US Monetary Spillovers to Latin America: The Role of Long-term Interest Rates*

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Abstract

This paper evaluates the effect of US bond yields on economic fundamentals of Latin American economies from a unified perspective. We rely on Factor-augmented VAR models to assess spillovers from US to the economies of Brazil, Chile, Colombia, Mexico and Peru. The results document a substantial degree of comovement among Latin American countries in their economic fundamentals, which is translated into similar responsiveness across country to US shocks. Specifically, we find that unexpected increases in US long-term rates increases unemployment, inflation, exchange rate, and decreases stock market returns in Latin American countries. Moreover, there is evidence of significant spillover effects of US interest rates to domestic bond yields, with a more significant role of the term premium channel during the zero lower bound period, and a more muted response of risk neutral rates.

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1 Introduction

The economic situation in emerging markets has deteriorated in recent years. Perhaps the single most important event, especially for LATAM, has been the end of the so called commodity super cycle, which intensified with the collapse in oil prices in late 2014. But the trend of weaker currencies and rising inflation can in many cases be traced back at least a year earlier to the taper talk episode in May of 2013. This event was a stark reminder of the interdependence of monetary conditions in small countries with core financial centers, and about the fickle nature of global liquidity and the consequences of its evaporation for developing economies.

Since that episode, the actual FED liftoff date has been on the short list of concerns of virtually every central bank in LATAM, and for good reasons. There is now plenty of evidence showing a link between global liquidity "push factors" and their consequences on key variables in EME.[1] The central narrative in this literature is that lax monetary conditions in core zones, such as the US and the ECB, incentivize more risk taking in the form of maturity extension within the risk-free yield curve (indeed, this is the explicit mechanism by which QE is supposed to work),[2] or through portfolio rebalancing of fixed income assets with different default risk, such as a substitution from treasuries to investment grade bonds, mortgages, all the way to fixed income and equity markets in the emerging world. The obvious concern is that this mechanism works in reverse too, and that a FED tightening might produce a further depreciation of exchange rates in a situation where most countries in the region are already deviating from their explicit inflation targets.

This paper contributes to the literature by studying spillovers from monetary conditions in the US to the 5 largest economies in LATAM (with reliable economic indicators), including Brazil, Chile, Colombia, Mexico, and Peru. One way to go about this question is through a country-by-country analysis. However, this approach makes it hard to convey a coherent narrative for the region without falling into idiosyncrasies of each economy. It also misses the potentially rich interactions between different countries in the region, a potentially important omission, given the close trade and financial ties between them.

[1] See Rey (2015); Bruno and Shin (2015); Ahmed and Zlate (2014); and Obstfeldt (2015).

[2] See Hanson and Stein (2015), Greenwood and Vayanos (2014), and Krishnamurthy and Vissing-Jorgensen (2011).

To tackle these issues we propose a factor-augmented restricted vector autoregressive (FAVAR) approach that includes an exogenous block information. Under this approach, we first compute a set of factors that are representative of the LATAMs performance in different dimensions. We include here an unemployment factor as a measure of real activity, an inflation factor, an exchange rate factor, and a stock market factor. We then model the dynamics of the estimated factors in a vector autoregressive framework including an exogenous block that contains information about US interest rates. This framework allows us to describe the effects of shocks to interest rates in the US on a particular variable in a specific LATAM country by tracing the dynamics of the associated factor. This is a suitable methodology for our purposes, as it allows assessing spillovers from US monetary conditions to the region in a parsimonious way, while at the same time keeping controlled the dimensionality of the problem.

To preview the results from applying this methodology, we find that for our sample period under study (2003 - 2015), there are significant spillovers from US monetary conditions into LATAM. We find that an unexpected increase in US 10-yr yields is associated with higher unemployment, higher inflation, a fall (depreciation) of local currencies vis-a-vis de USD, and a drop in stock markets. These effects hold for most LATAM countries, with Mexico being an important exception that can be rationalized by its much closer trade ties and proximity to the US.

One shortcoming of the data is the lack of systematic interest rate information for LATAM in the earlier part of the sample. To assess the spillover effects into monetary conditions in LATAM, we proceed in two parts. First, we estimate an alternative FAVAR using a shorter subsample beginning in Jan. 2009, date after which long-term (10-yr) interest rate data is available for all countries. In this exercise, we find significant spillover effects of long-term interest rates in the US to those in LATAM, but find generally insignificant effects on the other factors. One possibility is that after the GFC, economic fundamentals in the region -affected among other forces by the commodity super cycle– have diverged from those in the US to a large extent, which could explain why interest rates similarities at the long end of the yield curve might not show up elsewhere.[3]

[3]This result is consistent with Gilchrist et al. (2015), who show that the impact of US monetary policy shocks on EME exchange rates is largely diminished after 2009.

Second, we specialize in two specific countries with long dated yield curve information; Chile and Mexico. In this exercise, we study US interest rate spillovers using weekly data from financial variables, including exchange rates, stock returns, and bond yields. Moreover, we decompose long term rates into a risk neutral component that captures the future evolution of short-term interest rates, and a term premium component that reflects compensation for risk.[4] The same exercise is carried out with two subsamples, (i) before the Zero Lower Bound (ZLB) period (2003 - 2008), and (ii) during the ZLB (2009 - 2015). The results confirm that US interest rate spillovers after the ZLB, period associated to the GFC, are concentrated on bond yields, particularly on the term premium component. The effects on exchange rates are much smaller in the post crisis period than in the earlier subsample, while the impact on stock returns is not statistically significant.

There is a growing literature trying to understand the transmission of global liquidity conditions into EME, including the papers cited above. More specifically, a recent literature from fixed-income and yield curve modeling has attempted to quantitatively evaluate the effect of different monetary policy measures in core economies (typically conventional and unconventional FED MP measures) on interest rates at different maturities in said country, as well as the international spillover of such measures into interest rates abroad.[5] We see our contribution to this literature as twofold. First, we focus specifically on LATAM, which shares similarities with other EME but also displays important differences in economic structure, in particular the reliance on commodities. Second, we rely on an identification approach (the FAVAR model) that allows to trace the effects of US interest rate spillovers on several variables (including activity, prices, and financial markets) while keeping the dimensionality of the system at check. Indeed, we see as a potentially important result the fact that, while US interest rates have had a large degree of spillovers into long term rates in LATAM, the effects on other financial and real variables is weaker in the post 2009 sample.

The rest of the paper is structured as follows. In section 2, we document a significant degree of comovement within LATAM in a number of dimensions, and construct our set

[4]We perform the term structure decomposition following the methodology described in Adrian et al. (2013)

[5]See Gagnon et al. (2011); Christensen and Rudebusch (2012); Hellerstein (2011); Bauer and Rudebusch (2014); Gilchrist et al. (2015); Hoffman and Takats (2015); BIS (2015); Miyajima et al. (2014); and Albagli et al. (2015).

of factors. In section 3 we describe the proposed FAVAR model with exogenous block, its estimation, and report the main results regarding the spillover effects of US interest rate shocks under different specifications and sample periods. In section 4, we perform the individual case studies of Chile and Mexico with VAR models, at a weekly frequency, based on financial variables only. Section 5 concludes.

