Monetary Non Neutrality Across Borders

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Abstract

What are the consequences of an international monetary policy shock on domestic micro price adjustments? Using the CPI series of micro prices, we study the implications of a US monetary policy shock in the dynamics of price adjustments in Honduras. Building on the importance of remittances from the US to Honduras, we show that an unexpected monetary policy tightening in the US significantly affects both aggregate prices and activity in Honduras. More importantly, we document that this tightening causes price adjustment decisions in the local economy. We show that both the probability and the magnitude of micro-price adjustments are affected by such external shocks, and we study the dynamic response of prices.

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1 Introduction

The responses of prices are crucial to understanding monetary policy's real consequences. Much recent work has studied the features of price stickiness to model and assess the business cycle implications of changes in the money supply.[1] While the consequences of a policy tightening in domestic micro prices are well understood, there is no evidence on the potential effects of changes in the policy rate in price adjustments in foreign economies. If prices react to external monetary policy shocks, this will imply that international interest rate movements have real effects even beyond their own borders.

This paper studies the implications of US monetary policy surprises on the behavior of micro price adjustments in Honduras. Although the US and Honduras are very different, they are tightly connected through the remittance and the trade channel. Honduras is the economy that displayed the largest share of remittances to GDP (27%) of all Latin American countries in 2022, mostly explained by inflows of immigrants living in the US.[2] Exports to the US represent around 50% of total exports.[3] These two facts make Honduras a country where US monetary policy may have effects through different channels. We collect monthly micro price data series, which are used to construct the CPI in Honduras between 2015 and 2020. Relying on monetary policy surprises in the US, we show that local prices in Honduras significantly *react* to this shock. In particular, both the probability and the magnitude of price adjustments in Honduras respond to movements in the money supply in the US. Remittances are a significant channel through which US monetary policy affects prices in Honduras. Hence, we argue that US monetary policy is able to significantly affect price adjustment decisions abroad.

A US monetary policy surprise, as computed by Nakamura and Steinsson (2018), induces

[1] See for instance, Golosov and Lucas Jr (2007), Nakamura and Steinsson (2008), Midrigan (2011), Vavra (2014), Alvarez, Le Bihan, and Lippi (2016), among others.

[2] According to the World Bank, in 2022, Honduras was the country that displayed the largest share of remittances to GDP in Latin America and 5th worldwide after Tajikistan, Samoa, Kyrgyz Republic and Gambia.

[3] In 2022, total goods exports of Honduras were 12138 millions of US Dollars of which 6261 were exports to the US (52%). Source: Central Bank of Honduras.

a fall in CPI and economic activity in Honduras, with a peak around one year after the shock. This aggregate evidence is consistent with previous works that document the effect of monetary policy shocks on Emerging Economies and Latin American countries.[4] A 25 basis points US monetary policy tightening induces a persistent decline of 5% in remittances around six months after the shock, which synchronizes with the response of prices and economic activity. We further estimate the effects of this shock on more disaggregated prices, exploiting the availability of a panel of different prices that compose the CPI basket.

We show that both the frequency of price adjustments (extensive margin) and the magnitude of price revisions (intensive margin) react to the US monetary policy shock. The probability of revising prices upwards significantly *decreases* in Honduras after a tightening in the US policy rate. As the shock is contractionary in the two economies, we found that prices are less likely to increase in Honduras. Indeed the probability that they are revised downwards rises significantly as well. The effect on the revision probabilities is, in terms of magnitude, different, reflecting different levels of upward or downward rigidities. Moreover, the magnitude of the effect is relevant as it accounts for almost half of the effect that a domestic monetary shock will bring to the local economy. Consistent with the results of Karadi, Schoenle, and Wursten (2022), we found no empirical evidence of price selection in our sample.

Building on the extensive margin results, we study the dynamic responses of price revisions to the shock. While the probability of price decreases reacts immediately, price increases are more sluggish. Given the timing of this delayed response, we interpret it as a spillover effect of the negative real implications that the international shock brings to Honduras.

The remaining of this paper is organized as follows. Section 2 describes the dataset used in the analysis. Section 3 presents the macroeconomic spillovers of US monetary policy shocks in Honduras, with special emphasis on remittances. Section 4 characterizes the effects of the

[4]See, for example, Canova (2005); Dedola, Rivolta, and Stracca (2017); Vicondoa (2019); Degasperi, Hong, and Ricco (2023).

US monetary policy shocks on pricing decisions in Honduras. Finally, section 5 concludes.

2 Data

This section provides an overview of the utilized micro data set. We use confidential data of product level price quotes collected by BCH for computing the Honduran CPI. Each price quote corresponds to an individual item at a particular outlet. For example, a product in the database could be a one-pound bag of rice sold at a specific store in Tegucigalpa. BCH selects outlets on the basis of the last Survey of Households Income and Expenditures (ENIGH) conducted in 1999 and selects items within outlets on the basis of estimates of their relative sales. BCH collects prices monthly for most of mayor groups, but for some products such as food is weekly. Since our analysis focuses on monthly macroeconomic aggregates, these prices are then averaged to produce a monthly quote.

Our data set contains the monthly quotes of 229 items in 339 outlets across the three mains urban areas of Honduras (Distrito Central, San Pedro Sula, and La Ceiba). These data account for approximately 50% of the consumer expenditures. Items are grouped together according the Classification of Individual Consumption by Purpose (CCIF) in 10 categories of goods. We identify the presence of temporary sales based on the "sale filter", see Nakamura and Steinsson (2008) for additional description. The sample covers the period from January 2015 to December 2019.

2.1 Stylized Facts about Micro Price-Setting in Honduras

We take a first look at the data by computing some well-known stylized facts about micro prices for the case of Honduras.

2.1.1 Frequency of Price Adjustments

In Table 1, we show the frequency of price changes in Honduras using our micro data by sectors and across the entire economy. We also add the weight each of the sectors accounts for computing the CPI in the country.

The mean probability of price adjustments in the country of approximately 22%, which implies a price duration of roughly 12 months. The number is similar to the mean frequency of 20% reported for the US by Nakamura and Steinsson (2008), excluding sales.

Table 1: Frequency of price change by major group in 2015-2019

Sector	Weight	Mean frequency	Mean implied duration
Food and non-alcoholic beverages	36.2	33.1	8.9
Shelter, water, and energy	3.6	11.1	18.0
Alcoholic beverages and tobacco	2.2	6.2	13.2
Communications	1.4	9.2	20.4
Personal care	6.3	6.2	13.4
Household furnishings	12.9	4.4	17.3
Clothing and footwear	23.2	3.3	18.3
Recreation	7.5	2.8	19.8
Medical care	3.5	9.1	11.0
Transportation	3.2	36.4	9.4
All sectors	100	22.2	11.9

Notes: XX

With respect to the price-stickiness across categories, we notice that Food and non-alcoholic beverages are the ones whose prices change the most in the sample, followed by Transportation and Medical care. On the other extreme, sectors like communications and recreation keep their prices fixed for 20 months on average.

