Sovereign Yields with Credit Risk and U.S. Monetary Policy

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Abstract

Sovereign yield curve decompositions provide valuable information. Yet they rely on a risk-free assumption. Credit risk in emerging market yields is not zero, so traditional yield decompositions are biased. I show that their yields can be decomposed into an expected future short-term interest rate, a term premium and a credit risk premium using a new dataset of nominal and synthetic local currency yields along with survey forecasts for 15 emerging markets from 2000 to 2019. All of the components are weakly connected but react strongly to monetary policy changes in the U.S. The decomposition thus reveals that U.S. monetary policy shocks lead to a reassessment of policy rate expectations and a repricing of (interest and credit) risks in emerging markets.

Keywords: Emerging markets, synthetic yields, term premium, credit risk, monetary policy spillovers, affine term structure models.

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1 Introduction

[Go2ToC]

It is well-known that U.S. monetary policy has effects beyond its borders, but the extent to which it influences financial conditions in emerging markets is not yet well understood. Given the increasingly important role these countries play in the global economy, it is pressing to understand how their domestic interest rates respond to changes in the monetary policy of the U.S.

The analysis of U.S. monetary policy spillovers on sovereign bond yields has so far mainly focused on advanced economies, which partly reflects data constraints in emerging markets. Not so long ago, they used to issue bonds at short maturities and in foreign currency, but now it is more common for them to issue bonds with longer maturities and in local currency (LC). In fact, LC bonds have become an important source of funds for emerging markets over the last two decades (Du and Schreger, 2016b; Ottonello and Perez, 2019; Galli, 2020).

This paper answers the question: how does the LC bond yields of emerging markets respond to monetary policy changes in the U.S.? To better answer this question, I characterize the response of the yields in terms of their components. Yield decompositions provide valuable information because they compensate investors for bearing risks. I show that the yields of emerging markets can be decomposed into an expected future short-term interest rate, a term premium and a credit risk premium.[1] This last component is characteristic of emerging markets and, to the best of my knowledge, it has not been accounted for in the literature that decomposes their bond yields.

The credit risk premium acknowledges that not all sovereign bonds are equal. Contrary to the debt issued by advanced countries, international investors demand a credit risk premium to hold bonds issued by emerging markets (Du and Schreger, 2016a). Indeed, even though countries have the ability to print their own currency to avoid default-

[1] The term premium compensates investors for bearing interest rate risk, and the credit risk premium compensates them for the risk of not receiving the promised payments. Credit risk here is broadly defined including, for example, (selective) default risk, currency convertibility risk, regulation risk, capital controls, jurisdiction risk and, if any, liquidity risk. Therefore, when investors require compensation for any of these risks, it is considered that they demand a premium for credit risk even if the country does not default per se.

ing on their debt, emerging markets are prone to default (Reinhart and Rogoff, 2011; Erce and Mallucci, 2018).[2] To account for credit risk, I use synthetic LC yield curves, which essentially swap the U.S. yield curve into a LC, something akin to the U.S. issuing bonds in that currency.[3] These synthetic yields can be seen as being free of credit risk and can thus be decomposed into a future expected short-term interest rate and a term premium. The difference between the nominal (or actual) yields and the synthetic ones captures the credit risk premium in the LC debt of emerging markets (Du and Schreger, 2016a).

I show that the proposed decomposition of emerging market yields is sensible. Affine term structure models are the standard tool to decompose bond yields, but the decompositions can be unstable (Cochrane, 2007). Guimarães (2014) shows that incorporating survey data on interest rate forecasts in the estimation provides robust decompositions of the U.S. and U.K. yield curves. I then use data on survey forecasts to obtain robust decompositions of the synthetic yield curves of emerging markets. Accordingly, the model-implied expectation of the short rate for the 10-year maturity tracks the long-term interest rate forecasts reasonably well.[4] Since it is based on synthetic yields, the resulting term premium is genuine in terms of not been contaminated by credit risk (as would be the case if it were obtained from nominal yields). Wright (2011) documents a downward trend in the term premia of advanced countries that owes in part to a decline in inflation uncertainty. The estimated term premia reported here shows a similar trend and their association with inflation uncertainty is even stronger, consistent with the fact that inflation in emerging markets tends to be higher and more volatile than in advanced countries (Ha et al., 2019). Finally, the decomposition also shows a negative correlation between the term premium and the credit risk premium, suggesting a trade-off between implicit (diluting debt repayments via inflation) and explicit (actual) defaults.