2 Comovements in Latin American Economies

Latin American countries not only have strong ties with the US economy; they have strong commercial ties with each other as well. In previous studies, Imbs (2004) and Ductor and Leiva-Leon (2015) show that trade is a key driver of the comovement among the major world economies, and Latin American countries are not the exception. Our analysis focuses on the largest economies of Latin America, Brazil, Chile, Colombia, Mexico and Peru. We exclude Argentina from the sample due to the unreliability of official figures, particularly for inflation, exchange rate, and activity data.[6]

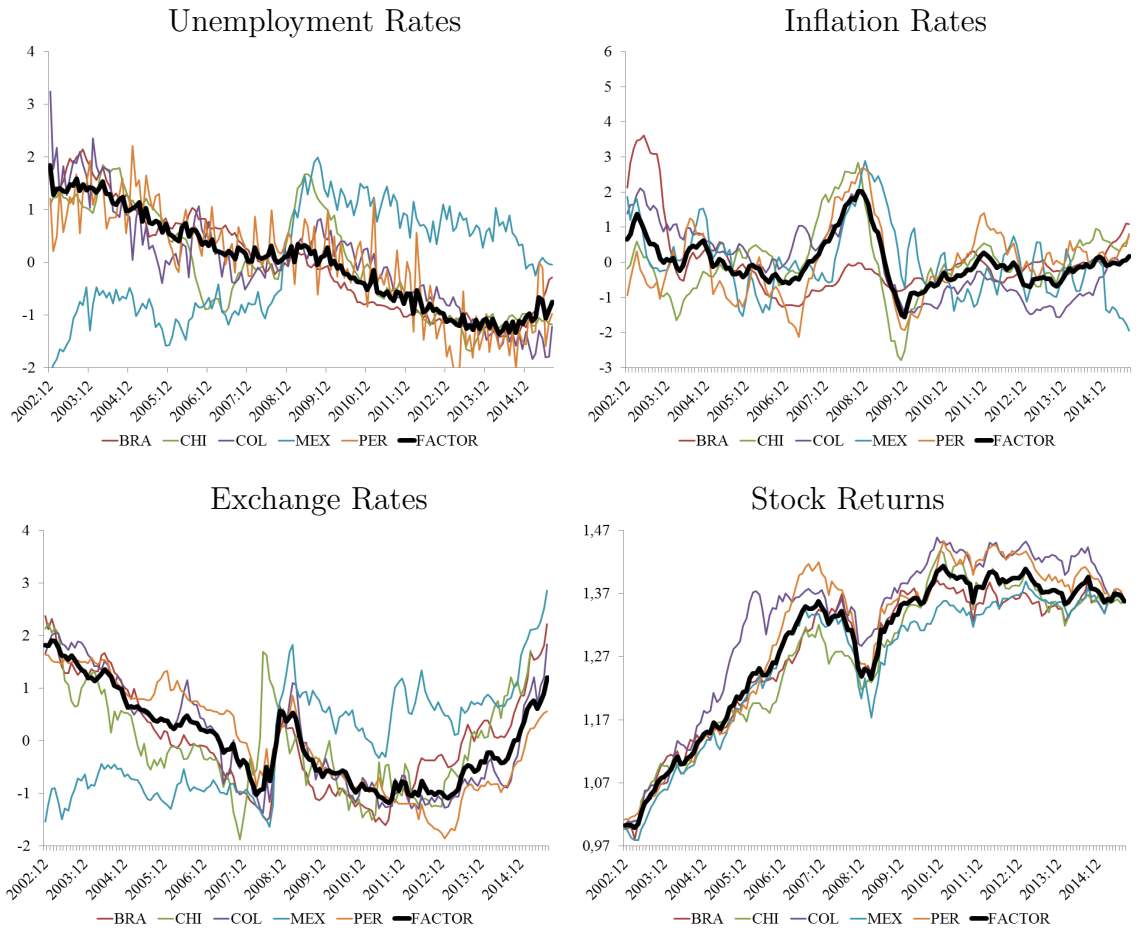
This section focuses on comovements among countries along four dimensions of economic fundamentals. First, we use the unemployment rate as a measure of the business cycle, which has the advantage of being available at monthly frequency and displays less volatility than industrial production. Second, as a measure of inflation dynamics we use the year on year growth rate of the Consumer Price Index. Third, we use the nominal exchange rate with respect to the US dollar (in levels). Fourth, we include information about the evolution of financial markets by using monthly stock returns. To abstract from hyperinflation and highly volatile periods, we focus on a sample of data that extends from January 2003 until August 2015.

To assess the degree of comovement in unemployment rates, denoted by $u_{i,t}$, for $i =$ Brazil, Chile, Colombia, Mexico and Peru, we rely on factor analysis and extract the first principal component, f_t^u, such that country-specific unemployment rates can be decomposed into common and an idiosyncratic components:

$$u_{i,t} = \lambda_i^u f_t^u + \epsilon_{i,t}, \tag{1}$$

[6]In fact, the IMF the unprecedented step in February 2013 of censuring this member, encouraging the country to improve its efforts to meet the IMF standards for inflation and GDP data.

Figure 1: Comovement in economic fundamentals in Latin America



Note: Each chart of the figure shows the data across country (color lines) used to extract the first principal component or common factor (black line).

where λ_i^u are the estimated factor loadings, and the common component, f_t^u, can be interpreted as a measure of Latin American unemployment. In the top left chart of Figure 1 we plot the country-specific unemployment rates, along with the Latin American unemployment. All the data in Figure 1 has been standardized for ease of comparison. The figure shows a strong comovement between Brazil, Chile, Colombia, and Peru, following a decreasing trend since the early 2000s up until 2014, and a moderate increase in the current year. The only significant exception is Mexico, which experienced an important increase in the level of unemployment rate in 2009. Such increase is not hard to rationalize due to the close commercial ties with the US economy and the recession that was taken place at that time.

The same procedure is used to extract the common component among inflation rates, $\pi_{i,t}$, obtaining a measure of Latin American inflation, f_t^{π}, shown in the top right chart of Figure 1. Inflation across countries have remained relatively stable, with the exception of the 2008-2009 period, when inflationary pressures increased temporarily. In the more recent periods, inflation has started to pick up, related in most cases to the strong currency depreciation. Again, an important exception is Mexico, with recent inflation receding even below their expected target.[7]

The bottom left chart of Figure 1 shows the country-specific exchange rates with respect to the dollar, $\chi_{i,t}$, along with a Latin American measure of exchange rate, f_t^{χ}. Similar to the case of unemployment rates, exchange rates have experienced a significant degree of co-movement, showing a continuous increase since 2013, period identified with Ben Bernanke's taper talk, and the global strengthening of the US dollar ever since. Although we extract the common factor of stock markets monthly returns across countries, $p_{i,t}$, we recover the level of stock market data to facilitate the interpretation and plot it along with the the Latin American index of stock markets, f_t^{p}, in the bottom right chart of Figure 1. The chart shows that the continuous growth of Latin American stock returns until 2007, followed by a significant downturn in 2008-2009, associated to the Great Recession in US. This is followed by a quick recovery up to 2011, period after which the stock market factor has been relatively flat, with some deterioration in the las few months of the series.

We performed a variance decomposition analysis, which is reported in Table 1 showing the share of each country's economic variables that are explained by the respective economic factor. For example, the first column of the table reports the share of unemployment rate's volatility of each country that is explained by the unemployment factor alone. The factors of unemployment and exchange rates explain a largest fractions of the country-specific series in most cases (with the exception of Mexico), while for inflation the comovement is somewhat less, although still explaining a significant fraction is some cases.

