015Q4. The choice of the sample period is dictated by data availability.

Table (1) provides some descriptive statistics on remittance inflows into the sample countries. The countries strongly vary with the magnitude of inflows relative to their economic size. The list of the most important source countries of inflows reveals the overwhelming influence of the U.S., which is why we pay special attention to the U.S. business cycle as a potential alternative explanation for our findings.

While Mexico, Colombia and the Philippines have adopted a formal inflation targeting regime, the Central Bank of Kenya pursues price stability without a formal inflation target. All four economies have a floating exchange rate. Thus, we are confident the small empirical model captures the monetary transmission process realistically. The main variables of interest characterizing the monetary transmission process are CPI, real GDP, the yield on long term government bonds, the short-term interest rate and the exchange rate against the U.S dollar.

We seasonally adjust CPI and real GDP and express them in natural logarithms. We use the Census X12 method to seasonally adjust our series. The exchange rate, which we also use in natural logs, is defined as the rate of exchange local of currency per U.S dollar thus Kenyan shilling, Mexican peso, Colombian peso and Philippine peso, respectively. The data sources and details for each country are given in the

[8] We restrict ourselves to two regimes since we only have a relatively short sample with quarterly data.

appendix.

The model includes also two variables capturing global economic conditions which are of particular relevance for developing and emerging economies. These variables are, first, the log-level of U.S. real GDP and, second, the log-level of the global food price index.[9]

A crucial variable is the inflows of remittances. For all four economies we use remittance inflows in U.S. dollars from the rest of the world. Again, details about each series can be found in the appendix. Remittances are used to separate two distinct regimes. We calculate the year-on-year growth rate in remittances to study swings in inflows since the quarter-on-quarter growth rates would be far too volatile. The dummy variable for the identification of states is set to one if the growth rate is higher than a critical value τ, which is the median of remittances growth.[10] We restrict the analysis to two regimes exhibiting high and low growth of remittance inflows. This is due to the short sample period available. We also use the log of remittances as a control variable in each regression.

Figure (1) shows the year-on-year growth rate of remittance inflows for all four economies. In addition, the horizontal line reflects the median growth rate of remittance inflows. The shaded areas are periods in which remittances growth lies above the median growth rate. In can be seen that all four economies experienced large swings in remittance inflows. Moreover, these swings do not appear to be synchronized across countries.

5 Results and robustness

The results are presented in three steps. First, we discuss the evidence from linear local projections. Second, we shed light on the nonlinear nature of the transmission process due to large swings in remittance inflows. In a third step, we present counterfactual results to corroborate the robustness of our findings.

5.1 Results from linear model

Figures (2) to (5) present the results from the estimated linear model. For each endogenous variable we show the coefficient on monetary policy as a function of the horizon h. The point estimates are surrounded by 90% confidence bands.

[9] Both variables are obtained from the FRED database.

[10] Using the mean instead would result in virtually identical results. Results for a higher critical value, e.g. the mean plus half the standard deviation of remittances, are available upon request.

Figure (2) displays the linear model for Kenya. A one percentage point increase to the Kenyan short-term interest rate leads to a hump-shaped fall in domestic prices. While prices start to decline immediately, output starts to fall after six quarters. Following the monetary tightening, the Kenyan currency appreciates against the U.S. dollar. If the short-term interest rate rises by one percentage point, the yield on long term bonds also increases by a quarter of a percentage point, thus the yield curve becomes flatter. These results are in line with our expectations and support the view that the transmission process in Kenya is similar to other small open economies.

Mexico's results are presented in Figure (3). In contrast to Kenya's case, prices are less sensitive to monetary policy and fall only moderately after three quarters. The response of real GDP is consistent with this as output exhibits no significant drop after a monetary tightening. As for the exchange rate, the interest rate increase leads to an appreciation of the Mexican peso against the U.S. dollar. The response of the long-term interest rate is positive, as in the case of Kenya, and highly significant. Again, the slope of the term structure flattens after the policy tightening.

Figure (4) shows the response of the endogenous variables to the short-term interest rate in Colombia. Prices and output respond immediately and decrease in their respective values after the interest rate increase. As expected, a policy tightening is contractionary as regards output and prices. While the exchange rate response is insignificant, the response of long-term interest rates is again consistent with the textbook model of monetary policy transmission.

Finally, the results for the Philippines are shown in Figure (5). Initially, Philippine prices seem to be insensitive to policy though prices start to fall eight quarters after the interest rate shock. As in Mexico and Kenya, output responds immediately and falls persistently reaching the maximum response after six or seven quarters. The interest rate increase raises the value of the Philippine Peso against the U.S. dollar, though this response becomes significant a year after the initial shock. As in all other countries, yields on long-term bonds increase when the central bank tightens. In all four countries, the transmission of policy impulses follows the textbook model of monetary policy in small open economies under (de facto) inflation targeting. Thus, the four countries highlighted here are well suited to study how strong swings in remittance inflows affect the transmission of policy.

5.2 Results from nonlinear model

The impulse responses from the nonlinear model are shown in Figures (6), (7), (8) and (9). In each figure, we report the impulse responses and the corresponding

90% confidence intervals for the two states. The responses to monetary policy if remittance inflows are high, hence the economy is in state I, are shown by the dotted green line. The responses for state II, a situation with remittance inflows being below the median, are shown by the dotted black line.

For all four countries, the fluctuations in state I are less pronounced than in state II. This implies that the endogenous variables react more strongly to monetary policy during low growth of remittances than during periods when a country receives high remittances suggesting that transmission of monetary policy is muted under exceptionally strong remittance inflows.

The difference between high remittances and low remittances is seen most clearly when prices and output are taken into account. Prices and output react more strongly when countries experience low remittance flows than when they receive high remittance inflows.

According to Figure (6), following a policy tightening prices in Kenya fall by approximately 0.1% in state I. When the economy is in state II, however, the same policy impulse leads prices to fall by 0.5%. The same pattern can be observed for output. Under strong remittance inflows, monetary policy depresses output by about 0.1%, while under low inflows policy triggers a contraction of -0.5%.

In the linear model presented before, the exchange rate appreciated against the U.S. dollar after the policy tightening. We expect the appreciation to le larger when, at the time of the policy shock, large amounts of remittances flow into the country. This is indeed what we observe for the case of Kenya.

Strong remittance inflows tend to increase liquidity and thus reduce long-term interest rates. Thus we expect a policy tightening to have a smaller effect on long-term interest rates in state I compared to state II with weak remittance inflows. For Kenya, see Figure (6), bond yields indeed increase strongly in state II and barely respond to monetary policy in state I.

For Mexico, see Figure (7), we see a similar pattern. In state I, monetary policy is less contractionary than under state II. Furthermore, under weak inflows of remittances, monetary policy has only a very small effect on the exchange rate. The response fluctuates around zero such that the cumulative response is insignificant. In state I, however, when the demand of overseas workers for the domestic currency multiplies the the effects of the policy tightening, we see a significant appreciation of the Mexican peso. Bond yields fall if remittances pour in and more than offset the effect of the policy tightening, while they clearly increase in state II.

For Colombia, see Figure (8), the state-dependent impulse responses are significantly different, although the difference between the two states is smaller than for Kenya

and Mexico. Again, the policy tightening is less effective in state I. While there seems to be no state-dependence of the exchange rate response, bond yields exhibit a negative response in state I and the standard response, which we could observe in the linear model, in state II.

Figure (9) for the Philippines shows that in regime I, prices increase rather than decrease following the shock. Output, however, does not respond differently across both states, although there is a small tendency for policy being less contractionary in state I. The exchange rate response is not in line with our expectations: we find the exchange rate to depreciate in state I and to slightly appreciate in state II. However, the response of bond yields is again consistent with the overall pattern shown in this paper.