2.1.2 Price Changes

We aim to compute the probability of price adjustments as a function of the relative price logarithm. Following the pricing literature, Campbell and Eden (2014), we construct a measure to account for the possible benefits of a nominal adjustment. We construct a gap indicator that measures the individual price relative to the average of other stores' prices for the same product.

In order to calculate a measure of product-level price mismatch, we follow Karadi, Schoenle, and Wursten (2022), which defines a proxy for the competitor-price gap for product p in store s at month t, as the distance of the log of reference price (p_{pst}) relative to the log of average price of the same product across stores (p_{st}): $gap_{pst} = p_{pst} - p_{pt} - \alpha_s$. Where α_s is the average store-level gap that accounts for the fixed-effect heterogeneity across stores.

Figure A.2 in the Appendix displays the frequency of price changes as a function of the gap. First, if we take the average of the frequency in the y-axis we have roughly the 20% probability of updating that we show in the previous section. In terms of the gap distribution, there is not much probability mass in the tails. Hence, there are not many stores in the sample that keep their prices far from the consensus. In reality, most of prices tend to keep relatively close to the competition.

2.1.3 Hazard Rate

While the previous evidence shed some light with respect to state-dependent pricing, now we assess whether the data reflects some time-dependent adjustment patterns as well. For doing this, we compute the unconditional hazard-rate function, which shows the probability of a price revision as a function of the price's age, i.e., the number of months the price has remained unchanged. The hazard rate has become relevant as a validation of different models of price-setting. For instance, under the well-known Calvo (1983)'s model of price revisions, the adjustment probability should remain constant throughout the age's profile. Similarly, models of state-dependent price adjustments predict that the hazard rate must be upward-slopping. Intuitively, this happens since no price-setter would want to pay the cost of a price revision (menu cost) after a new and theoretical optimal price has recently been set.

Figure A.3 in the appendix displays the unconditional Hazard Rate for the case of

Honduras. We show that the empirical hazard rate is downward sloping as a function of the price age. While puzzling at first, this result is consistent in the empirical literature of price revisions, see Nakamura and Steinsson (2008) and Campbell and Eden (2014). Motivated by this fact, there are new models array of models aiming to rationalize this feature of prices.[5] We perform this exercise to further validate our micro price data and show that, while the Honduran price data has not being used much in pricing literature before, it delivers some of the same stylized facts.

3 Macroeconomic Spillovers of US Monetary Policy

In this section, we explore the aggregate consequences of a US monetary policy shock in Honduras. We start estimating the dynamic response of remittances after a monetary policy tightening in the US, and then we study the responses on other relevant macro variables.

3.1 Estimated Effects on Remittances

To quantify the dynamic effects of a US monetary policy shock on Remittances to Honduras, we estimate the following Smooth Local Projection (see, for example, Barnichon and Brownlees, 2019):[6]

$$x_{t+h} \approx \sum_{k=1}^{K} a_k B_k(h) + \sum_{k=1}^{K} b_k B_k(h) s_t^{mp} + \sum_{s=1}^{p} \sum_{k=1}^{K} c_{ik} B_k(h) \omega_{it} + u_{(h)t+h} \quad \forall h \in [0, 18] \quad (1)$$

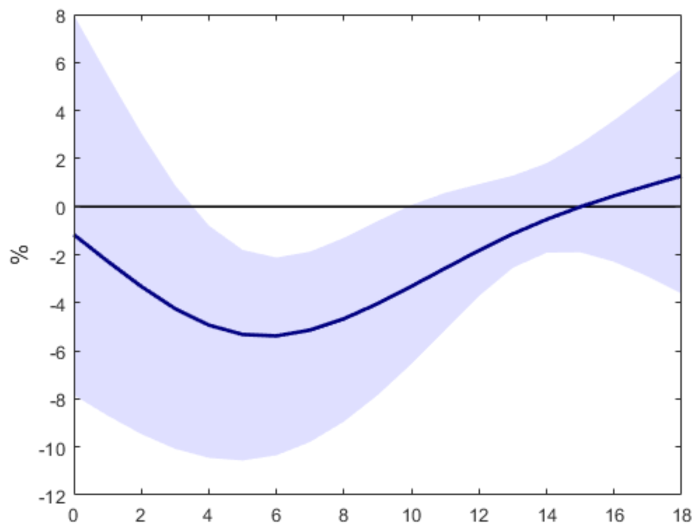
where x_{t+h} is the log of real remittances at different horizons, s_t^{mp} is the measure of US monetary policy shocks computed by Nakamura and Steinsson (2018), ω_{it} is a set of control variables that considers lagged values of real remittances, the 1-Year Treasury Bill

[5]For example, while Aruoba et al. (2023) reconciles the downward sloping rate of the hazard through a price-setting model with adjustment frictions, Baley and Blanco (2019) matches it relying on information frictions.

[6]We use Smooth Local Projections for our baseline analysis to obtain smoother IRFs in our relatively short sample. We present the results using Local Projections in Appendix XX.

Secondary Market Rate, the US High Yield Index, and US monetary policy shock series.[7] Finally, $\beta_h \approx b_k B_k(h)$ is the smoothing coefficient. Figure 1 displays the estimated effect in response to a one standard deviation US monetary policy shock.

Figure 1: Response of Remittances to One Standard Deviation US monetary policy shock



Note. Estimated effects of US monetary policy shock on real remittances from US to Honduras over the sample 2015M1-2019M12. Blue continuous lines denote the median IRFs to a US monetary policy shock. Shaded blue areas denote 95% confidence interval.

A monetary tightening in the United States induces a persistent and delayed decline in remittances in Honduras. An increase of 25 basis points in the US short-term interest rate causes a decrease of 5% in remittances 5 months after the shock.[8] The delayed response in remittances can be linked to the delayed effects of US monetary policy on US economic activity. The total effect last approximately two quarters.

[7]Remittances are deflated using the U.S. Consumer Price Index. Nominal remittances database is available `https://www.bch.hn/EN/institutional-policies/exchange-policy/exchange-statistics/foreign-exchange-balance`.

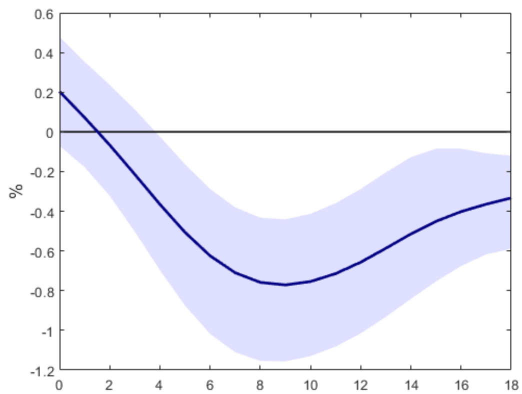
[8]We rescale the series of shocks from Nakamura and Steinsson (2018) such that in induces a monetary policy tightening of 25 basis points.