[2] Examples of actual defaults in LC debt include El Salvador (2017), Ecuador (2008), Argentina (2001), Russia (1998); and in 1999 after an earthquake, Turkey retroactively taxed its debt. Du and Schreger (2016b) and Ottonello and Perez (2019) provide theoretical explanations for these episodes.

[3] This implicitly assumes that the U.S. yield curve and the financial instruments used to swap it are free of credit risk. I argue that these are reasonable assumptions in section 2.

[4] In addition, the levels of the implied long-term expected real interest rates are also in line with the evidence for advanced countries (Holston, Laubach, and Williams, 2017).

To analyze the spillover effects of U.S. monetary policy, I consider three types shocks. They capture unanticipated changes to the current policy rate, to its future path and to the large-scale asset purchase (LSAP) programs that were implemented by the U.S. Federal Reserve (Fed) as part of its unconventional monetary policy response to the global financial crisis (GFC). The shocks are identified using high-frequency data around the Fed's monetary policy announcements, which is by now a well-established strategy to overcome endogeneity concerns because it isolates the surprise component of monetary policy decisions (Gürkaynak and Wright, 2013; Nakamura and Steinsson, 2018).

The main finding of this paper is that U.S. monetary policy has a strong and persistent effect on the yields of emerging markets, despite a moderate initial reaction. The nominal yield decompositions help to better understand how the yields respond. I show that the Fed's monetary policy decisions influence each of the components of emerging market yields. The magnitude of the initial response of nominal yields is lower than the response of U.S. yields, some yield components do not even respond initially. However, the effects are sluggish and amplify over time (for up to 2 months) to such an extent so as to become a one-to-one response, or even more in the case of LSAP shocks. In fact, path and LSAP shocks—more prevalent since the GFC—have larger and longer effects on emerging market yields.

I also find that Fed's decisions impact the credit risk premium in emerging markets, where the direction of the effect depends on the type of shock. The credit risk premium increases in response to target and path shocks given that a lower forward premium reduces the compensation for a future currency depreciation, thereby decreasing the cost of borrowing in LC at the risk-free rate. By contrast, the credit risk premium decreases in response to LSAP shocks because the compensation for a future currency depreciation goes up. Unlike the delayed response in nominal yields and the components of synthetic yields, the reaction by the credit risk premium is short lived, generally only at the time of the shock due to a similarly short response of the forward premium. All in all, surprises in Fed's policy decisions give rise to a reassessment of policy rate expectations in emerging markets and a repricing in their interest and credit risks.

This paper contributes to different branches of the literature. It pioneers the application of term structure models on synthetic yields, which have been widely used recently to study deviations from covered interest parity (CIP).[5] Instead of concentrating on the CIP deviations, this paper focuses on the synthetic yields themselves to decompose the nominal bond yields of emerging markets more finely. It also contributes to the literature on the international comparison of sovereign yields (Dahlquist and Hasseltoft, 2016)—so far mainly focused on advanced economies. On the spillover effects of U.S. monetary policy, this paper extends the work of Gilchrist, Yue, and Zakrajšek (2019) by studying its effects not only on sovereign yields but on its components, as in Curcuru, Kamin, Li, and Rodriguez (2018) and Adrian, Crump, Durham, and Moench (2019), but focusing on the yields of emerging markets and adjusting for their credit risk.

The rest of the paper proceeds as follows. Section 2 explains how the LC yield curves are constructed. Section 3 presents the affine term structure model used to decompose them. Section 4 assesses the yield decompositions. Section 5 analyzes the U.S. monetary policy spillovers to the yields of emerging markets. The last section concludes.

2 Local Currency Yield Curves [Go2ToC]

This section explains how to construct the nominal and synthetic LC yield curves of emerging markets, and explains that the difference between the two captures a credit risk premium. In the next section, the *synthetic* yield curve will be decomposed into an expected future short-term interest rate and a term premium. The decomposition of the *nominal* yield curve will then be used to characterize the response of emerging market yields to U.S. monetary policy.