Taken together we see evidence for a reduction in the effectiveness of monetary policy under strong inflows of remittances. A monetary policy shock is less contractionary if at the same time the economy receives large inflows of remittances.

Figure (10) gives a summary of the baseline results. For output and inflation in each country we calculate the cumulative impulse response in each of the two states. We then calculate the differences between the cumulative response in state I and state II. The higher the resulting number, the larger is the difference in policy effectiveness with policy having a larger effect in state II. The resulting four observations for output and inflation, respectively, are shown in a scatter plot against the standard deviation of remittances flows.

A few observations stand out: first, in all four countries the difference is positive. Second, with the exception of Mexico, the difference is larger for inflation than for output. Third, again with the exception of Mexico, the differences for both variables increase with the standard deviation of remittances. While we should be careful not to over-interpret the findings based on four countries only, this plausible finding highlights the role played by the volatility of remittances inflows. We will elaborate this further in the concluding section.

5.3 Robustness

In this section we provide additional results which underline the hypothesis of less powerful monetary policy in periods of strong remittances inflows. The robustness checks are meant to rule out alternative explanations which would result in observationally equivalent findings.

The first explanation could be that the results presented in the previous section reflect the domestic business cycle. In fact, if remittances are countercyclical, they should strongly flow into the economy during recessions and less strongly in boom

periods. For the U.S. economy, Tenreyro and Thwaites (2016) show that monetary policy is more effective in booms rather than recessions. If, by measuring remittances inflows, we indirectly capture the domestic cycle, our findings would be similar.

To rule out this competing explanation, we construct a counterfactual. We re-estimate the model with the regime-dummies now reflecting the domestic cycle. In particular, I_t equals one if the domestic GDP growth rate is below the median and zero otherwise. To save space, we do not report the entire set of impulse responses again. Instead, we summarize the information content by showing the cumulative impulse responses over $h = 0, ..., 12$ as a single number in Table (2).[11] We report the results for prices and GDP only since these are the core variables for gauging the effectiveness of monetary policy. The table also contains the cumulative responses of the linear model and the benchmark nonlinear model, respectively.

We would rule out an alternative explanation for our findings if (1) the resulting cumulative responses are not different across regimes or (2) the relative magnitudes of the responses are inconsistent. The former would be the case if one of the two cumulative responses lies in the confidence band around the other response. The latter would be the case if, for example, prices respond more strongly in state I while output is more sensitive to monetary policy in state II.

For Kenya, we find that the response of prices, which is -2.29% in state II, lies in the 90% confidence interval around the cumulative estimate in state I. Hence, the price responses are not not statistically distinguishable. Likewise, the output response in state II, which is -1.38%, lies in the confidence band around the estimate for state I. Hence, the estimation based on the domestic cycle does not result in a significantly different transmission mechanism and, as a result, speaks against the domestic cycle being an explanation for our findings.

For Mexico, each price response lies in the confidence band of the other response. The same is true for the output responses. Hence, we can also exclude the alternative explanation. In the case of Colombia, both the price and the output responses of state I are not distinguishable from the responses in state II. Hence, the alternative explanation can be discarded. The same is true for the Philippines. These findings strengthen the case for remittances inflows being the source of policy ineffectiveness.

The second alternative explanation is that with two states of remittances inflows we simply capture the U.S business cycle or the cycle in advanced economies, respectively. A reduction in policy effectiveness in Kenya could simply be the result

[11] As a matter of fact, the cumulative responses are just one way to summarize the impulse response functions. A typical caveat is that the cumulative response contains no information about the shape of the response, e.g. the hump-shaped response of most macroeconomic aggregates. Hence, the cumulative number discussed here should be interpreted with some caution.

of Kenya being positively affected by high export demand from the U.S. In this case monetary policy has less grip on domestic demand, which instead is driven by booming economies abroad. If a boom in the U.S. allows workers to transfer higher remittances, the resulting impulse responses would be observationally equivalent to our benchmark model.

To rule out this explanation, we run the model presented before with an important modification: now the indicator variable I_t is one if the growth rate of the U.S. economy is above its median and is zero otherwise. The results are shown in the fourth row for each country in Table (2). For Kenya, the responses of prices and output are again indistinguishable as each response lies in the confidence band of the other. The same can be observed for Colombia and the Philippines.

For Mexico, however, we find that the U.S. cycle leads to significantly different price and output responses in the two regimes. However, here our second criterion spelled out before applies: the response are inconsistent across variables, thus speaking against the U.S. cycle being an explanation for our findings. In particular, prices appear to be more sensitive to monetary policy in state I while output increases in state I and falls in state II after a policy tightening. Hence, as regards output policy is more effective in state II. Based on this inconsistency, we also rule out the U.S. business cycle as a competing explanation for our results.

It could also be argued that the economy is not jumping between different states but rather adjusting gradually to changes in remittances inflows. Since we need to modify the models to account for a smooth transition between states, we devote a separate section to this robustness check.

6 Evidence from smooth-transition local projections

The model estimated before allows for two distinct states with an abrupt transition between them. If the economy experiences a growth rate which crosses the median, the economy immediately jumps from state II to state I. This is a strong assumption which we now want to relax. We draw on the work of Tenreyro and Thwaites (2016) and Born et al. (2016), among others, and combine state-dependent local projections with a smooth transition between states. While these models haven been used to study fiscal multipliers and monetary policy shocks in advanced economies during expansionary and contractionary periods, they have not been applied to small open economies.

The estimated smooth-transition local projection (STLP) model is

$$
\begin{aligned}
y_{t+h} &= F\left(v_{t-1}\right)\left[\alpha_h^I + \beta_h^I R_t + \left(\gamma_h^I\right)' \sum_{s=1}^{q} \mathbf{x}_{t-s}\right] \\
&\quad + \left(1 - F\left(v_{t-1}\right)\right)\left[\alpha_h^{II} + \beta_h^{II} R_t + \left(\gamma_h^{II}\right)' \sum_{s=1}^{q} \mathbf{x}_{t-s}\right] + \delta_h' \sum_{s=1}^{q} \mathbf{z}_{t-s} + \varepsilon_{t+h},
\end{aligned} \tag{3}
$$

where the transition function $F(v_t)$ has replaced the I_t dummy variable. Otherwise the interpretation of the coefficients remains unchanged.

The term $F(v_t)$ determines in which of the two states the economy is as a function of v_t. The important difference with regard to the model in the previous section is the fact that $F(v_t)$ is a smooth, increasing function of v_t. In accordance to the literature, this function is parameterized as a logistic function with

$$
F\left(v_t\right) = 1 - \frac{1}{1 + \exp(\alpha v_t)}, \tag{4}
$$

where v_t is now the standardized and centered year-on-year growth rate of remittances and $\alpha > 0$. This function is bounded between zero and one. The parameter α determines how sharp the transition between regimes is. In this application, as in Tenreyro and Thwaites (2016), we impose rather than estimate α. Specifically, we set $\alpha = 3$.[12] Figure (11) plots $F(v_t)$ as a function of two alternative values for α. It can be seen that $\alpha = 3$ allows for a relatively smooth transition. For $\alpha \to \infty$, the model immediately shifts from one state to the other if demeaned and standardized remittance inflows cross zero. As a result, the model approaches the state-dependent model from the previous sections.

For each country, the resulting probabilities of state I, the state with high remittances growth, are plotted in Figure (12). An important difference with regard to the state-dependent model estimated before is that the model allows economies to be in the transition process towards state I or II, respectively. In this sense the STLP model is a generalization of the state-dependent model. In fact, given the relatively smooth evolution of macroeconomic variables, it is plausible to assume that the economy gradually moves from one state to the other.