3.2 Estimated Business Cycles Effects

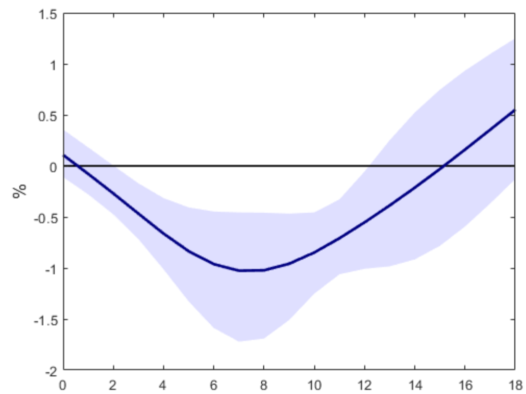
Considering that remittances represent around 20 percent of GDP on average in this sample, the negative effect on remittances may be coupled with strong effects in Honduras business cycle. We estimate the same specification as in equation (2) but instead of the remittances, we use both the Core and headline CPI, an economic activity index, and the nominal exchange rate in Honduras. Figure 2 displays the estimated impulse responses of both variables.

Figure 2: Response of Macroeconomic Variables in Honduras to a US Monetary Policy Shock

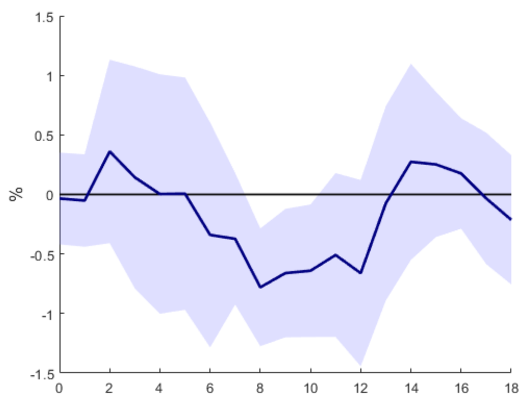
(a) Core CPI



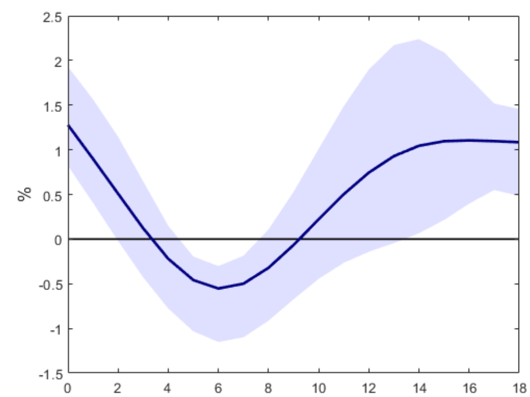
(b) Economic Activity



(c) Headline CPI



(d) Exchange Rate



Note. Estimated effects of US monetary policy shock on Core and Headline CPI, economic activity, and on the nominal exchange rate over the sample 2015M1-2019M12. Blue continuous lines denote the median IRFs to a US monetary policy shock. Shaded blue areas denote 95% confidence intervals.

Building on the response of remittances, after a 25 basis points monetary policy contraction in the US, the domestic price level drops significantly, attaining a 0.7 percent drop around a year after the shock. Similarly, economic activity also falls 1 percent in Honduras as a response to the shock, coupling the dynamics of the remittances. Interestingly, and in line with the results in Figure 1, while the negative effects of remittances start around the third or fourth months after the US monetary policy shock hits, the response of aggregate prices only becomes significant after the fifth month. The dynamics in prices are coupled with an appreciation of 0.5 percent in the exchange rate after the strong depreciation of 1.2 percent that occurs on impact in response to the shock. Hence, based on the timing of the responses, we interpret both the inflation and the activity response as being influenced by the initial drop in remittances. Moreover, the fact that the effects look like a demand shock plus the comovement between economic activity and remittances reinforces the idea that remittances may be an important driver. The effects of the shock last around 10 months. These results are robust to estimating the effects with local projection (see Figures A.6 and A.7 in Appendix C.1).

4 Price Effects of a US MP shock in Honduras

In this Section, we study the micro-price implications of the MP shock in the US. In particular, we study the effects of the shock on the probability of price adjustments and on the magnitude of such price revisions. Throughout the section, we compare the estimated effects with the ones caused by domestic monetary policy surprises along with the ECB and the Bank of England MP shocks.

4.1 Extensive Margin

We define $I^{\pm}_{pst,t+h}$ as a dummy variable that indicates whether a price of product p in store s has increased (decreased) between periods t and $t+h$. Through this variable we estimate the following Lineal Probability Model (LPM):

$$I^{\pm}_{pst,t+h} = \alpha^{\pm}_{psh} + \beta^{\pm}_{1}\Delta i^{US}_{t} + \beta^{\pm}_{2}Gap_{pst-1} + \beta^{\pm}_{3}Age_{pst-1} + \alpha^{\pm}_{mh} + \delta'_{h}\sum_{s=0}^{6} X_{t-s} + \epsilon^{\pm}_{psth} \tag{2}$$

Where $\alpha^{\pm}_{psh}$ is a product-store fixed effect, Δi^{US} is the Nakamura and Steinsson (2018) measure of the US monetary policy shock revealed at the FOMC announcement dates, Gap_{pst-1} is one-month lagged price gap, Age_{pst-1} is the lagged age of a price (in logs), $\alpha^{\pm}_{mh}$ is a Calendar-month fixed effects and where X_{t-s} are an additional set of controls including the (log) core consumer price index, the (log) monthly economic activity index, and interbank lending market rate of Honduras, and 1-Year Treasury Bill Secondary Market Rate as US policy indicator. In the estimation, we clustered the standard errors across groups and time. We also rely on the rescale series of shocks, as we did in the previous sections. The results of estimating (2) by OLS are presented in Table 2.