[5] Du, Tepper, and Verdelhan (2018c) show that there are persistent and systematic deviations from CIP reflecting a higher regulatory burden for financial intermediaries. Du, Im, and Schreger (2018b) show that CIP deviations reflect differences in the convenience yield of advanced countries relative to the U.S. Du and Schreger (2016a) meanwhile show that CIP deviations capture a credit risk premium for emerging markets.

2.1 Construction of Synthetic Yield Curves

The main idea to construct the synthetic LC yield curves is to swap the U.S. yield curve into LC using the forward premium at each maturity (see Du, Im, and Schreger, 2018a). The forward premium compensates investors for the expected depreciation of a currency, an increase in the exchange rate when it is expressed in LC per U.S. dollar (USD), as is used throughout this paper. The key assumption behind this approach is that the U.S. yield curve is free of default risk; as such, it serves as the benchmark for all the other countries in the sample.

The calculation of the forward premium depends on the maturity. For maturities of less than one year, the forward premium is calculated as the annualized difference between the forward and the spot exchange rates. For maturities equal or larger than one year, the forward premium is calculated using cross-currency swaps (XCS) since outright forwards are less liquid. Although, the fixed-for-fixed XCS rates are rarely observed in the market directly, they can be constructed using cross-currency basis swaps and interest rate swaps. The idea is to start by swapping fixed payments in LC into floating-rate cash flows in USD using cross-currency basis swaps (referenced to the Libor—London interbank offered rate—in USD), and swap them into fixed-rate cash flows also in USD using interest rate swaps. Both types of swaps are liquid and collateralized instruments and so the bilateral counterparty risk in XCS is small.

Let $y_{t,n}^{US}$ denote the zero-coupon yield for an n-period U.S. Treasury security at time t, and $\rho_{t,n}$ the n-period forward premium from USD to LC at time t. The zero-coupon synthetic LC yield for the n-period bond at time t, $\widetilde{y}_{t,n}^{LC}$, is calculated as

$$\widetilde{y}_{t,n}^{LC} = y_{t,n}^{US} + \rho_{t,n}. \tag{1}$$

In contrast, the actual or nominal zero-coupon yield, $y_{t,n}^{LC}$, can be obtained directly from the quotes of the bonds traded in the market. Notice that the construction of the synthetic yield curve $\widetilde{y}_{t,n}^{LC}$ does not require information about the nominal yield curve $y_{t,n}^{LC}$,[6] as it relies on the U.S. yield curve and XCS rates.

[6] For the U.S., $\widetilde{y}_{t,n}^{US} = y_{t,n}^{US}$ since there is no forward premium for the USD relative to the USD.

According to the CIP condition, the nominal (direct) and the synthetic (indirect) LC interest rates should be equal. Thus, CIP implies that an issuer should be able to borrow directly or indirectly (synthetically) in LC at the same yield. Du, Tepper, and Verdelhan (2018c) show, however, that there are persistent and systematic deviations from CIP. The spread between the nominal and synthetic yields ($y_{t,n}^{LC} - \widetilde{y}_{t,n}^{LC}$) therefore measures CIP deviations in sovereign yields. In the case of advanced countries, Du, Im, and Schreger (2018b) argue that the CIP deviations reflect differences in convenience yields relative to the U.S.

CIP deviations have a different interpretation for emerging markets. Whereas the nominal yields of advanced countries are usually considered free of credit risk, it is reasonable for the nominal yields of emerging markets to include a credit risk premium since emerging markets are prone to default (Reinhart and Rogoff, 2011; Erce and Mallucci, 2018). The credit risk in the components of the synthetic yields in equation (1) is small, a synthetic yield can therefore be seen as the borrowing rate paid by a hypothetical issuer in LC with no credit risk. Du and Schreger (2016a) indeed show that the nominal-synthetic spread captures a credit risk premium in the sovereign yields of emerging markets. In particular, the spread is highly correlated with the rates of credit default swaps (CDS) (CDS)—financial derivatives aimed to protect investors against default by a bond issuer.