The impulse response functions are shown in Figures (13) to (16). For Kenya, see Figure (13), the results of the smooth-transition model are very similar to those from the model discussed in the previous section. Again, we find strong evidence in favor of a state-dependent monetary transmission mechanism. In Mexico, the smooth-transition results exhibit a smaller difference in the response of prices across

[12] Using alternative values for α does not change the results.

regime than in the previous model. For the output response, see Figure (14), the difference between the two states is larger. Under strong remittance inflows a one percentage point increase in the interest will be expansionary, while under weak remittance inflows the same shock causes a drop in GDP by 1% to 2%. Likewise, the state-dependence of the response of the exchange rate is more pronounced in the smooth-transition model. The results for Colombia and the Philippines, respectively, see Figures (15) and (16), also support the previous set of results.

As a result of the previous discussion we can conclude that the state-dependence of monetary policy effectiveness is relatively robust with respect to the way the transition between states is modeled. All findings suggest that monetary policy has a larger impact on inflation, output and long-term interest rates when remittance inflows are low. In the high-remittances regime, the effectiveness is reduced significantly.

7 Conclusions

Many developing and emerging countries strongly depend on remittance inflows from overseas workers. In this paper we showed that these inflows reduce the effectiveness of monetary policy. An interest rate increase is less contractionary in periods of strong remittance inflows. Likewise, a policy easing implies less stimulus during times with low remittance inflows. The results have been derived from a series of state-dependent local projection models for Kenya, Mexico, Colombia and the Philippines.

The interference of remittance inflows with monetary policy is a facet of the dilemma of open-economy macroeconomic policy. As Rey (2013) argues, to the extent there is a global cycle in financial flows which is decoupled from domestic conditions and capital is free to flow in and out of countries, monetary policy at the national level is constrained. Importantly, this is independent from the exchange rate regime, thus turning the traditional trilemma of macro policy into a dilemma between openness for capital inflows and independent monetary policy. Our results corroborate Rey's (2013) view for the special case of remittance inflows.

As a matter of fact, one way to escape the dilemma is to restrict the flow of capital. However, from the perspective of developing countries this is unwise given the beneficial long-term impact of capital inflows including the inflow of remittances. In particular, remittances have been shown to improve financial development (Aggarwal et al., 2011) and reduce poverty (Gupta et al., 2009), among other long-term effects.

Countries could also design policies to channel remittance inflows into long-term growth enhancing investments such as human capital formation, institution-building and infrastructure investments. The less remittance inflows drive up aggregate demand, the more monetary policy is able to target inflation.

A second option is the design of monetary and financial stability policies, respectively. The results have shown that ability of the central bank to target inflation can be severely hampered if the economy experiences swings in remittances. For an inflation targeting central bank this means that policy should take remittance flows into account when setting policy and, to the extent possible, scale their policy step accordingly. To elicit the same effect on macroeconomic aggregates, a more bold interest rate step is needed if remittance inflows are high.

We have seen that, with the exception of Mexico, the state-dependence of policy effectiveness increases with remittances volatility. This suggests that policies conducive to stabilizing the inflow of remittances might also reduce the state-dependence of monetary policy effectiveness.

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A Data Sources and Definitions

This appendix contains details about the data series used in this paper.

Kenya

The series for CPI and real GDP are obtained from the Kenya National Bureau of Statistics website. The GDP series exhibits a structural break in the level in 2009 due to the rebasing of Kenyan national accounts. We use the pre-2009 growth rates to extrapolate the post-2009 series backwards in order to overcome this problem. Remittances data is obtained from Central Bank of Kenya (CBK) website. We interpolate annual remittances series to obtain a quarterly series between 2000-2003. Both the short-term interest rate and the exchange rates for Kenya are also obtained from CBK website. The yield on long term government bond for each of the four countries is obtained from investing.com, a global financial portal, and is expressed in percentage points.

Mexico

Mexican CPI data is obtained from Instituto Nacional de Estadistica y Geografia. We derive the real GDP series from Thomson Datastream while we rely on remittance data from the Banco de Mexico website. We obtain both the short-term interest rate and the exchange rate for Mexico from the FRED database.

Colombia

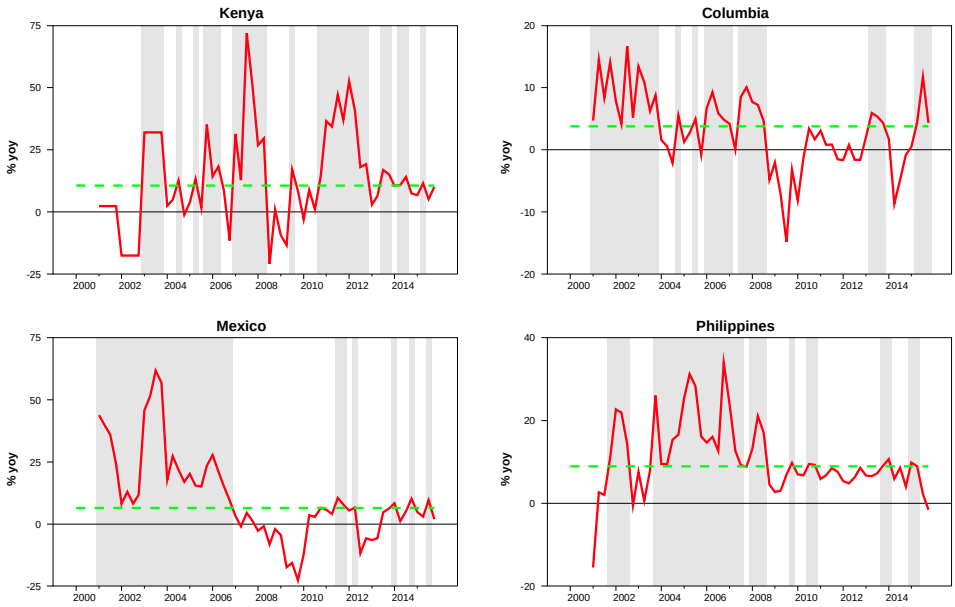
We obtain Colombian quarterly CPI series from Thomson Datastream. The National Administrative Department of Statistics is the official statistical website for Colombia and we extract real GDP series from this website. We obtain remittance flows, the short term interest rate and the exchange rate from the Banco de la Republica de Colombia website.

Philippines

The Philippine Statistics Authority is our source of Philippine CPI data. We obtain real GDP series from Thomson Datastream. We obtain both remittances and the short term interest rate data from the Bangko Sentral ng Pilipinas website. We also obtain the exchange rate of the Philippine peso per U.S dollar from the Central Bank of the Philippines website.