Overall, this section provides evidence of strong comovement patterns in Latin American economic fundamentals. Brazil, Chile, Colombia, and Peru experience similar fluctuations in the unemployment rate, inflation, exchange rates, and stock returns. Mexico, on the

[7]According to the Bank of Mexico's latest (June) inflation report (Bank of Mexico, 2015), inflation remains low mostly due to the lack of wage pressures in the context of a relatively weak labor market, despite the exchange rate pass through pressures due to the recent depreciation of the currency.

Table 1: Fraction of country-specific variables explained by common factors

	UR	INF	EXC	STO
BRA	0.93	0.16	0.79	0.73
CHI	0.74	0.53	0.83	0.58
COL	0.82	0.64	0.96	0.52
MEX	0.44	0.35	0.08	0.71
PER	0.82	0.58	0.84	0.64

other hand, shows some important differences, in particular unemployment and inflation, that can be attributed to its proximity and strong integration with the US economy.

3 Assessing International Spillovers

We now study the spillover effects of monetary conditions in the US to Latin American countries. As highlighted in the introduction, there are several recent papers that study the implications of global liquidity conditions more generally, and interest rate spillovers more specifically, into EME. Our central contribution relies on the sample choice, namely LATAM, and the identification strategy based on the FAVAR approach. While several papers base their identification on event study analysis,[8] a VAR-based approach identifies US interest rate "shocks" from the data by recovering the structural innovations in US interest rates. Moreover, the FAVAR approach in particular allows to study jointly different LATAM countries, with potentially important interaction effects, while at the same time keeping the dimensionality of the problem under control. Also, as documented in the previous section, the degree of comovement between most LATAM countries is significant along most economic dimensions considered (with the exception of Mexico), which makes the chosen methodology particularly informative.

[8]See Hanson and Stein (2015) for US MP spillovers into US long-term yields, and Gilchrist et al. (2015), and Albagli et al. (2015) for the case of EME.

3.1 The Model

We use FAVAR models, initially proposed by Bernanke et al. (2005), to assess the responsiveness of the country-specific economic fundamentals to shocks in US interest rates. This econometric framework allows us to tackle the high-dimensionality of the problem and permits us to elegantly relate the two blocks of information, (i) Latin American economic developments and (ii) US monetary conditions. In doing so, we also need to deal with the exogeneity of the US block to ensure identification of the spillover effects. Therefore, we follow the line of Canova (2005) and impose some restrictions in the coefficients of the model.

The proposed FAVAR model with exogenous block is defined as follows

$$\begin{bmatrix} X_t \\ r^h_{US,t} \end{bmatrix} = \begin{bmatrix} \Lambda^f & \Lambda^r \\ 0 & I \end{bmatrix} \begin{bmatrix} F_t \\ r^h_{US,t} \end{bmatrix} + \begin{bmatrix} \varepsilon_t \\ 0 \end{bmatrix}, \quad \varepsilon_t \sim N(0, \Omega) \tag{2}$$

$$\begin{bmatrix} F_t \\ r^h_{US,t} \end{bmatrix} = \begin{bmatrix} \Psi_f(L) & \Psi_{f,US}(L) \\ 0 & \Psi_{US}(L) \end{bmatrix} \begin{bmatrix} F_{t-1} \\ r^h_{US,t-1} \end{bmatrix} + \begin{bmatrix} e_{f,t} \\ e_{US,t} \end{bmatrix}, \quad e_t \sim N(0, \Sigma), \tag{3}$$

where the first block of information consists on the economic fundamentals of Latin American economies contained in $X_t = (Y_{BRA,t}, Y_{CHI,t}, Y_{COL,t}, Y_{MEX,t}, Y_{PER,t})'$. Accordingly, each element of X_t is given by $Y_{i,t} = (u_{i,t}, \pi_{i,t}, \chi_{i,t}, p_{i,t})'$. The information contained in X_t can be appropriately summarized in a small set of factors collected in $F_t = (f^u_t, f^\pi_t, f^\chi_t, f^p_t)'$. We use the factors obtained from Section 2, which provides two main advantages with respect to unobserved factor models. First, by assuming that the factors are observed, the estimation uncertainty of the model is reduced substantially. Second, this modeling strategy allows us to provide identification and a clear interpretation of what each factor represents. This is usually not well achieved when several factors are extracted from a set of data without imposing any identification restriction.

The second block of information, $r^h_{US,t}$, makes reference to the US monetary conditions, proxied by the US bond yield at horizon h. To ensure proper identification of the US interest rate shocks we impose some constraints in the coefficients of the VAR in equation

(3), in such a way that current emerging market dynamics depend on its lagged values and US past developments, while US current dynamics depend only on its lagged values. We also assume a variance-covariance matrix of the VAR's disturbances with a block diagonal structure, Σ =blockdiag$\{\Sigma_f, \Sigma_{US}\}$, as in Canova (2005).

The model is identified with a recursive (Cholesky) structure. We adopt the following ordering for the variables in F_t: the unemployment rate factor, followed by the inflation rate factor, the exchange rate factor, and finally the stock market return factor. This ordering is consistent with a criteria of placing slow moving variables first (i.e., activity and goods prices), and let the fast-moving (financial) variables be affected by the previous ones contemporaneously.

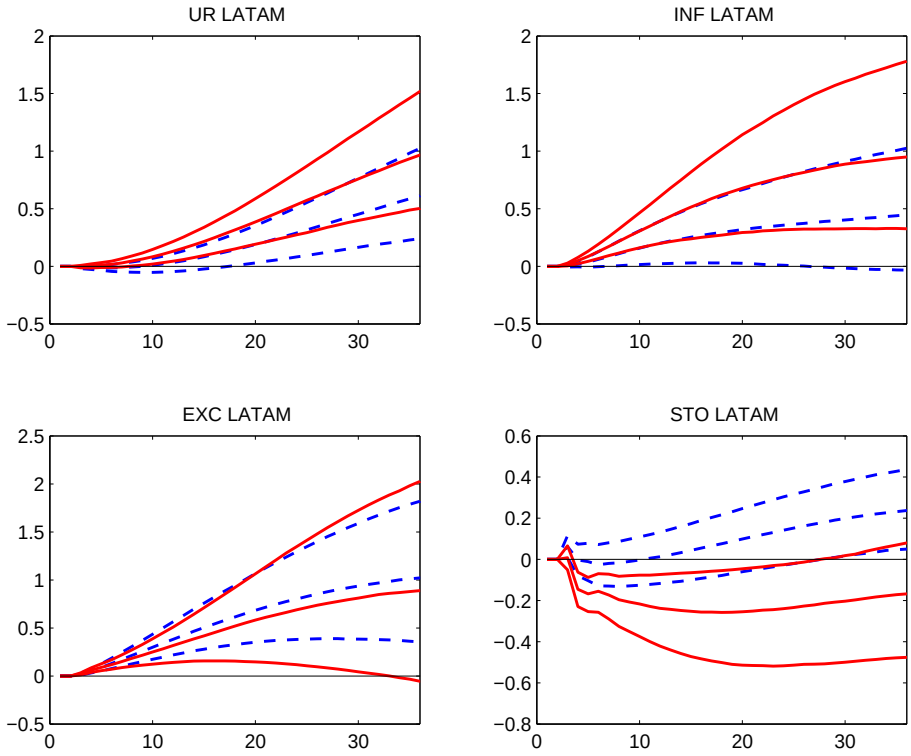
The estimation of the model is based on Bayesian methods to provide robust inferences on the parameter estimates. We use the Gibbs sampler to compute draws of the parameter estimates of the FAVAR model and simulate their posterior distribution of parameters and impulse responses. For further details on the estimation method see Bernanke et al. (2005).