Table 2: Probability of a Price Adjustment

	(1)	(2)	(3)	(4)
	Price increase $(I^{+}_{pst,t+12})$		Price decrease $(I^{-}_{pst,t+12})$	
Δi^{US}_{t}	-22.07***	-22.07***	5.74***	5.74***
	(6.23)	(6.22)	(1.22)	(2.55)
Gap_{pst-1}	-0.58***	-0.58***	0.34***	0.34***
	(0.10)	(0.10)	(0.06)	(0.06)
Age_{pst-1}	0.06***	0.06***	0.002	0.002
	(0.01)	(0.01)	(0.006)	(0.007)
$Gap_{pst-1} \times \Delta i^{US}_{t}$		-1.48		-0.06
		(2.09)		(4.23)
Product-Store FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓
N	339,280	339,280	339,280	339,280
within R^2	0.328	0.328	0.061	0.061

As noticed, a 25 basis point MP tightening in the US brings a drop of roughly 22% in the probability of a price increase in the next twelve months. Likewise, the same tightening increases the probability of a price decrease in Honduras by approximately 6% in the same horizon. These two effects reflect the asymmetric response of price adjustments to the same shock.

The gap with respect to the average price of competitors also matters for triggering price adjustments. In particular, a higher distance between the actual price and the competitors correlates negatively (positively) with the probability of an upward (downward) price revision. Thus, the direction of the adjustment is consistent with the different stores aiming to close or reduce the gap. With respect to the age of a price, we notice that the probability of a positive price revision significantly increases by approximately 0.06% with the number of months the price has remained unchanged. However, age is not a significant predictor for the decision to adjust prices downwards.

In Table 3, we show the results for the probability of adjustment after adding the MP shock in Honduras and the ECB and the BoE monetary policy surprises to our baseline specification. The domestic MP shock is identified using sign restrictions (see, for example, Uhlig, 2005). We identify a monetary policy shock as the rotation of the reduced form residuals that a contractionary monetary policy shock in Honduras induces a decline in CPI index, an increase in the short-term interest rate, and an appreciation of the domestic currency. Appendix C.2 describes the identification strategy in more detail and presents the estimated macroeconomic effects of a 25 basis points monetary policy tightening in Honduras. We use the series of monetary surprises of the ECB and the Bank of England computed by Altavilla et al. (2019) and Cesa-Bianchi, Thwaites, and Vicondoa (2020), respectively.

As expected and consistent with the evidence that most of the Remittances come from the US, neither of these two former shocks brings any meaningful effect on the extensive margin of prices. A positive domestic shock, instead, significantly decreases the probability of an upward revision of prices by 56% while it increases the chances of a price decrease by 11%. As noticed, the magnitude of the US shock on the adjustment probability is non-negligible as it roughly accounts for half of the effect that a local shock will bring into the

Table 3: Probability of a Price Adjustment - All Shocks

	(1)	(2)	(3)	(4)	(5)	(6)
	Price Increase ($I^{+}_{pst,t+12}$)			Price Decrease ($I^{-}_{pst,t+12}$)		
Δi_t^{US}	-22.07***	-24.19***	-26.13***	5.74***	5.91***	6.29***
	(6.23)	(4.47)	(4.84)	(1.21)	(1.81)	(0.67)
Δi_t^{HND}		56.25***	59.64***		11.27***	11.91***
		(7.26)	(8.36)		(1.75)	(0.83)
Δi_t^{EU}		0.01	0.03		-0.02	-0.02
		(0.10)	(0.10)		(0.02)	(0.02)
Δi_t^{Eng}			6.30			-1.22
			(8.93)			(3.62)
Gap_{pst-1}	-0.58***	-0.58***	-0.58***	0.34***	0.34***	0.34***
	(0.10)	(0.10)	(0.10)	(0.06)	(0.09)	(0.09)
Age_{pst-1}	0.06***	0.06***	0.06***	0.002	0.002	0.002
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Product x store FE	✓	✓	✓	✓	✓	✓
Month FE	✓	✓	✓	✓	✓	✓
N	339, 280	339, 280	339, 280	339, 280	339, 280	339, 280
Within R^2	0.327	0.332	0.332	0.062	0.062	0.062

economy.

4.2 Intensive Margin

Given the evidence about the probability of changing prices, we now explore the magnitude of price revisions as a response to the shock. In this case, we can estimate the cumulative percentage change h months ahead. In particular, we estimate the following LP model.

$$\Delta p_{pst,t+h} = \alpha_{psh} + \beta_1 \Delta i_t^{US} + \beta_2 Gap_{pst-1} + \beta_3 Age_{pst-1} + \alpha_{mh} + \delta_h' \sum_{s=0}^{6} X_{t-s} + \epsilon_{psth} \quad (3)$$

Where $\Delta p_{pst,t+h}$ corresponds to the log difference between individual prices at time t and $t+h$. For comparison, we add the same controls and fixed effects as in equation (2). Assuming $h = 12$, we present the results of (3) in Table 4.

A positive MP surprise in the US leads prices in Honduras to decrease by approximately

Table 4: Magnitude of Price Revisions

	(1)	(2)	(3)
Δi_t^{US}	-1.92*	-2.25*	-2.26*
	(0.64)	(0.76)	(0.72)
Δi_t^{HND}		-3.46**	-3.43**
		(1.18)	(1.21)
Gap_{pst-1}	-0.59***	-0.59***	-0.59***
	(0.04)	(0.04)	(0.05)
Age_{pst-1}	0.002	0.002	0.002
	(0.004)	(0.002)	(0.004)
$Gap_{pst-1} \times \Delta i_t^{US}$			2.95
			(3.49)
Product-Store FE	✓	✓	✓
Time FE	✓	✓	✓
N	269,421	269,421	269,421
with in R	0.136	0.136	0.136

1.9%. Likewise, a monetary surprise by the local Central Bank will bring a 3.4% downward adjustment. This reinforces the aforementioned connection between the two economies and the relevance of the remittances channel, as the effects are roughly similar in magnitude. In terms of the distance with respect to the competitor's prices, whenever $Gap > 0$, prices are adjusted downwards and by a magnitude of 0.6% on average. As expected, the price age does not play a significant role in the intensive margin. While we interpret age as a relevant trigger for the adjustment decision, we do not expect this variable to play any role in the magnitude of adjustments. The evidence is consistent with the absence of selection effects on price revisions.

4.3 Dynamic Response of Price Revisions

While the evidence suggests that, indeed, a monetary policy tightening in the US will cause pricing revisions in Honduras over the next twelve months, we now turn to study its underlying adjustment dynamics. In particular, we aim to explore whether prices react right upon impact or if they take some time to adjust after the shock. Studying the timing of the response will shed some light on the actual transmission of such international MP shocks.