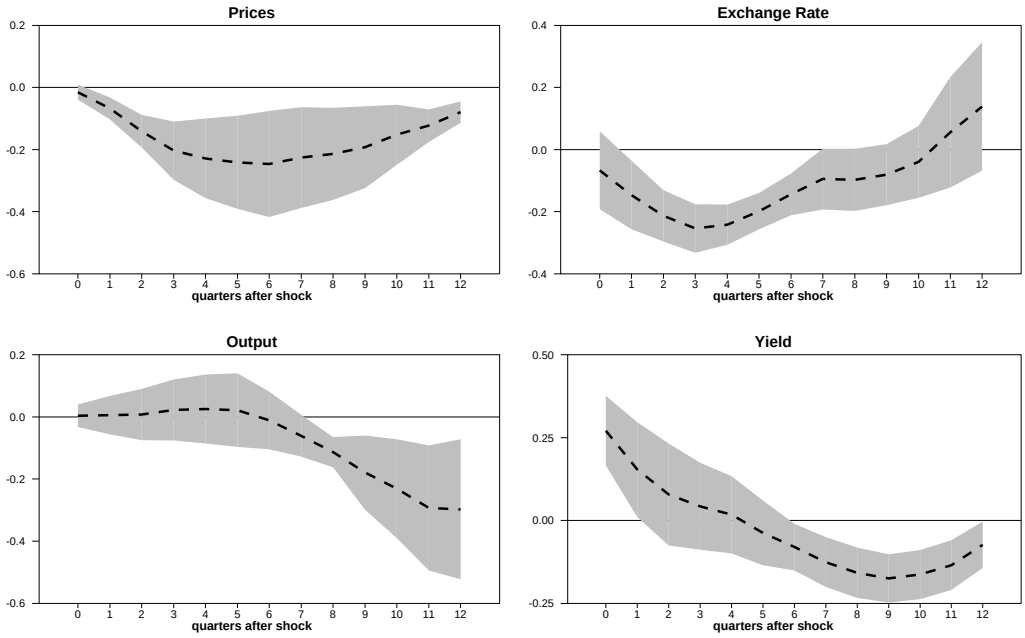
B Figures and Tables

Figure 1: Remittance inflows



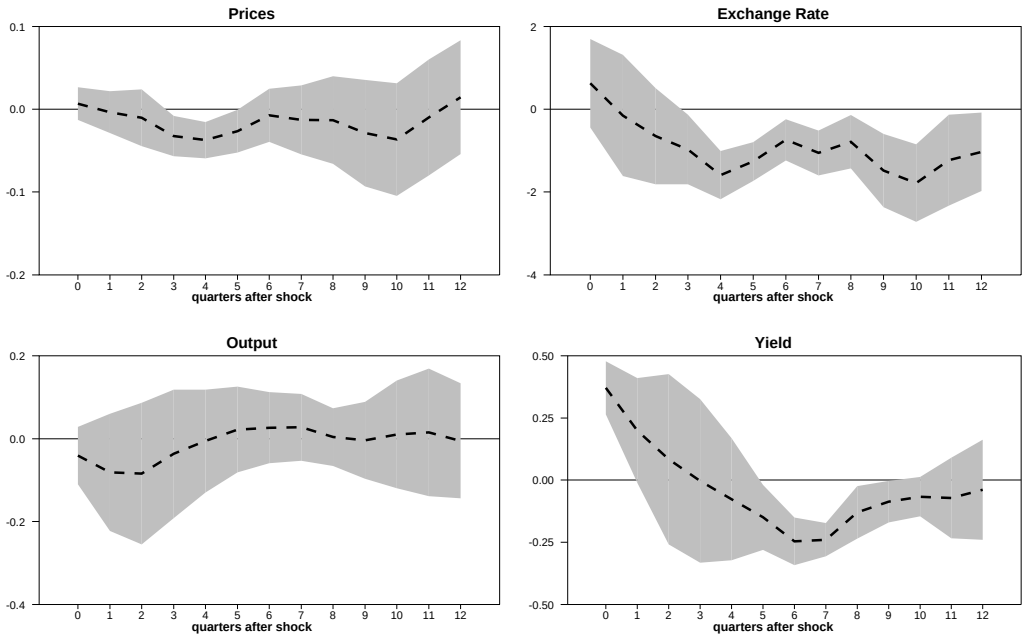
Notes: Quarterly year-on-year percentage changes in remittance inflows (in %) in red (solid line). The green dotted line is the median growth rate. Shaded regions are episodes with above-median growth rates.

Figure 2: Kenya - Response to interest rate change



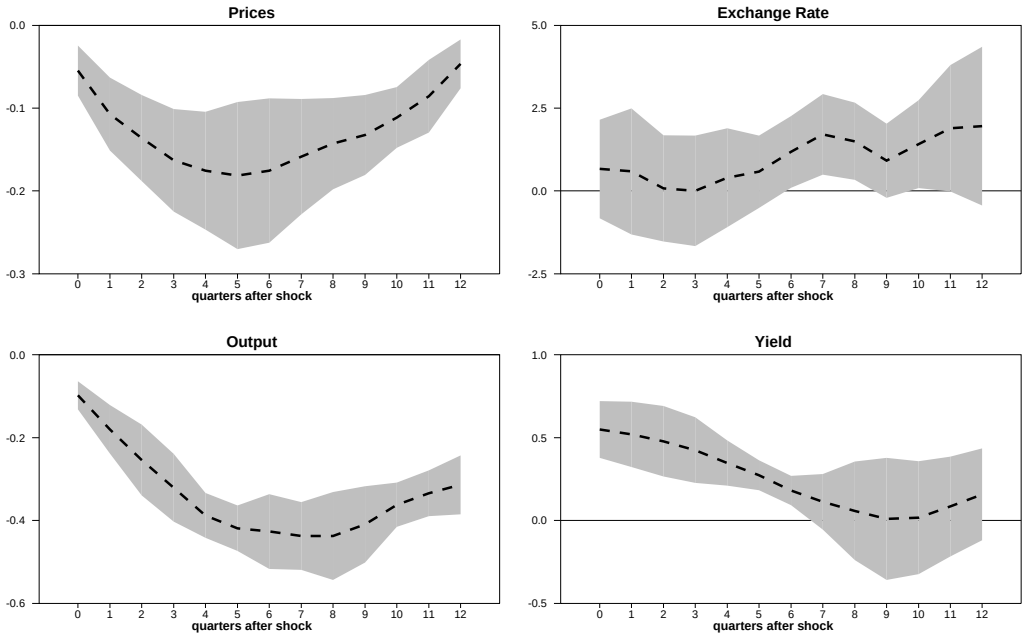
Notes: The dotted line is the impulse response based on local projections. The shaded area reflects a 90% confidence band around the point estimate.

Figure 3: Mexico - Response to interest rate change



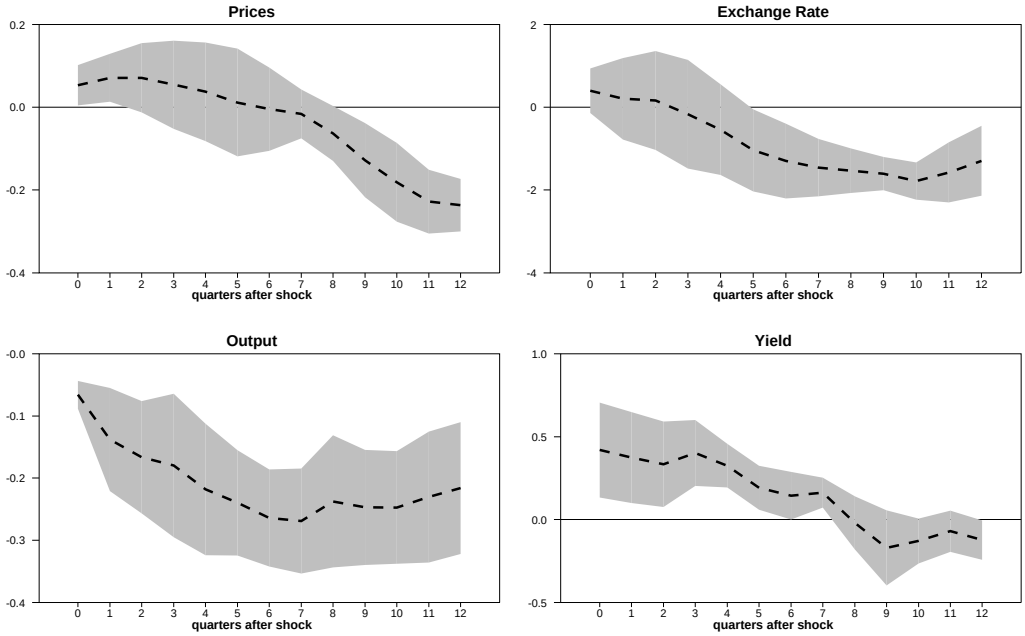
Notes: The dotted line is the impulse response based on local projections. The shaded area reflects a 90% confidence band around the point estimate.