3.2 US monetary spillovers: the effects of interest rate shocks

We now quantify and compare the effect of shocks in the short-term and long-term US bond yields on Latin American economies. This is done by relying on two FAVAR models with different information on US. One model includes only information about the one-year bond yield, $r_{US,t}^{h=1}$, in the US block, and another model includes only information of the ten-year bond yield, $r_{US,t}^{h=10}$, in the same block. Figure 2 reports the responses of each of the factors, constructed in section 2, to a 25 basis points shock in the short-term and long-term rates, represented by the dashed blue line and solid red line, respectively. Recall that because we have standardized all series in the factor analysis, the unit of measure in the Y-axis corresponds to number of standard deviations from the mean.

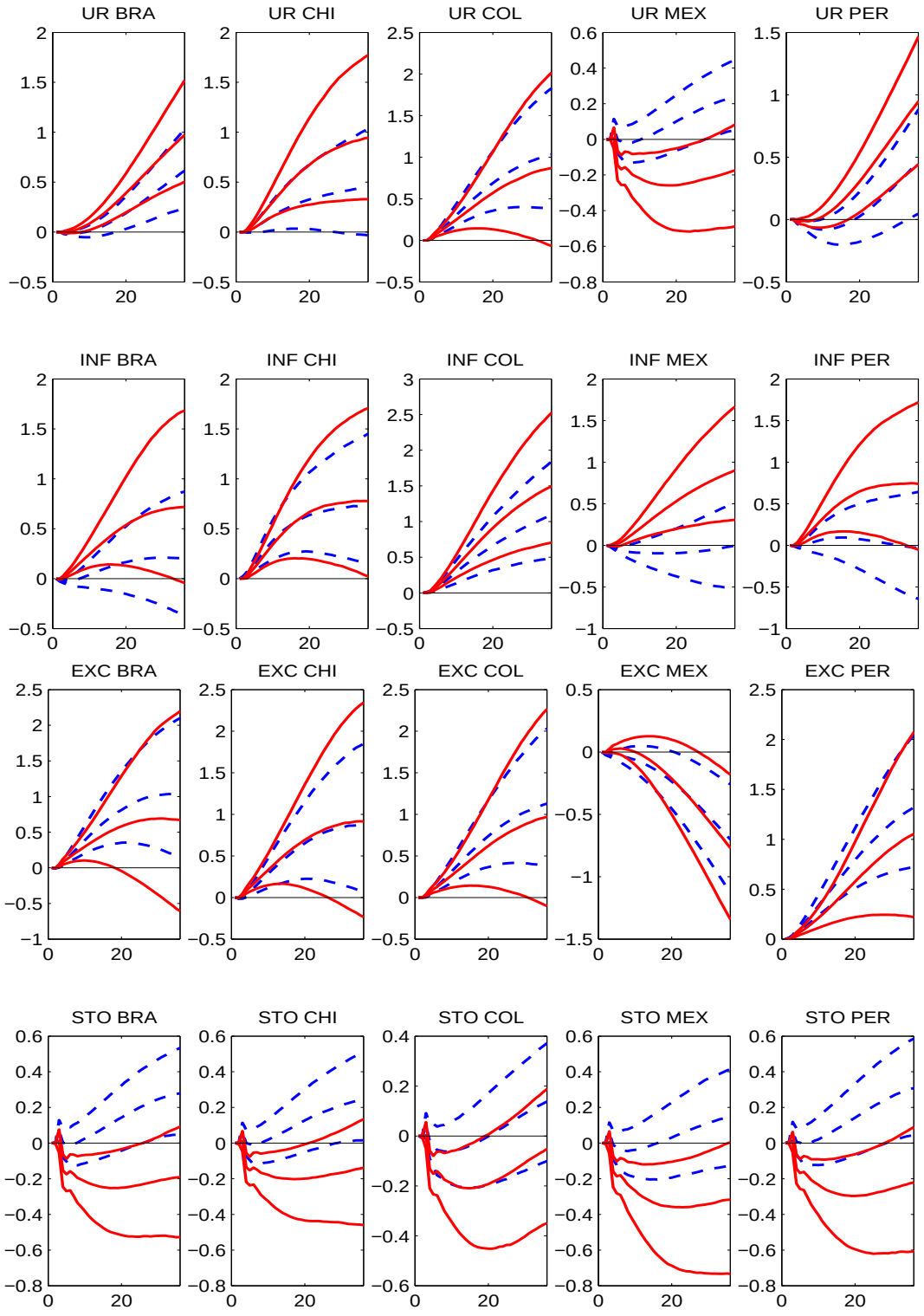
We see that a shock in US short-term rates has a rather small impact on the unemployment factor, the inflation factor, and stock market factor (blue dotted lines). The long-term rate, on the other hand, has a significant impact on all factors, and in the direction one would expect: higher unemployment, a more depreciated exchange rate, higher inflation and lower stock market returns.

Figure 2: The effect of a shock in the short-term and long-term US observed bond yield on LATAM factors



Note: The blue dashed (red solid) lines plot the responses to a shock in the 1 year (10 year) Observed bond yield. In all figures, the central line corresponds to the response according to the median draw of the simulation, while the lower and upper lines correspond to the 16 and 84th percentile, respectively. All responses are cumulated.

Figure 3: The effect of a shock in the short-term and long-term US observed bond yield on LATAM fundamentals



Note: The blue dashed (red solid) lines plot the responses to a shock in the 1 year (10 year) Observed bond yield. In all figures, the central line corresponds to the response according to the median draw of the simulation, while the lower and upper lines correspond to the 16 and 84th percentile, respectively. All responses are cumulated.