Although CDS capture credit risk in the medium to long term (Palladini and Portes, 2011), they are not used in this paper to account for credit risk for several reasons. First, credit risk in CDS themselves is not eliminated, it simply shifts from the bond issuer to the CDS seller, i.e. there is counterparty credit risk. Second, a credit event is not clearly defined and, thus, borrowers can intentionally circumvent the CDS payout. Third, since investors do not need to hold the underlying bond to buy a CDS, there is a chance for market manipulation.

2.2 Construction of Nominal Yield Curves [Go2ToC]

I use the Bloomberg Fair Value (BFV) curves to estimate the nominal yield curve $y_{t,n}^{LC}$.

Since these curves report coupon-equivalent par yields, I convert them into continuously-compounded yields (see Gürkaynak, Sack, and Wright, 2007) to obtain the implied zero-coupon curves.[7] This is done for all but two countries for which there are no BFV curves. For Brazil and Israel, Bloomberg provides zero-coupon yields with coupon-equivalent compounding. I also convert these yields, known as IYC curves, into continuously-compounded yields.[8]

The resulting continuously-compounded zero-coupon curve for each country is what this paper refers to as the nominal yield curve $y_{t,n}^{LC}$.

2.3 Yield Curve Data [Go2ToC]

Nominal and synthetic yield curves are constructed for 15 emerging markets and, to compare the results, 10 advanced economies.[9] The countries are selected based on data availability. It is worth noting that all of the emerging markets in the sample, with the exception of Malaysia, have adopted an inflation targeting regime.[10] In fact, the central banks in Hungary, Philippines, Indonesia, Russia and Turkey adopted inflation targeting during the sample period.[11]

The data for nominal and synthetic yields is available daily. The sample starts in January 2000 and ends in January 2019; the starting dates, however, vary by country. All the yields for advanced countries start no later than September 2001, but the sample

[7]As a robustness check, I estimate the nominal yield curves from actual prices for some of the countries in the sample following Nelson and Siegel (1987). These estimated yield curves follow those reported by Bloomberg closely.

[8]For some emerging markets, Bloomberg reports both BFV and IYC curves. BFV curves are preferred for several reasons: they have a longer history than IYC curves, IYC curves are not available for advanced countries—the benchmark for some of the results reported later—and, compared to the BFV curves, the short end of the IYC curves seems disconnected from the rest of the curve for some countries and dates.

[9]For each of the following countries, the currency identifier is shown in parenthesis. The 15 emerging markets are: Brazil (BRL), Colombia (COP), Hungary (HUF), Indonesia (IDR), Israel (ILS), Korea (KRW), Malaysia (MYR), Mexico (MXN), Peru (PEN), Philippines (PHP), Poland (PLN), Russia (RUB), South Africa (ZAR), Thailand (THB) and Turkey (TRY). The 10 advanced economies are: Australia (AUD), Canada (CAD), Denmark (DKK), Germany (EUR), Japan (JPY), Norway (NOK), New Zealand (NZD), Sweden (SEK), Switzerland (CHF) and the U.K. (GBP).

[10]Although Malaysia does not follow an inflation targeting regime, it has several characteristics that are aligned with such a regime, see Pennings, Ramayandi, and Tang (2015).

[11]Hungary in June 2001, Philippines in January 2002, Indonesia in July 2005, Turkey in January 2006 and Russia in 2014. Also, Hungary and Poland were accepted to join the European Union in April 2003.

sizes for emerging markets are generally smaller. The nominal yields of 9 and the synthetic yields of 7 emerging markets start before March 2004; both types of yields for the rest of the countries start no later than June 2007. Thus, there are at least 10 years of data for most of the emerging markets in the sample.[12] In principle, this is a reasonable time period for the estimation of the affine term structure model presented in section 3.1, but in practice there may be too few interest rate cycles per country. This small sample problem is addressed using surveys of professional forecasters in section 3.4.

The yields have maturities of 3 and 6 months, and 1 through 10 years, ranging from a minimum of nine to a maximum of twelve maturities per country.[13] The maximum maturity considered is 10 years because bonds and swaps with larger maturities tend to have less history and be less liquid, especially for emerging markets who do not issue longer-term bonds as often as advanced countries.