Figure 4: Colombia - Response to interest rate change



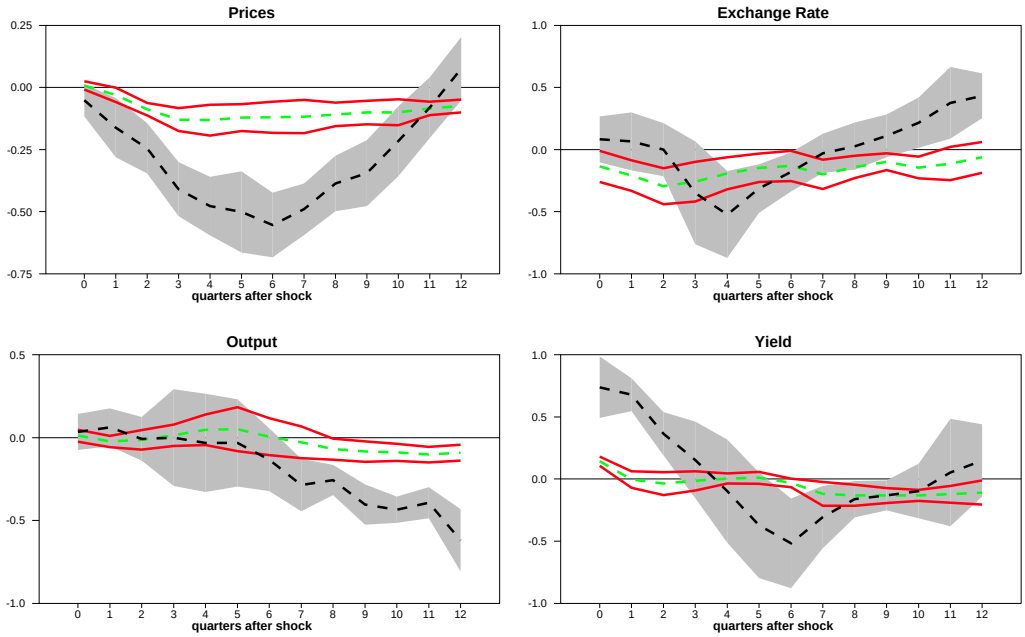
Notes: The dotted line is the impulse response based on local projections. The shaded area reflects a 90% confidence band around the point estimate.

Figure 5: Philippines - Response to interest rate change



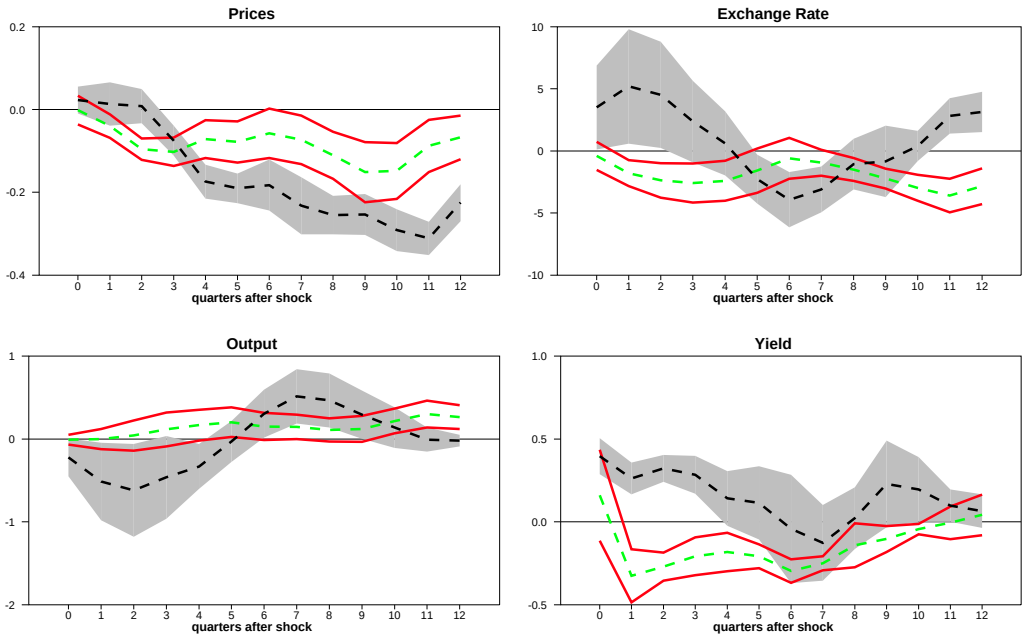
Notes: The dotted line is the impulse response based on local projections. The shaded area reflects a 90% confidence band around the point estimate.

Figure 6: Kenya - State-dependent response to interest rate change



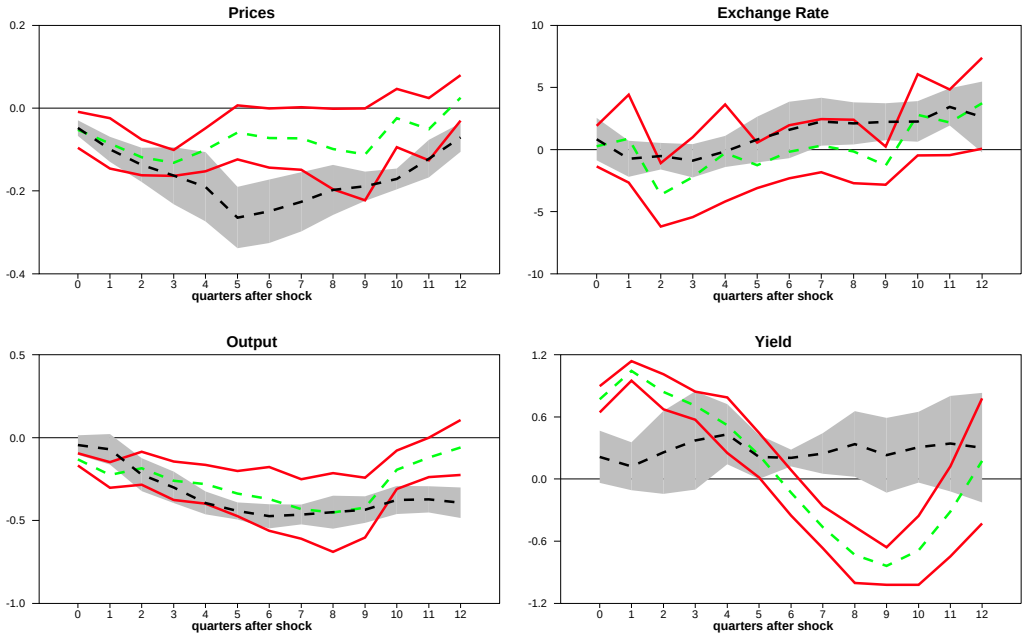
Notes: The green (black) dotted line is the impulse response based on local projections in regime I (II). The grey shaded area reflects a 90% confidence band around the point estimate in state I and the red solid lines reflect the confidence band in state II.