Figure 4: Historical decomposition of LATAM factors

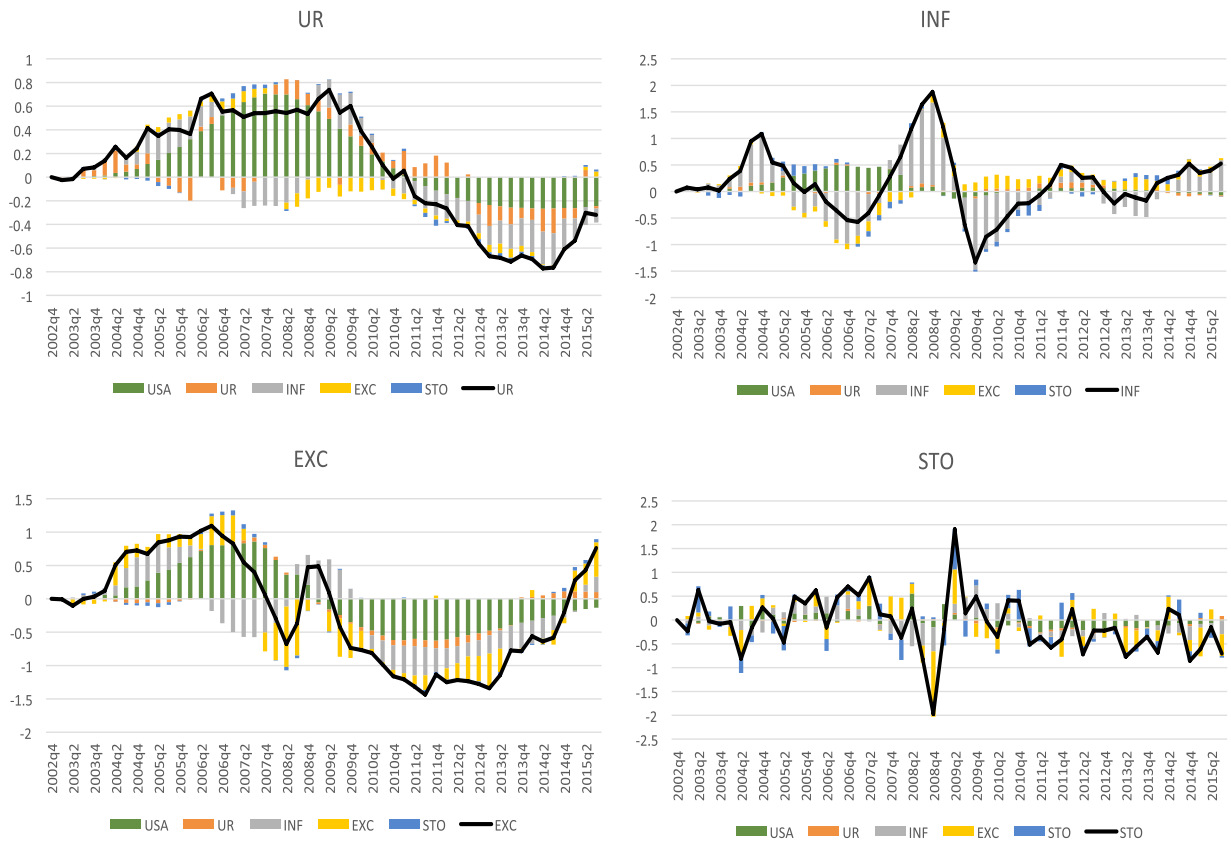


Figure 3 complements the analysis by showing the response of these variables for each individual country, according to the factor loadings estimated in equation (2). Consistent with Figure 2, we find that short-term rate shocks most of times have an negligible effect on Latin American economies. However, these economies are highly affected by long-term rate shocks. Specifically, an increase in the long-term US rate increases unemployment rates, inflation, exchange rates, and decreases stock returns in Brazil, Chile, Colombia and Peru. Indeed, the direction and magnitude of responses across countries reflects the high degree of comovement in Latin American economies, as documented in section 2. Mexico, on the other hand, exhibits a clearly different pattern of responses in some key variables. As mentioned before, this economy experienced a break that can be mainly associated to the global financial crisis, and its sensitivity to US economic conditions.

To get a better understanding about the importance of US interest rates in explaining

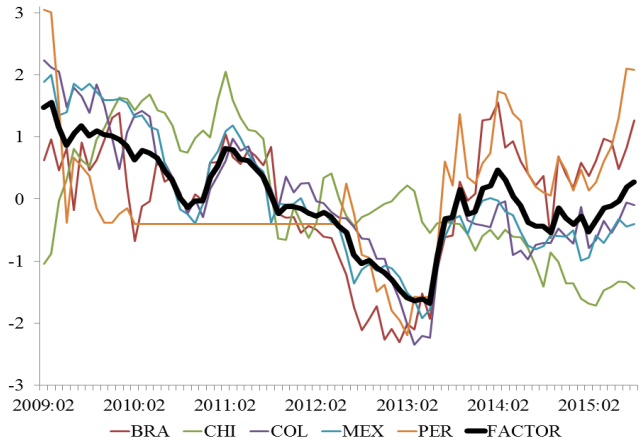
LATAM factors, Figure 4 plots the historical decompositions of the four factors considered, where the bars correspond to the cumulative effects of the structural innovations of each variable on the respective factor. The top left graph shows the high importance attributed to US interest rates for explaining the unemployment factor, where it contributes a sizable portion of the increase in unemployment between 2004 and 2007 (which coincides with a significant FFR hike), and the posterior decline in unemployment in the aftermath of the financial crisis. Likewise, US interest rates also explain a large part of the exchange rate depreciation until 2007, and subsequent appreciation starting in 2009. The taper talk episode around May 2013 marks the beginning of the depreciation of LATAM currencies, which is explained also by an important reversal of the contribution of US interest rates. On the other hand, US rates seem to have a rather minor role for the dynamics of both inflation and stock market returns over this period.

3.3 Spillovers at the Zero Lower Bound

We now present a related exercise by estimating a similar FAVAR model but for a period starting in January 2009. This exercise is motivated by several reasons. First, the conduit of monetary policy and the level of interest rates have truly been exceptional in the period post GFC, hence 2009 seems like a natural break point to test for differential effects. Second, beginning in 2009 we have systematic, reliable data on long term interest rates for our complete set of LATAM economies, which allows us to enlarge our previous FAVAR model by including information about interest rates, and extract the corresponding factor into the otherwise unchanged specification characterized by equations (1)-(3). In our baseline specification, the interest rate factor, which is plotted in Figure 5, comes in last among the LATAM factors in equation (3). Figure 6 reports the responses of each of the factors to a 25 basis points shock in the long-term rate for the post-2009 sample, while Figure 7 plots the responses on each individual country.

These figures reveal interesting patterns. First and foremost, US interest rate shocks appear to have little to no significant effects on unemployment, inflation, and exchange rates, as compared to the full-sample specification. Indeed, while the effect according to the median draw of response simulations has the intuitive sign, they are generally not significant at the confidence intervals considered. Secondly, the impact of US long term

Figure 5: Long-term interest rates in LATAM



Note: The figure shows the data across country (color lines) used to extract the first principal component or common factor (black line).

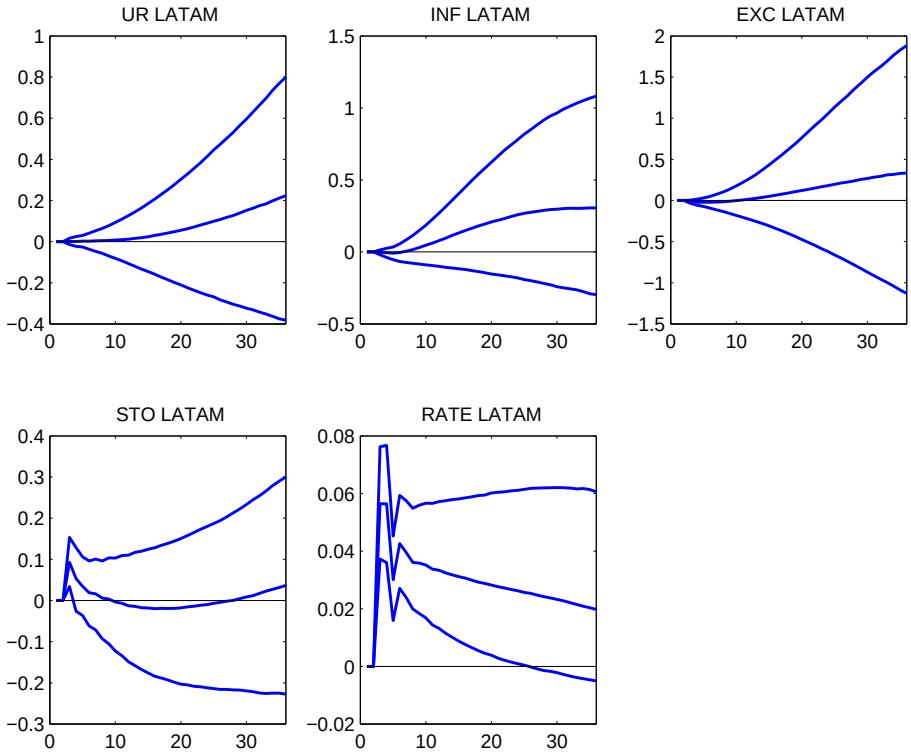
interest rates is in general highly significant, both for the LATAM interest rate factor, as well as for individual interest rates in each country. Notice, in particular, that even Mexico responds in the same direction, breaking the orthogonal behavior displayed on other dimensions with respect to LATAM.