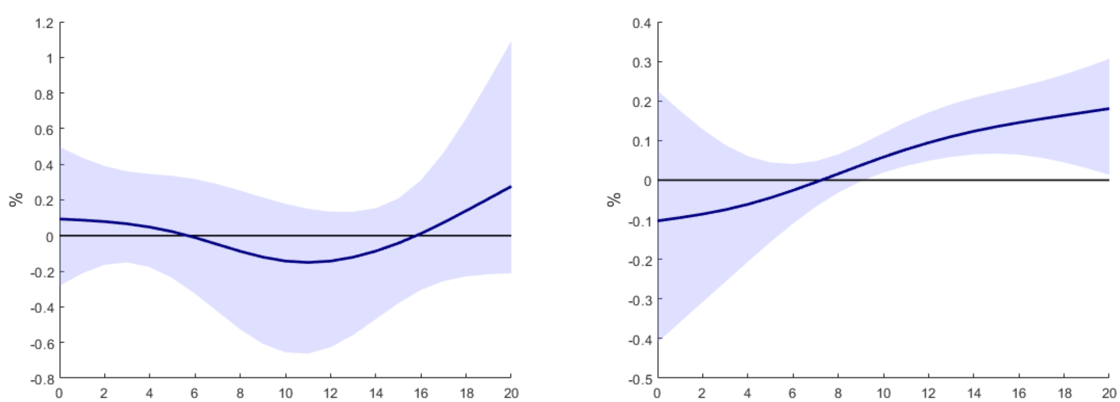
Using the microdata on prices, and as shown in Figure A.5, for each month over the sample period, we construct the share of prices that are revised upwards and downwards. With this information at hand, we run the following regression:

$$S_{t+h}^{\pm} \approx \sum_{k=1}^{K} a_k B_k(h) + \sum_{k=1}^{K} b_k B_k(h) s_t^{mp} + \sum_{s=1}^{p} \sum_{k=1}^{K} c_{ik} B_k(h) \omega_{it} + u_{(h)t+h} \quad \forall h \in [0, 18] \quad (4)$$

Where $S_{t+h}^{\pm}$ is the share of prices that are revised upward or downward, depending on the specification. Again, s_t^{mp} are the rescaled Nakamura and Steinsson (2018)'s US monetary policy shocks, and ω_{it} is a set of control variables that include lagged values of the dependent variable, the monthly inflation in Honduras and monthly dummies to account for possible aggregate time-dependent patterns in price revisions. Again the smoothing coefficient $\beta_h \approx b_k B_k(h)$. Figure 3 shows the results after estimating equation (4).

Figure 3: Response of Probability of Price Change in Honduras to a US Monetary Policy Shock

(a) Probability of Prince Increase (b) Probability of Prince Decrease



Note.

Panel (a) of Figure 3 shows the results for a positive revision. As noticed, although at medium horizons, the probability of upwards revisions decreases, the responses are not statistically significant. Interestingly, the share of firms that revise their prices downward is positively affected by the shock. As shown in panel (b) of Figure 3, the response is significant after horizon 9. In fact, the probability of price decreases increases by approximately 0.1 percentage points a year after the shock. We conjecture that the delayed effect is explained by the spillover effects of the shock in Honduras, such as the drop in real activity.

5 Conclusions

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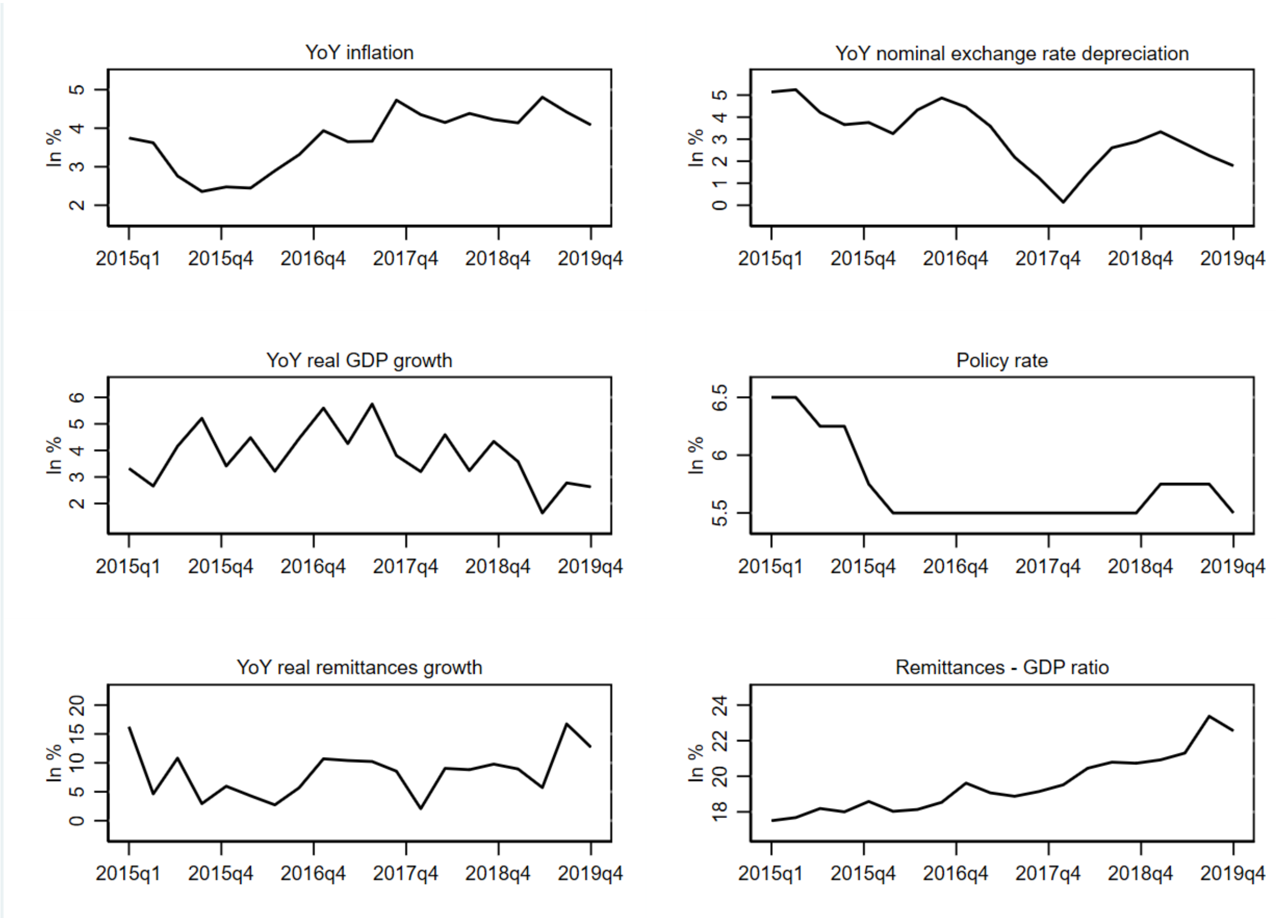
Figure A.1: Macroeconomic Indicators of Honduras