Figure 7: Mexico - State-dependent response to interest rate change



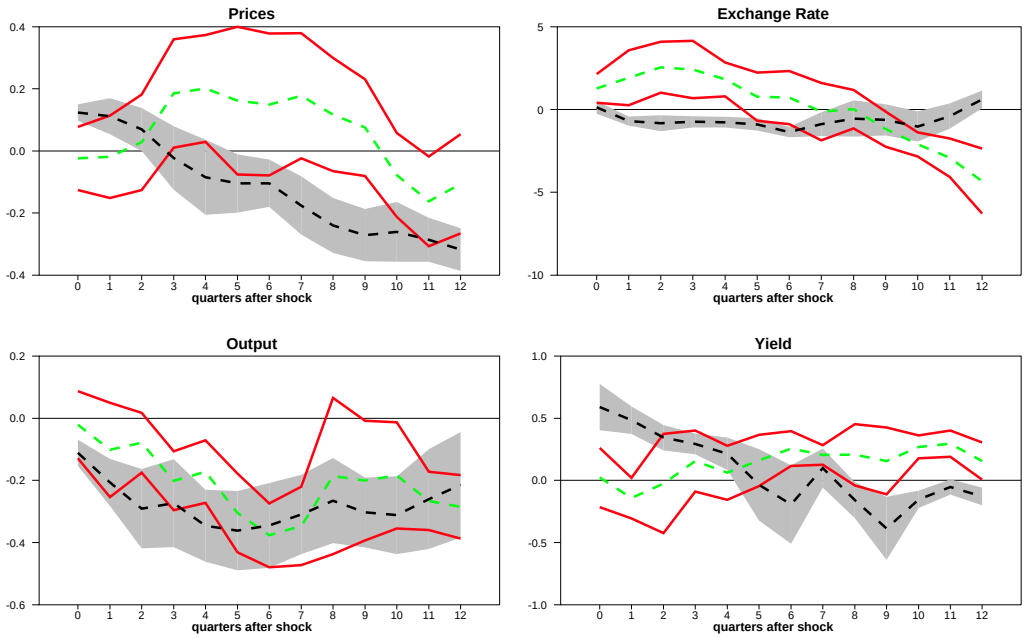
Notes: The green (black) dotted line is the impulse response based on local projections in regime I (II). The grey shaded area reflects a 90% confidence band around the point estimate in state I and the red solid lines reflect the confidence band in state II.

Figure 8: Colombia - State-dependent response to interest rate change



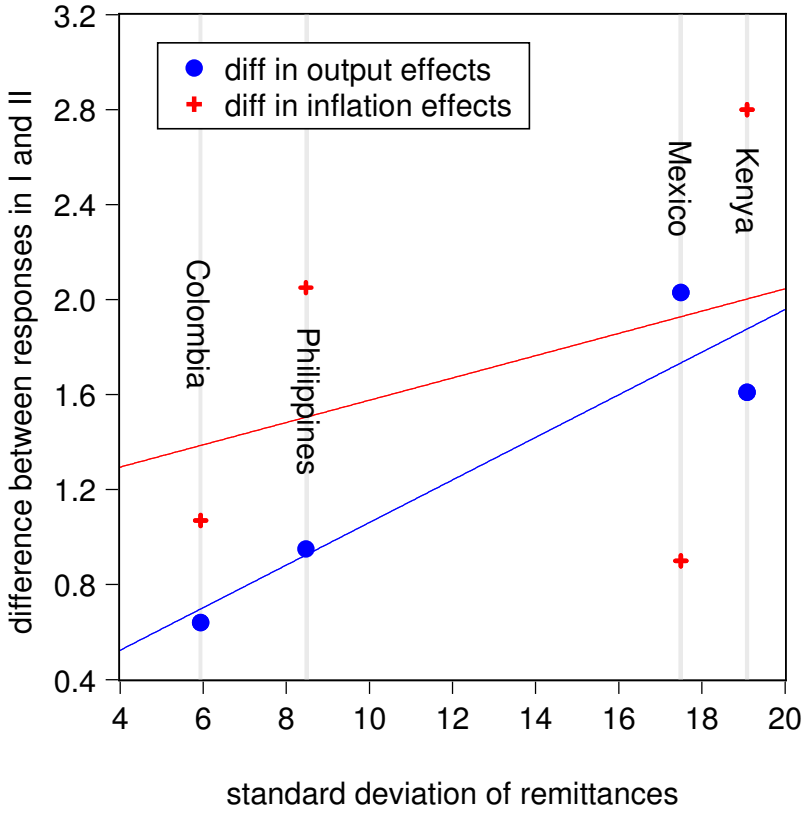
Notes: The green (black) dotted line is the impulse response based on local projections in regime I (II). The grey shaded area reflects a 90% confidence band around the point estimate in state I and the red solid lines reflect the confidence band in state II.

Figure 9: Philippines - State-dependent response to interest rate change



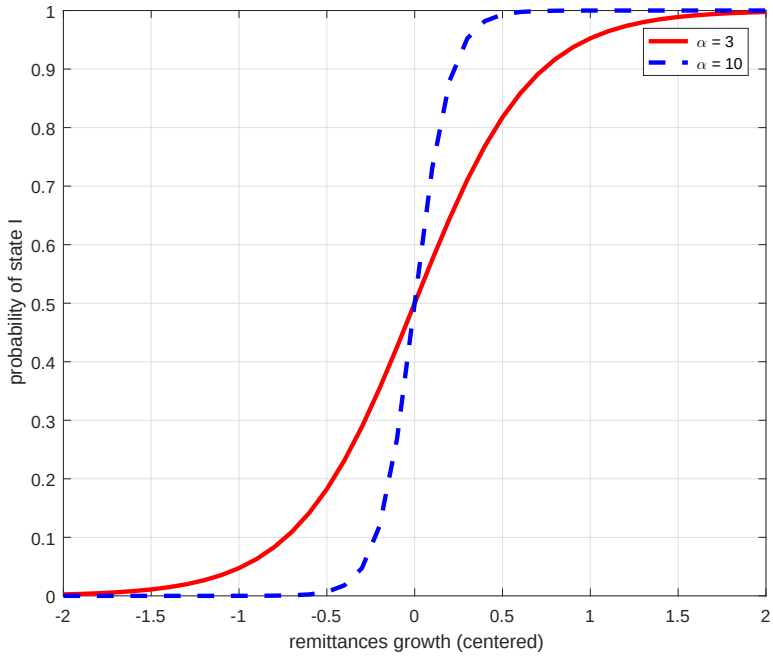
Notes: The green (black) dotted line is the impulse response based on local projections in regime I (II). The grey shaded area reflects a 90% confidence band around the point estimate in state I and the red solid lines reflect the confidence band in state II.