4 Spillovers through Financial Markets

The analysis of section 3 suggests that US interest rates have played a role in activity, prices, and financial variables in LATAM over the past 12 years. Moreover, our results indicate that in the post 2009 period, the impact of US long-term interest rate shocks have a significant impact on LATAM long-term rates, but in general a non-significant impact on other variables over this shorter subsample. One potential objection to our identification strategy, however, is that it might be too restrictive to assume dynamics associated to lags of one month or more when it comes to financial variables. Moreover, the sample size in monthly frequency after 2009 is rather limited, which could also cast doubt into our results.

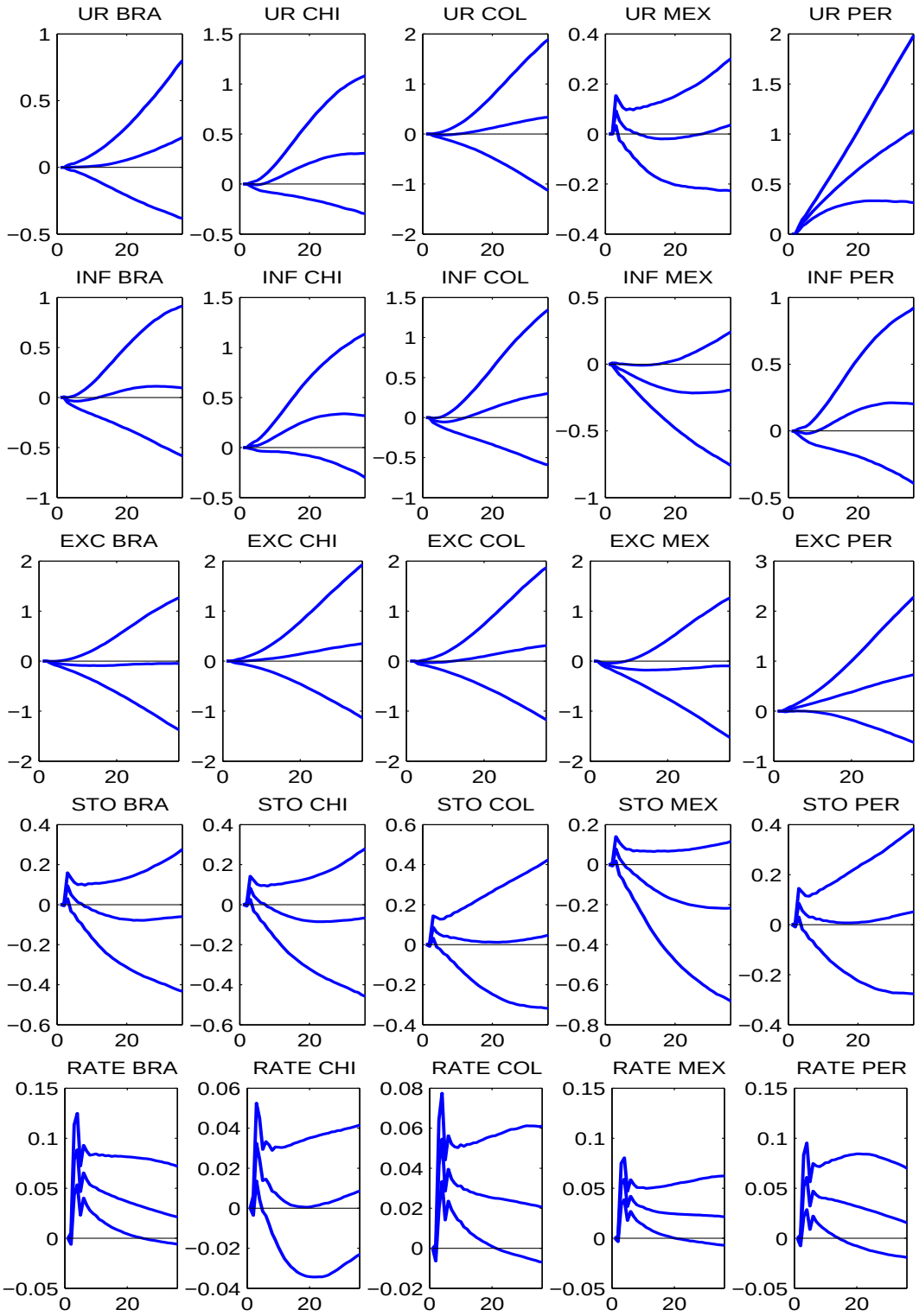
To deal with these issues, we perform a country-specific analysis for the cases of Chile and Mexico, where good yield curve information exists for a long sample. In these case studies, we focus on high frequency data, namely weekly interest rates, exchange rates,

Figure 6: The effect of a shock in the 10 years US observed bond yield on LATAM factors at the Zero Lower Bound



Note: The lines plot the responses to a shock in the 10 year Observed bond yield during the zero lower bound. In all figures, the central line corresponds to the response according to the median draw of the simulation, while the lower and upper lines correspond to the 16 and 84th percentile, respectively. All responses are cumulated with the exception of interest rates.

Figure 7: The effect of a shock in the 10 years US observed bond yield on LATAM fundamentals at the Zero Lower Bound



Note: The lines plot the responses to a shock in the 10 year Observed bond yield during the zero lower bound. In all figures, the central line corresponds to the response according to the median draw of the simulations, while the lower and upper lines correspond to the 16 and 84th percentile, respectively. All responses are cumulated with the exception of interest rates.

and stock markets. More specifically, for each country we run a VAR which includes an exogenous bloc for the US interest rate, as before. Among the endogenous domestic variables we include the level of the nominal exchange rate, the weekly stock return, and a measure of interest rates, in that particular ordering. Therefore, we estimate the restricted VAR specified in equation (3) with the new data. The availability of high frequency data allows to enlarge the information set in our sample size, and also reduces concerns about results being driven by a particular ordering.

We also dig deeper into the specific channels that drive interest rate spillovers from the US into these countries. Specifically, we perform a decomposition of overall domestic yields into a risk-neutral component, which captures the expected evolution of short-term rates, and a term-premium component. Hence, we run three separate VAR models, using in each the respective measure of interest rates (one with overall yields, one with the risk-neutral component, and one with the term-premium component). In all cases, the US interest rate variable corresponds to the 10-yr observed treasury yield.