A Data Appendix

B Stylized facts about micro price-setting in Honduras

B.1 Price Changes

Figure A.2: Competitor Price-Gap Density

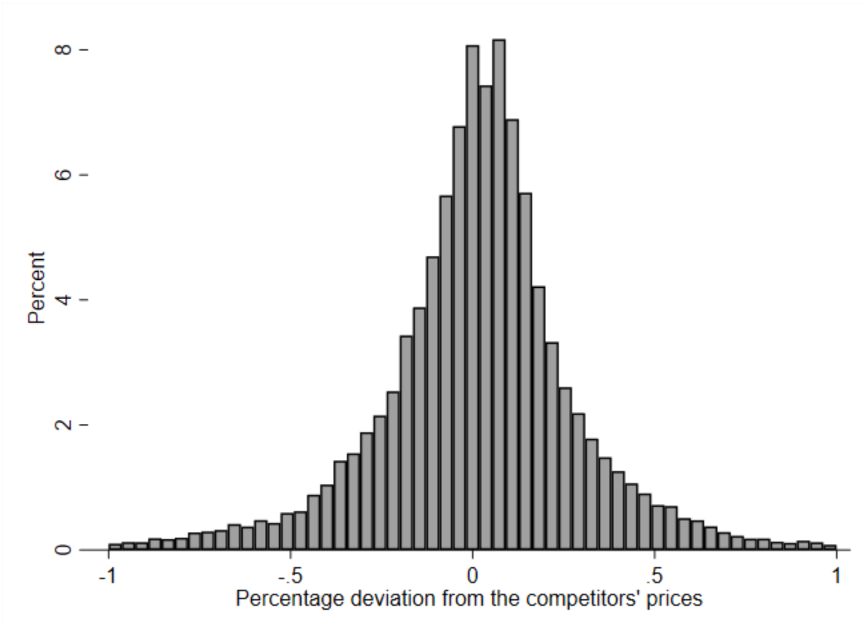


Figure A.3: Hazard Rate

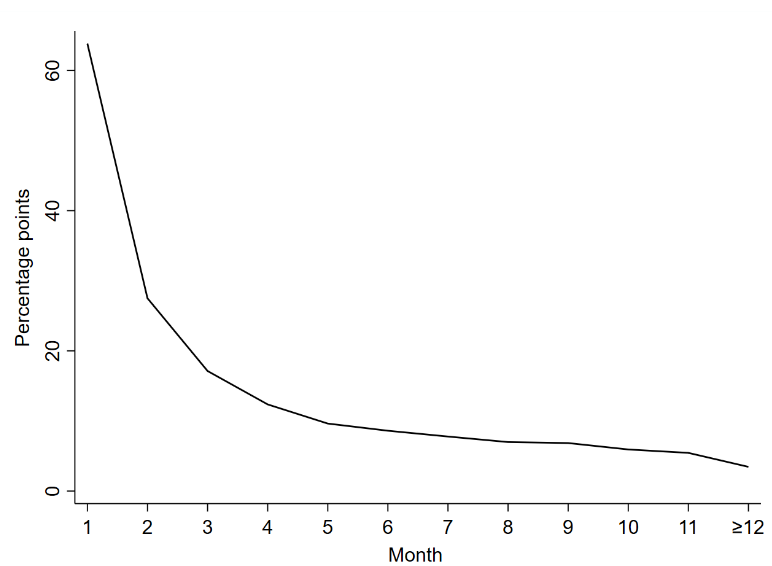


Figure A.4: Mean Frequency of Price Changes as Function of Number of Goods Sold by Stores

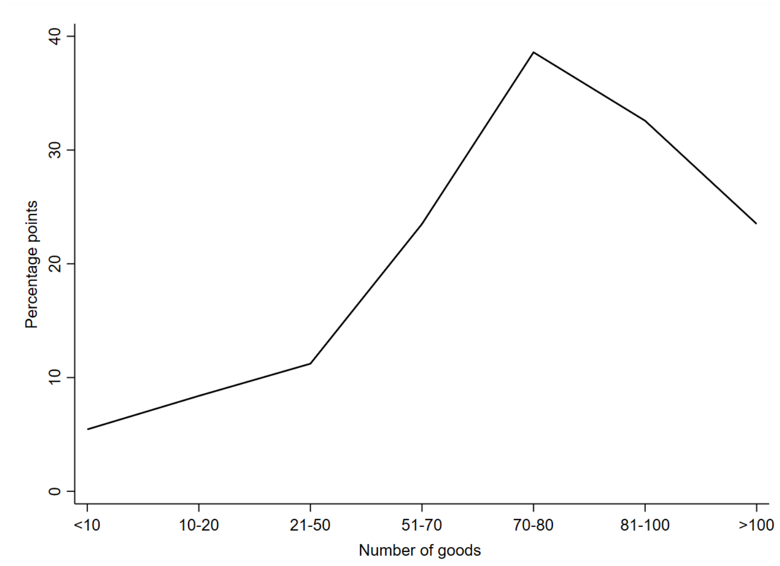
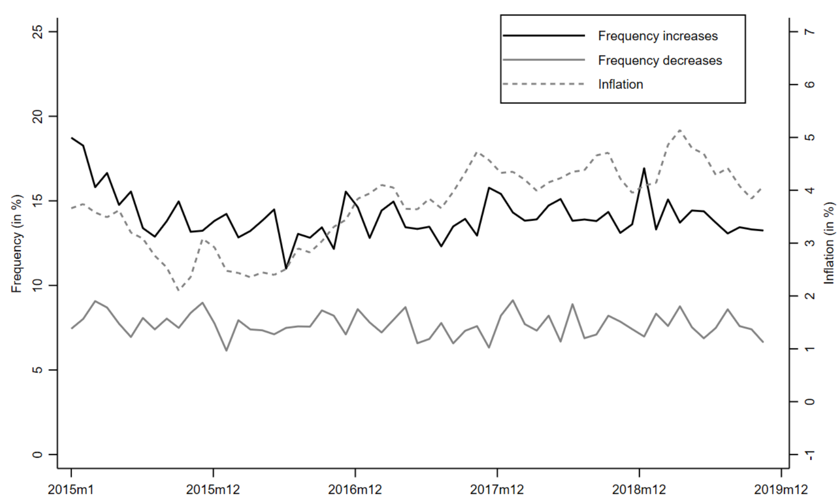