Figure 10: Summary of baseline results



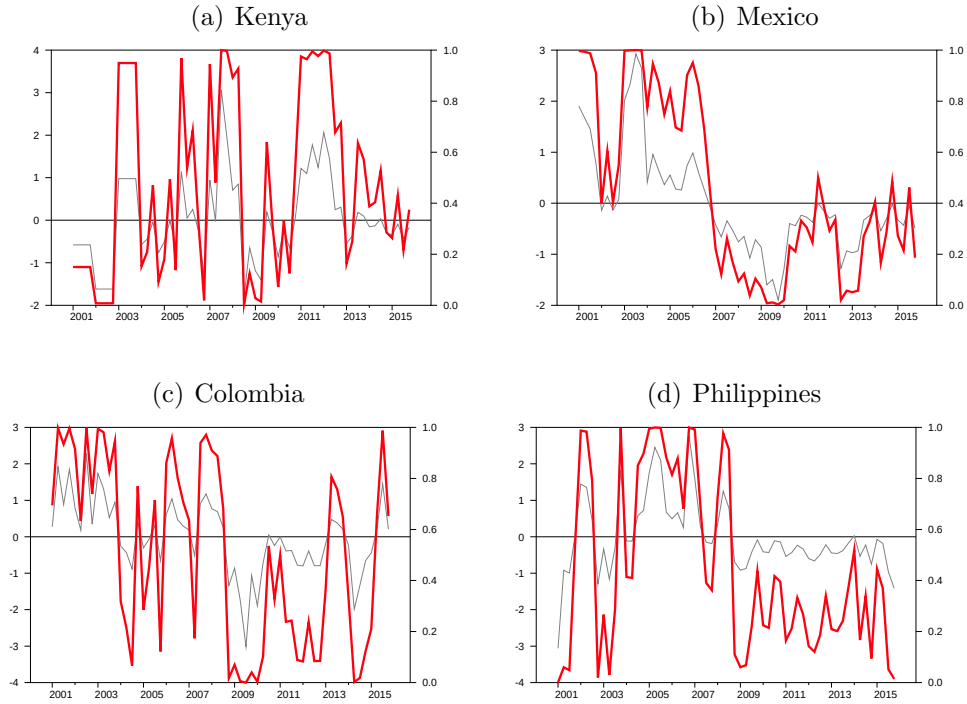
Notes: The scatter plot shows the differences in the cumulative output effects (blue dots) and inflation effects (red crosses). In both cases, the difference is calculated as the response in state I minus the response in state II. The differences are plotted against the sample standard deviation of remittance inflows.

Figure 11: Transition functions



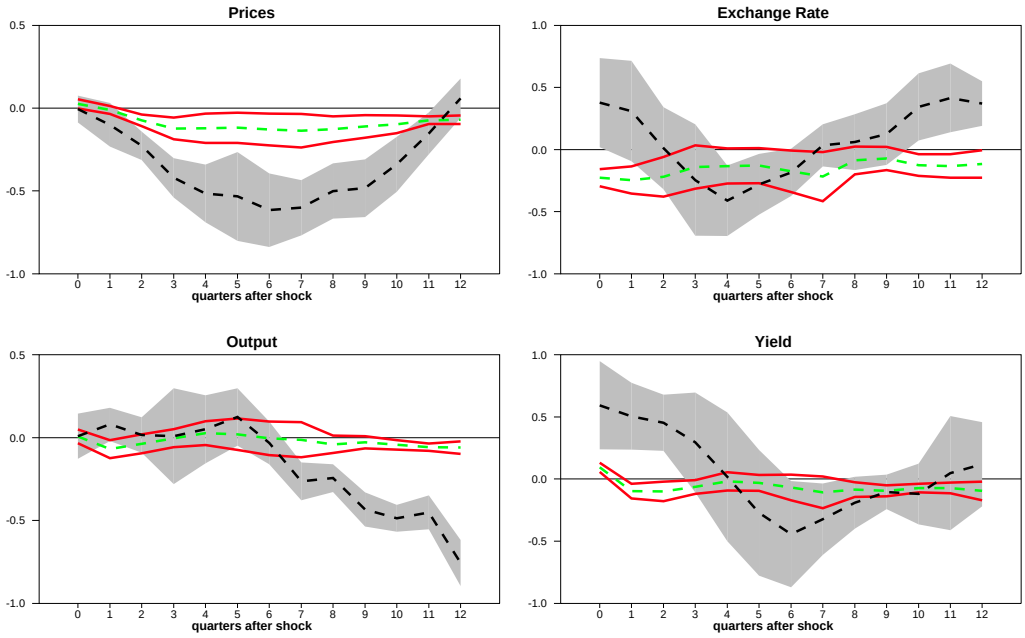
Notes: Calibrated logistic transition functions for alternative values of α. The horizontal axis measures centered and standardized remittances growth and the vertical axis depicts the probability of being in state I.

Figure 12: Probability of high-remittances inflow state



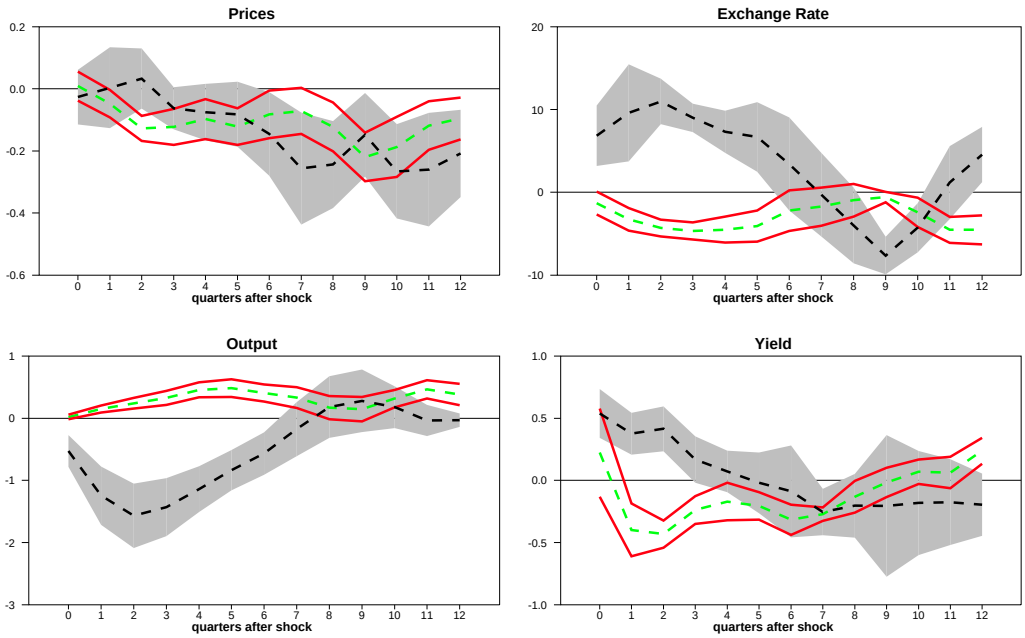
Notes: The red line is the probability of being in state I (right scale). The grey line is the quarterly year-on-year growth rate of remittances (left scale).

Figure 13: Kenya - State-dependent response to interest rate change from STLP



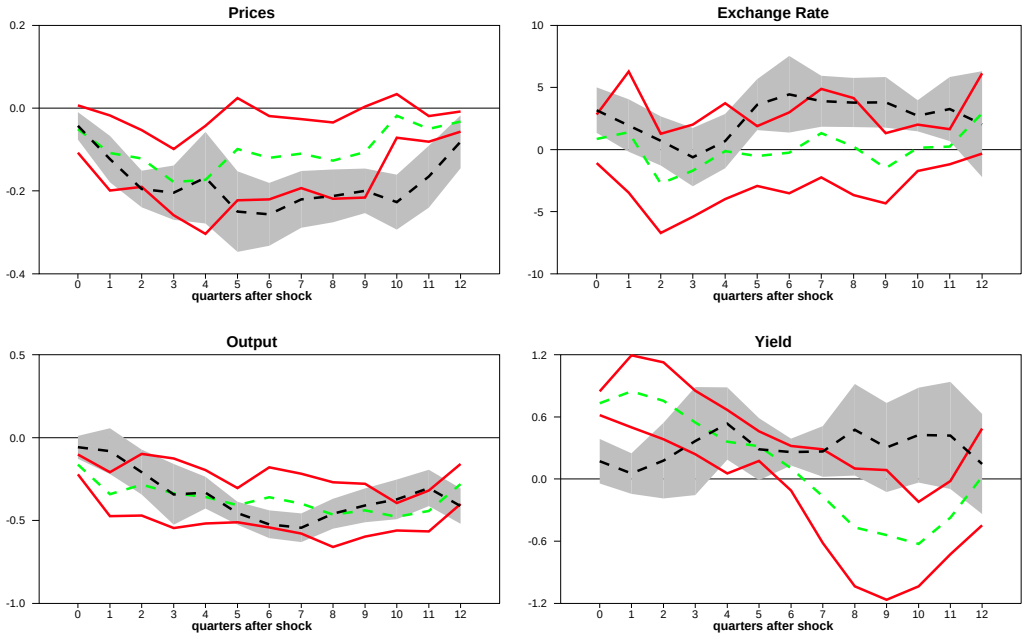
Notes: The green (black) dotted line is the impulse response based on smooth-transition local projections in regime I (II). The grey shaded area reflects a 90% confidence band around the point estimate in state I and the red solid lines reflect the confidence band in state II.