The construction of the LC synthetic yield curves involves data from the U.S. yield curve and the forward premium for different maturities, as explained in section 2.1. Data for the U.S. zero-coupon yield curve is obtained from two sources. For maturities of one through ten years, the yields come from the dataset constructed by Gürkaynak, Sack, and Wright (2007) (hence GSW).[14] Treasury securities with less than one year to maturity are less actively traded than longer-maturity ones. The estimates from the Center for Research in Security Prices (CRSP) are thought to be more robust at the short end of the curve (Duffee, 2010). Specifically, the 3- and 6-month yields are the annualized 13- and 26-week rates (bid/ask average) in the CRSP Risk-Free Rates Series.[15]

As mentioned before, the calculation of the forward premium varies by maturity. For maturities of less than one year, I use data on the spot exchange rate along with 3- and 6-month forwards from Bloomberg for all but three countries; for Korea, Philippines and

[12] For Turkey, the nominal yields with a maturity of up to 10 years start on June 2010, although its synthetic yields start on May 2005. For Russia, data on both types of yields start in 2007 but due to low liquidity at the beginning of the sample, it starts in July 2009.

[13] All countries have data from 3 months to 5 years and 10 years. All countries except Brazil have data for the 7-year maturity. Data for 6, 8 and 9 years vary per country.

[14] Available at: https://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html.

[15] The 3- and 6-month yields implied by the GSW fitted model are highly correlated with the CRSP yields (0.9985 and 0.9995, respectively) but the former are on average higher (by 16 and 10 basis points, respectively) using data since 1983.

Thailand the data is obtained from Datastream. To construct the XCS rates, I use data on cross-currency basis swaps and interest rate swaps for each available maturity from one through ten years. The data for the swap curves comes from Bloomberg.[16]

2.3.1 Timing

The parameters of the affine term structure models are estimated using end-of-month data, as explained in section 3.4. Since the U.S. yield curve is the benchmark for the synthetic yield curves, those dates are the last business days of each month according to the U.S. calendar.

Getting the timing right is key to adequately measure the responses of emerging market yields to U.S. monetary policy shocks. The analysis of monetary policy spillovers in section 5.3 uses daily changes in nominal and synthetic yields, which need to correctly capture the surprises in Fed announcements. Since the nominal yields reported by Bloomberg are pulled at around 16 hours New York time, they are shifted one day forward for the non-Western Hemisphere countries so that their daily changes adequately capture surprises in Fed announcements. The credit risk premium for those countries is calculated using the shifted nominal yields.

3 Methodology

[Go2ToC]

This section describes the affine term structure model used to decompose the yield curve of each country in the sample. It discusses the difficulty in identifying the parameters of the model and how survey data helps in the identification. The next section will assess the decomposition, so that it can later be used to characterize the response of emerging market yields to U.S. monetary policy.

[16] A spreadsheet with the tickers used in the construction of the forward premiums and in the estimation of the nominal yield curves is available upon request. The file consolidates and expands (with tenors and tickers) similar files kindly posted online in Wenxin Du and Jesse Schreger's websites.

3.1 Affine Term Structure Model

Let $P_{t,n}$ be the price at time t of a zero-coupon risk-free bond with maturity n. The continuously compounded yield on that bond is then $y_{t,n} = -\ln P_{t,n}/n$. In particular, the one-period continuously compounded risk-free rate is $i_t = y_{t,1} = -\ln P_{t,1}$.

If there is no arbitrage, there exists a strictly positive stochastic discount factor (SDF), M_{t+1}, that prices all assets. Accordingly, the bond price today equals the expectation, conditioned on all current information, of tomorrow's discounted price; recursively defined as follows:

$$P_{t,n} = \mathrm{E}_t^{\mathbb{P}} \left[M_{t+1} P_{t+1,n-1} \right], \tag{2}$$

where $\mathrm{E}_t^{\mathbb{P}}[\cdot]$ denotes the conditional expectation at time t of a random variable taken using the actual or physical probability measure, $\mathbb{P}$, that generates the data. The existence of the SDF also implies that there exists a theoretical risk-neutral or risk-adjusted pricing measure, $\mathbb{Q}$—different from the $\mathbb{P}$ measure—that is defined as follows:[17]

$$P_{t,n} = \mathrm{E}_t^{\mathbb{Q}} \left[\exp\left(-i_t\right) P_{t+1,n-1} \right], \tag{3}$$

where $\mathrm{E}_t^{\mathbb{Q}}[\cdot]$ also denotes conditional expectation at time t but taken using the $\mathbb{Q}$ measure.