It is important to note that there are different approaches in the literature for decomposing yields into expected rates, and compensation for risk. We follow the methodology advocated by Adrian et al. (2013), which among several advantages relies only on yield curve data for its estimation, making it suitable for constructing high frequency variables. Their methodology exploits the log excess holding return predictability showed in empirical studies, such as Cochrane and Piazzesi (2005).[9] Based on that idea, Adrian et al. (2013) propose a simple methodology to construct market prices of risk into an affine model consistent with the predictability of excess bond returns. We refer the reader to that paper for the specific details of the methodology.

4.1 Country-specific Analysis

Figure 8 plots the impulse response functions to a 25 basis points increase in US long term rates for the case of Chile. The blue dashed lines plot the response in the first half of the sample (prior to 2009), while the red lines correspond to the response in the sample after 2009. The graphs along the first row consider the results of the VAR which incorporates

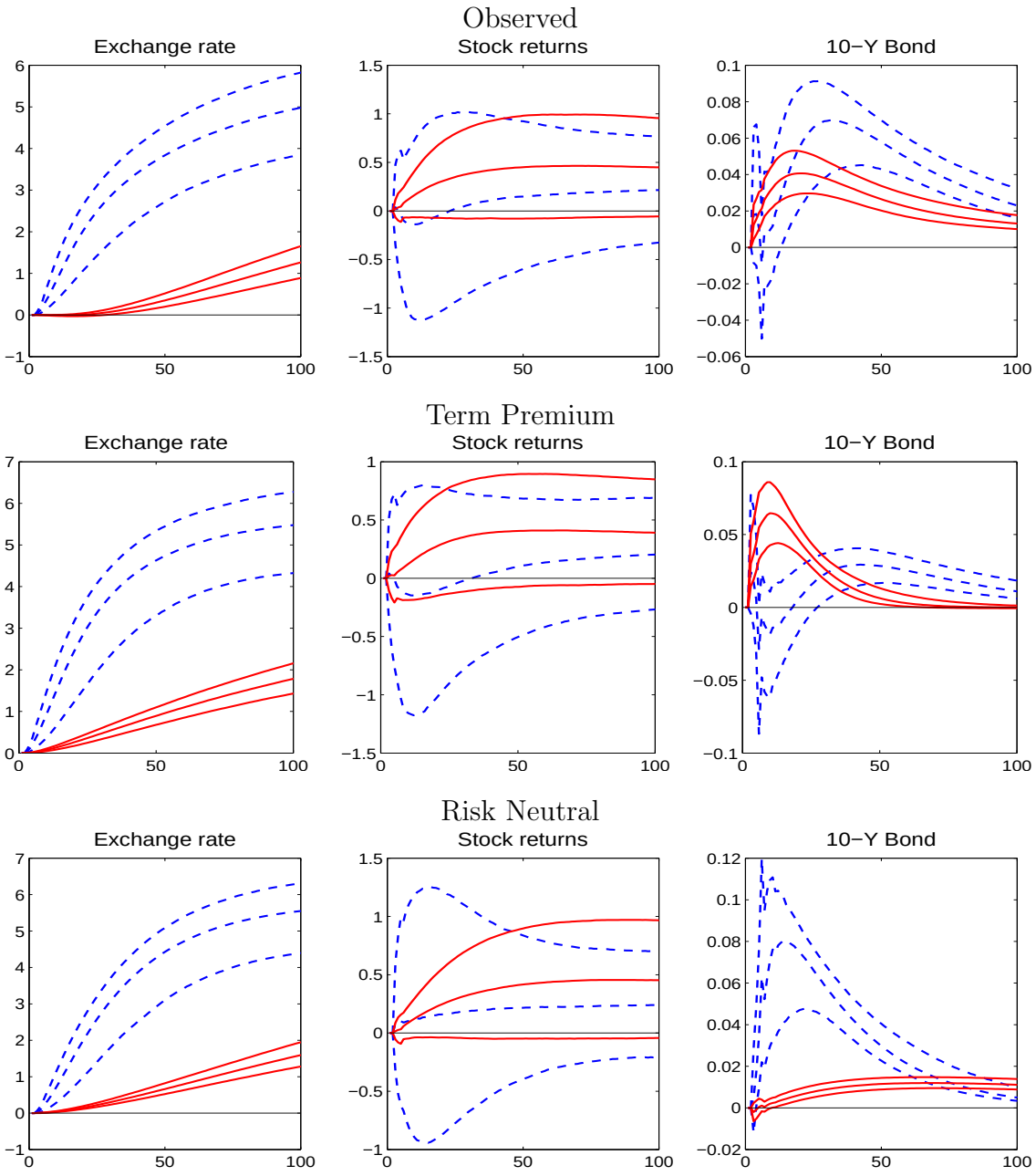
[9]See Gürkaynak and Wright (2012) for a comprehensive revision of this literature.

overall yields as a measure of interest rates in Chile, while the second a third rows use, respectively, the term premium and risk neutral component instead. The figure largely confirms our previous results. First, interest rate shocks have relatively large impact on exchange rates prior to 2009 (an increase in rates induces a depreciation of the Chilean peso), but a smaller (though still significant) impact during the ZLB period. The impact on stock markets, however, is non-significant in both samples. This result is somehow consistent with Gilchrist et al. (2015), who document a significant spillover effect of US interest rates on stock markets before, but not during, the ZLB period.

Second, the impact on Chilean long-term rates is significant in both samples, although in the ZLB period the spillover seems to be acting faster. Moreover, as columns 2 and 3 of the figure show, the effect is largely concentrated on the term premium component post 2009, while the bulk of the response is due to the risk-neutral component in the earlier period. This result is consistent with Albagli et al. (2015), who show with an identification strategy based on event studies that spillover from US monetary policy are concentrated in the term premium component for a larger sample of emerging countries post 2009. This result probably reflects the fact that activity and indeed monetary policy decision in Chile have been largely decoupled from the US after the global financial crisis, so it is unlikely that changes in US interest rates affect the expectations of future short-term rates (the signaling channel) in Chile. On the other hand, as documented in the papers cited above, there is mounting evidence that US monetary conditions are strongly associated with global liquidity factors, which in turn affect the flow of capital into EME's. The evidence presented here for the case of Chile seems to confirm this notion.

Figure 9 plots the impulse response functions for the case of Mexico. It is interesting to note that the effects on the exchange rate (first column) change sign after when comparing sub samples. In particular, an increase in US interest rates is associated with an appreciation of the Mexican peso during the ZLB episode. One possible explanation for this phenomenon is that economic activity in Mexico has been strongly linked to that is the US, particularly after the global financial crisis. It is plausible then that an increase in US yields caused by expectations of stronger economic activity in that country could also reflect good news for the Mexican economy, thus appreciating the currency. On the other hand, as was the case for Chile, there is no significant impact of US interest rates on the Mexican stock market in either period (second column).

Figure 8: The Effect of a Shock in the 10 years US Observed Bond Yield before and at the Zero Lower Bound at Weekly Frequency in Chile



Note: The blue dashed (red solid) lines plot the responses to a shock before (after) the zero lower bound. All responses are cumulated with the exception of interest rates.