Figure 14: Mexico - State-dependent response to interest rate change from STLP



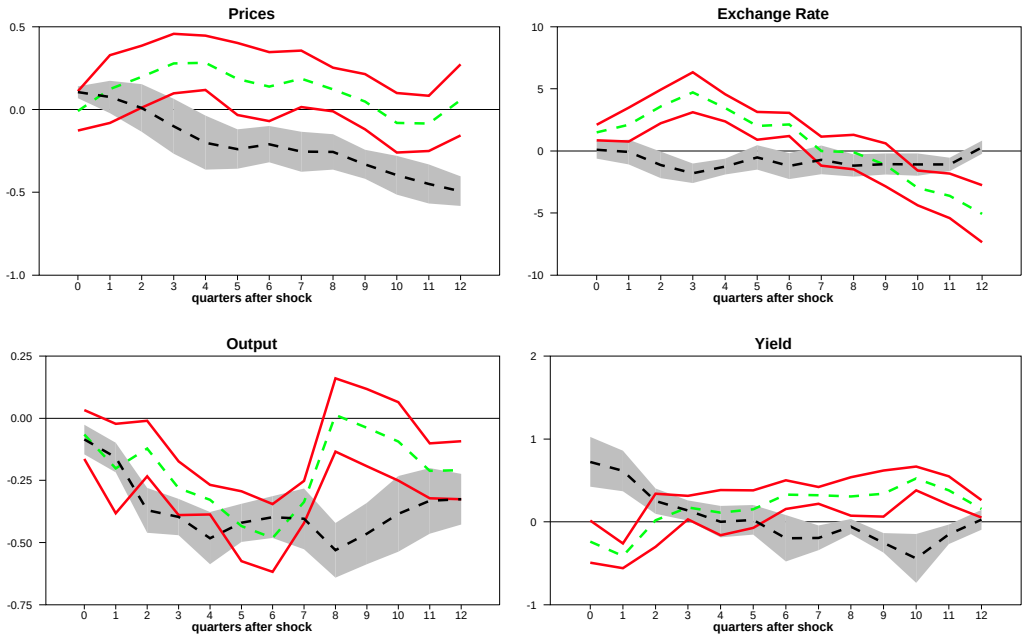
Notes: The green (black) dotted line is the impulse response based on smooth-transition local projections in regime I (II). The grey shaded area reflects a 90% confidence band around the point estimate in state I and the red solid lines reflect the confidence band in state II.

Figure 15: Colombia - State-dependent response to interest rate change from STLP



Notes: The green (black) dotted line is the impulse response based on smooth-transition local projections in regime I (II). The grey shaded area reflects a 90% confidence band around the point estimate in state I and the red solid lines reflect the confidence band in state II.

Figure 16: Philippines - State-dependent response to interest rate change from STLP



Notes: The green (black) dotted line is the impulse response based on smooth-transition local projections in regime I (II). The grey shaded area reflects a 90% confidence band around the point estimate in state I and the red solid lines reflect the confidence band in state II.

Table 1: Descriptive statistics on remittance inflows

Kenya	Mexico	Colombia	Philippines
	total inflows (2015, in mil USD)		
1,560	24,792	4,639	28,422
	as share of GDP (2014)		
2.4%	1.9%	1.1%	9.6%
	main source countries		
UK (33%)	USA (98%)	USA (31%)	USA (34%)
USA (30%)	CAN (<1%)	VEN (30%)	UAE (12%)
TAN (7%)	ESP (<1%)	ESP (15%)	KSA (11%)
CAN (6%)		ECU (6%)	CAN (7%)
UGA (5%)		CAN (2%)	MAS (6%)

Notes: The table shows the volume of remittance inflows in absolute terms as well as relative to GDP. We also give the main source countries for inflows. All data comes from the Worldbank.

Table 2: Cumulative impulse response functions for alternative models

	Prices		Output	
	I	II	I	II
Kenya				
linear	−2.05		−0.80	
	[−3.30,−0.80]		[−2.00,0.39]	
baseline	−1.12	−3.92	−0.28	−1.89
	[−1.66,−0.59]	[−5.33,−2.50]	[−1.13,0.57]	[−3.82,0.05]
domestic cycle	−2.24	−2.29	−0.80	−1.38
	[−3.57,−0.91]	[−3.62,−0.96]	[−2.15,0.55]	[−2.81,0.04]
U.S. cycle	−2.26	−1.74	−1.44	−0.75
	[−3.82,−0.70]	[−2.94,−0.54]	[−3.19,0.30]	[−1.56,0.05]
Mexico				
linear	−0.21		−0.15	
	[−0.69,0.26]		[−1.53,1.23]	
baseline	−1.02	−1.92	1.55	−0.48
	[−1.61,−0.42]	[−2.48,−1.36]	[−0.30,3.41]	[−4.38,3.42]
domestic cycle	−0.06	−0.50	−1.01	−0.78
	[−0.63,0.51]	[−1.17,0.17]	[−3.04,1.03]	[−3.27,1.70]
U.S. cycle	−1.74	−0.14	3.07	−0.59
	[−2.27,−1.21]	[−0.67,0.38]	[1.05,5.09]	[−1.95,0.77]
Colombia				
linear	−1.62		−4.07	
	[−2.31,−0.93]		[−4.92,−3.22]	
baseline	−0.98	−2.05	−3.41	−4.05
	[−1.77,−0.18]	[−2.69,−1.42]	[−5.02,−1.80]	[−4.99,−3.11]
domestic cycle	−1.74	−1.35	−3.44	−4.84
	[−2.24,−1.24]	[−2.21,−0.50]	[−4.26,−2.62]	[−6.34,−3.34]
U.S. cycle	−1.66	−1.58	−3.18	−3.50
	[−2.67,−0.64]	[−2.21,−0.95]	[−4.92,−1.45]	[−4.26,−2.73]
Philippines				
linear	−0.32		−2.50	
	[−1.35,0.71]		[−3.56,−1.44]	
baseline	0.81	−1.24	−2.44	−3.39
	[−1.21,2.83]	[−2.22,−0.26]	[−4.06,−0.82]	[−4.82,−1.96]
domestic cycle	−0.57	−1.38	−3.82	−2.03
	[−1.68,0.53]	[−2.89,0.13]	[−5.66,−1.97]	[−3.15,−0.91]
U.S. cycle	0.81	−0.32	−3.01	−3.08
	[−1.15,2.78]	[−1.22,0.58]	[−4.47,−1.56]	[−4.36,−1.79]

Notes: The table reports impulse response functions which are accumulated over 12 periods. The confidence band (in brackets), is the cumulative upper and lower bound, respectively, over 12 periods. "Domestic cycle" refers to a model which is in state I if the domestic GDP growth rate is below the median. "U.S. cycle" is a model which is in state I if U.S. output growth is above its median. "Linear" and "baseline" are the models from section 3.