Figure A.5: Mean Frequency of Price Changes and Inflation



C Additional Macroeconomic Results

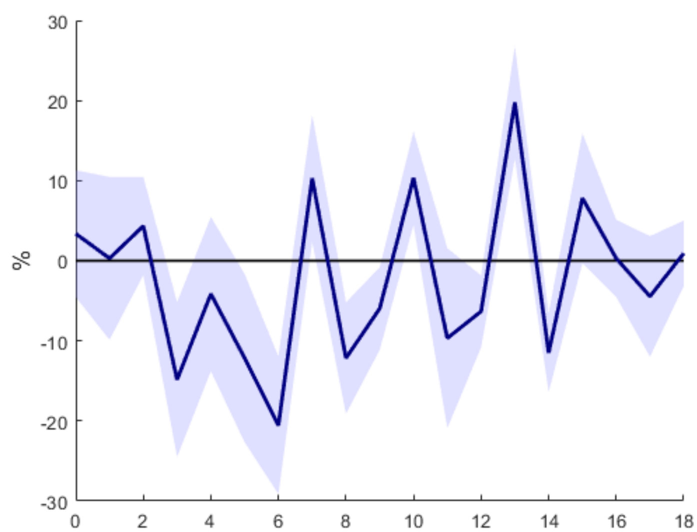
C.1 Local Projections

In this section we present the estimated effects of the US monetary policy shock on the main macroeconomic variables in Honduras using Local Projections instead of Smooth Local Projections. In particular, we estimate the following specification:

$$x_{t+h} = a_h + \sum_{k=1}^{K} b_k(h) s_t^{mp} + \sum_{k=1}^{K} c_k(h)\omega_t + u_{(h)t+h} \quad \forall h \in [0, 18] \tag{5}$$

Figure A.6 displays the response of remittances to the US monetary policy shock. We still observe a decline in remittances some months after the shock with a peak effect of around 1.5 percent, which is in line with the estimated effect using Smooth Local Projections.

Figure A.6: Response of Remittances to One Standard Deviation US monetary policy shock



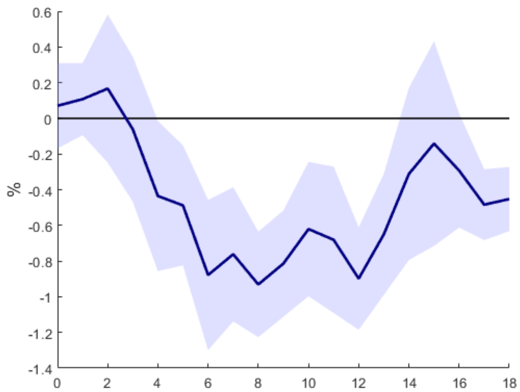
Note. Estimated effects of US monetary policy shock on real remittances from US to Honduras over the sample 2015M1-2019M12. Blue continuous lines denote the median IRFs to a US monetary policy shock. Shaded blue areas denote 90% confidence bands based on Newey-West standard errors.

Figure A.7 displays the response of Core CPI and industrial production to the US monetary policy shock. The results are also consistent with the ones presented in Section

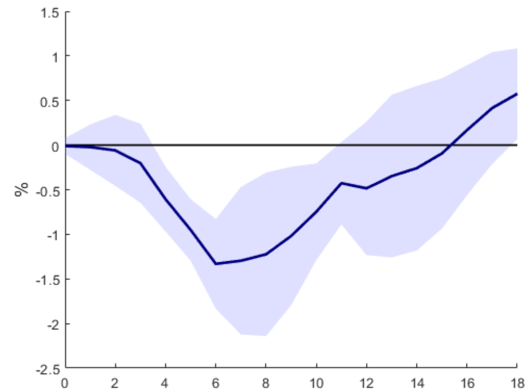
3. Both Core CPI and industrial production decline with a delay and after the decline in remittances, which may suggest that remittances is one important driver of the spillovers.

Figure A.7: Response of Macroeconomic Variables in Honduras to a US Monetary Policy Shock

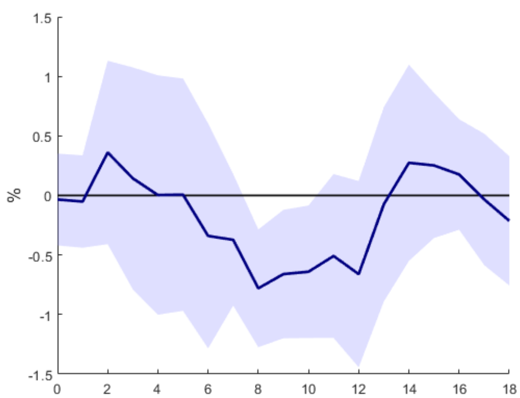
(a) Core CPI



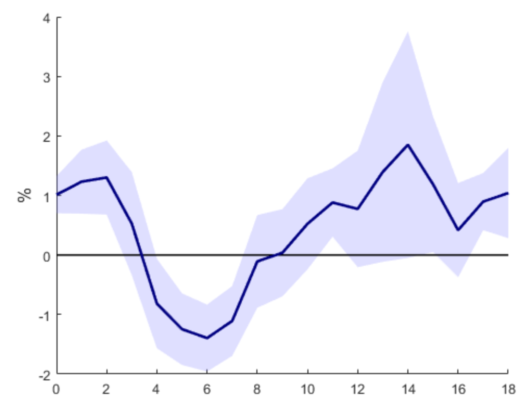
(b) Economic Activity



(c) Headline CPI



(d) Exchange Rate



Note. Estimated effects of US monetary policy shock on Core and Headline CPI, economic activity, and on the nominal exchange rate over the sample 2015M1-2019M12. Blue continuous lines denote the median IRFs to a US monetary policy shock. Shaded blue areas denote 90% confidence intervals.

C.2 Estimating the Effects of a Monetary Policy Shock in Honduras

Unfortunately there are no series of identified monetary policy shocks for Honduras from previous works. We identify a monetary policy in Honduras using sign restrictions (see, for example, Uhlig, 2005). We estimate a monthly VAR that includes the following variables: Fed Funds rate (FRED Code: FEDFUNDS), a commodity price index (All Commodity Price

Index computed by the IMF), an index of economic activity, the Consumer Price Index, the monetary policy interest rate targeted by the Central Bank of Honduras, and the nominal exchange rate relative to the US Dollar.[9] The VAR is estimated over the sample 2005:5-2019:12 to exploit additional variability before 2016 and obtain a more precise estimate of the shock series.[10] We identify a monetary policy shock as the rotation of the reduced form residuals that a contractionary monetary policy shock in Honduras induces a decline in CPI index, an increase in the short term interest rate and an appreciation of the domestic currency. We impose the restrictions for 6 months ahead. Following Uhlig (2005) we leave the response of economic activity unrestricted. Figure A.8 displays the IRFs to a 25 basis point contractionary monetary policy in Honduras.