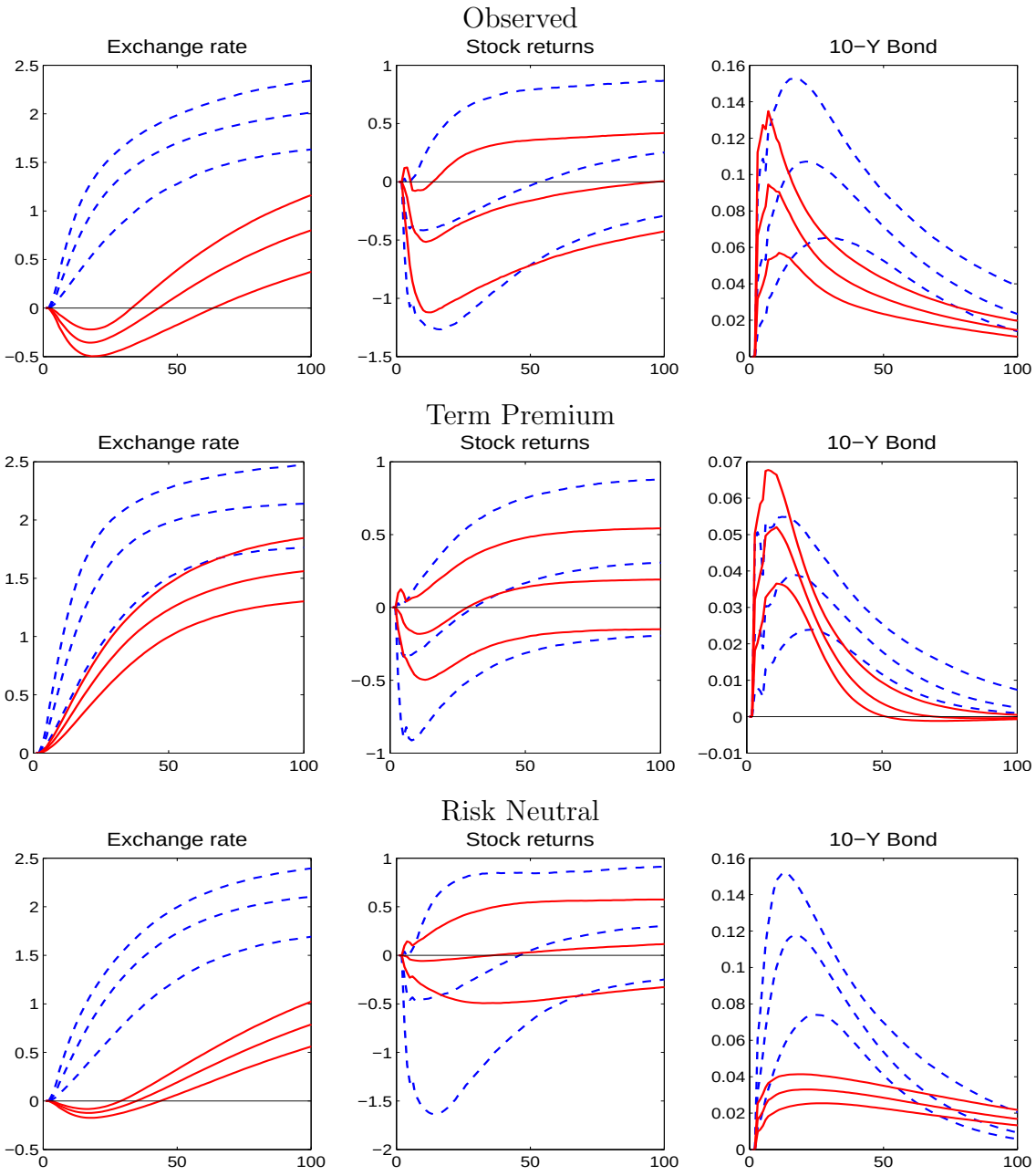
The spillover of US interest rates into Mexican long term rates is plotted in the the third column. The figure reveals that these spillovers are significantly larger than in the case of Chile, which is intuitive given the much closer economic interaction with the US economy in the case of Mexico. Indeed, spillovers are of similar magnitude in both subsamples. However, as was the case with Chile, the spillover effect also seems to be more biased towards the term premium component during the ZLB, while the risk neutral component seems to dominate in the earlier part of the sample.

To get a better understanding of the magnitudes of US interest rates spillovers, Table 2 computes the pass through coefficients. These are calculated as the ratio between the cumulative response in domestic bond yields (and the risk neutral and term premium component), divided by the cumulative response of the US long-term interest rate. We see that the cumulative pass through to Chile is close to 0.5 in both samples at a 1 year horizon, although at two years the pass through increases between 0.8 and 1. The analysis done at the level of yields components reveals that, as expected, the pass through to risk neutral rates falls drastically during the ZLB subsample, while the pass through to term premium increases substantially.

In the case of Mexico, the pass through to overall yields is larger than for Chile at all horizons. Consistent with Figure 9, the pass through to the risk neutral component is significantly diminished after 2009, while for term premium it increases somewhat, especially for a 1-hr horizon.

Overall, the evidence presented in this section corroborates the analysis presented in section 3. We find significant spillover effects of US interest rates to domestic bond yields, which extend for a considerable period of time, with larger effects in the case of Mexico. Moreover, we see a more significant role of the term premium channel during the ZLB episode, and a more muted response of risk neutral rates. This evidence supports the view that spillovers via the risk taking channel to EME have been more prevalent in the exceptionally low interest rate environment which has characterized fixed income markets after the global financial crisis.

Figure 9: The Effect of a Shock in the 10 years US Observed Bond Yield before and at the Zero Lower Bound at Weekly Frequency in Mexico



Note: The blue dashed (red solid) lines plot the responses to a shock before (after) the zero lower bound. All responses are cumulated with the exception of interest rates.

Table 2: Pass through of US interest rates to bond yields and its components

Type of rate	Period	Chile	Mexico
Observed	1Y before ZLB	0.56	1.05
	2Y before ZLB	1.01	1.55
	1Y at ZLB	0.56	0.96
	2Y at ZLB	0.81	1.34
Risk Neutral	1Y before ZLB	0.64	1.02
	2Y before ZLB	0.80	1.30
	1Y at ZLB	0.12	0.50
	2Y at ZLB	0.28	0.82
Term Premium	1Y before ZLB	0.13	0.36
	2Y before ZLB	0.36	0.45
	1Y at ZLB	0.57	0.46
	2Y at ZLB	0.58	0.46

5 Concluding Remarks

This paper assesses the spillover effects of unexpected US bonds interest rate increases into the economic fundamentals of Latin American economies. Four main results arise form the analysis. First, we find evidence of strong comovement patterns in the economic fundamentals of Brazil, Chile, Colombia, and Peru. Mexico, on the other hand, shows some important differences, that can be attributed to its proximity and strong integration with the US economy.

Second, we find that short-term rate shocks most of times have an negligible effect on Latin American economies. However, these economies are highly affected by long-term rate shocks. Specifically, an unexpected increase in the long-term US rate increases unemployment rates, inflation, exchange rates, and decreases stock returns in most of Latin American economies. Mexico, on the other hand, exhibits a clearly different pattern of responses in some key variables.

Third, when focusing on the zero lower bound period, we find significant spillover effects of long-term interest rates in the US to those in LATAM, but also find generally insignificant

effects on the other factors. One explanation for this is that after the global financial crisis, economic fundamentals in the region have diverged from those in the US to a large extent.

Fourth, our analysis point to significant spillover effects of US interest rates to domestic bond yields. Moreover, the term premium seems to play a key role during the zero lower bound period, while risk neutral rates show a more muted response. This evidence supports the view that spillovers via the risk taking channel to emerging economies have been more prevalent in the exceptionally low interest rate environment which has characterized fixed income markets after the global financial crisis.

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