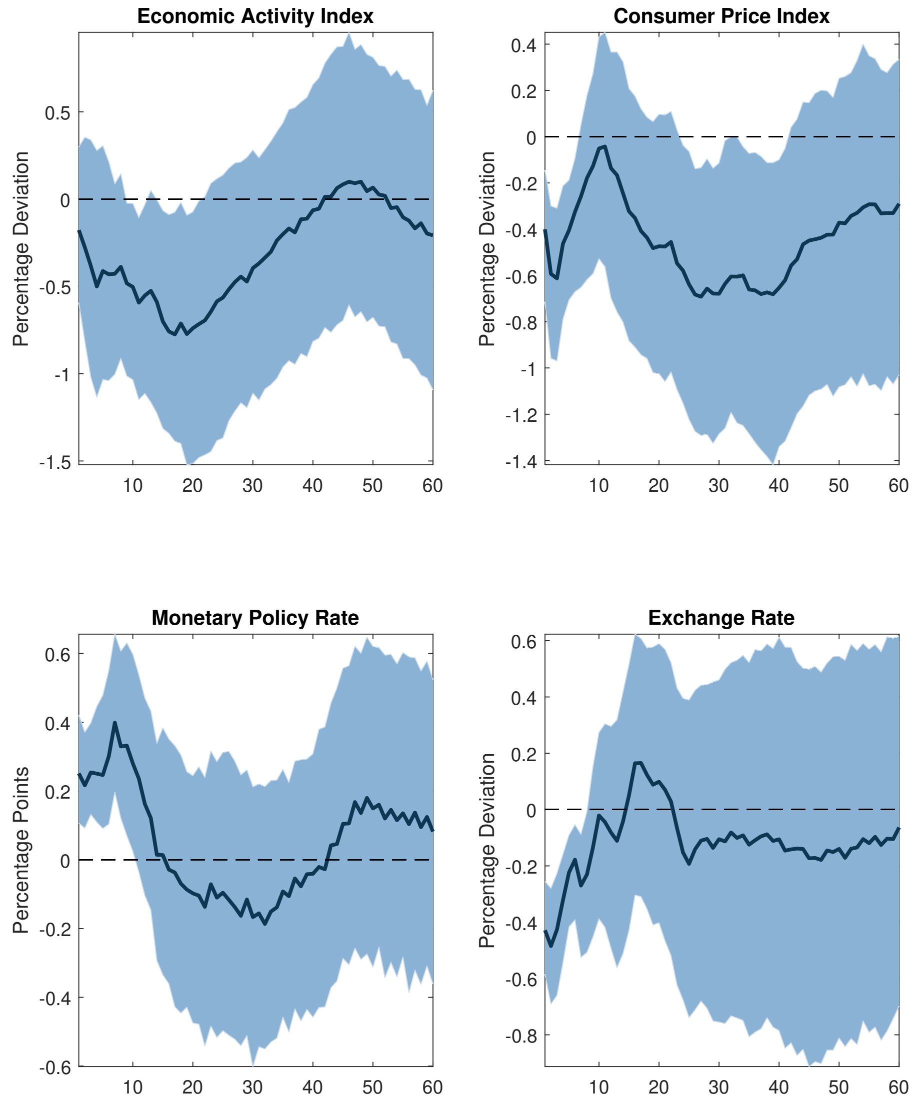
The increase of 25 basis points in the monetary policy interest rate induces an immediate appreciation of around 0.4 percent in the domestic currency relative to the US Dollar which lasts around 10 months. This appreciation may contribute to explain the immediate decline in the Consumer Price Index, which declines by approximately the same magnitude and also lasts 10 months. The shock also induces a decline of around 0.75 percent in economic activity one year and a half after the shock hits the economy. While the effect on consumer price index and exchange rates are partially explained by the identification strategy, the effect on economic activity is unconstrained and the estimates are consistent with the empirical evidence for other economies. Figure A.9 displays the identified series of US monetary policy shock.[11] The identified series of monetary policy shocks does not display outliers and reflects different monetary policy decisions of the Central Bank. The major change

[9]The links to the series are as follows: commodity prices (https://www.imf.org/-/media/Files/Research/CommodityPrices/Monthly/external-datamay.ashx), an index of economic activity which covers different production sectors of the economy (IMAE - https://www.bch.hn/EN/economical-statistics/real-sector/monthly-economic-activity-index), the Consumer Price Index (https://www.bch.hn/EN/economical-statistics/price-publications), monetary policy interest rate (https://www.bch.hn/politica-institucional/politica-monetaria/tasa-de-politica-monetaria), nominal exchange rate with the US Dolar (https://www.bch.hn/estadisticas-y-publicaciones-economicas/tipo-de-cambio-nominal).

[10]The sample period is restricted by the availability of the monetary policy interest rate, which starts in May 2005.

[11]This series is obtained using the median from all the rotation matrices that satisfy the sign restrictions times the reduced form residuals.

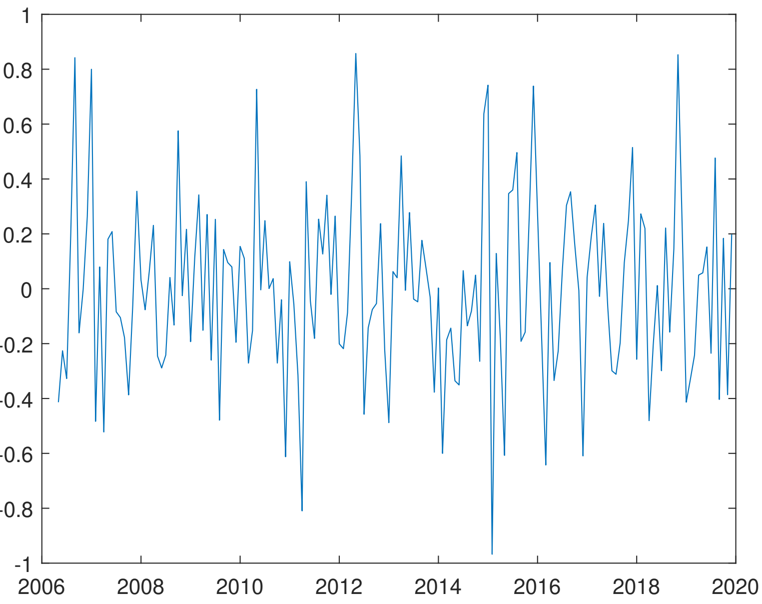
Figure A.8: Impulse Responses to Honduras Monetary Policy Shock



Note. Estimated effects of Honduras monetary policy shock on industrial production, CPI index, and exchange rate with respect to US Dolar in Honduras over the sample 2005M1-2019M12. The monetary policy shock is identified using sign restrictions. Blue continuous lines denote the median IRFs. Shaded blue areas denote 68% confidence bands.

during this sample is that Honduras changed in July 2011 from a fixed exchange rate regime to a managed floating regime which gave the Central Bank of Honduras more space to do monetary policy. The identified series displays a mild increase in the volatility after that date.

Figure A.9: Series of Honduras Monetary Policy Shock



Note. Identified series of Honduras monetary policy shock for the sample 2006M5-2019M12. The monetary policy shock is identified using sign restrictions.