A discrete-time affine term structure model assumes that the dynamics of a $\mathrm{K} \times 1$ vector of unobserved pricing factors or state variables, X_t, follow a first-order vector autoregression, VAR(1), under the risk-neutral measure $\mathbb{Q}$:

$$X_{t+1} = \mu^{\mathbb{Q}} + \Phi^{\mathbb{Q}} X_t + \Sigma \nu_{t+1}^{\mathbb{Q}}. \tag{4}$$

where $\mu^{\mathbb{Q}}$ is a $\mathrm{K} \times 1$ vector and $\Phi^{\mathbb{Q}}$ is a $\mathrm{K} \times \mathrm{K}$ matrix of parameters, Σ is a $\mathrm{K} \times \mathrm{K}$ lower triangular matrix with positive diagonal elements, and $\nu_{t+1}^{\mathbb{Q}}$ is a $\mathrm{K} \times 1$ independent and identically distributed, normal vector with zero mean and covariance equal to the identity matrix conditional on the pricing factors, which is written as $\nu_{t+1}^{\mathbb{Q}} | X_t \sim \mathcal{N}_{\mathrm{K}}\left(0, I\right)$.

[17] Since the price at maturity of a zero-coupon bond is 1, recursive substitution of equation (2) implies that today's price equals the conditional expectation of the product of SDFs over the life of the bond, $P_{t,n} = \mathrm{E}_t^{\mathbb{P}} \left[\Pi_{j=1}^{n} M_{t+j} \right]$. Similarly, recursive substitution of equation (3) implies that ...

The dynamics of the one-period interest rate are driven by the pricing factors:

$$i_t = \delta_0 + \delta_1' X_t, \tag{5}$$

where δ_0 is a scalar and δ_1 is a K × 1 vector of parameters.

These assumptions imply that the bond price is an exponentially affine function of the pricing factors:

$$P_{t,n} = \exp\left(A_n + B_n X_t\right),$$

such that the corresponding continuously compounded yield of the bond is an affine function of those factors:

$$y^{\mathbb{Q}}_{t,n} = A^{\mathbb{Q}}_n + B^{\mathbb{Q}}_n X_t, \tag{6}$$

where $A^{\mathbb{Q}}_n = -\frac{1}{n}A_n$, $B^{\mathbb{Q}}_n = -\frac{1}{n}B_n$, where in turn the scalar $A_n = \mathcal{A}(\delta_0, \delta_1, \mu^{\mathbb{Q}}, \Phi^{\mathbb{Q}}, \Sigma, n)$ and the 1×K vector $B_n = \mathcal{B}(\delta_1, \Phi^{\mathbb{Q}}, n)$ are loadings that satisfy the recursive equations:[18]

$$A_{n+1} = -\delta_0 + A_n + B_n' \mu^{\mathbb{Q}} + \frac{1}{2} B_n' \Sigma \Sigma' B_n, \quad A_0 = 0, \tag{7}$$

$$B_{n+1} = -\delta_1 + \Phi^{\mathbb{Q}\prime} B_n, \quad B_0 = 0. \tag{8}$$

The yields $y^{\mathbb{Q}}_{t,n}$ are the model's fitted yields, which means that the risk-neutral measure $\mathbb{Q}$ is sufficient for pricing bonds. However, to be able to decompose the yields into a future expected short-term interest rate and a term premium, the model also specifies the dynamics for the market prices of risk, which control the transformation between the $\mathbb{Q}$ and $\mathbb{P}$ measures. Following Duffee (2002), the K × 1 vector of market prices of risk, λ_t, is also an affine function of the pricing factors:

$$\lambda_t = \lambda_0 + \lambda_1 X_t, \tag{9}$$

where λ_0 is a K × 1 vector and λ_1 is K × K matrix of parameters.

Given this structure for the market prices of risk, the dynamics of the pricing factors

[18] The price coefficients are obtained recursively after combining the no-arbitrage condition and the functional form for bond prices.

can also be described by a VAR(1) under the physical measure $\mathbb{P}$ as follows:

$$X_{t+1} = \mu^{\mathbb{P}} + \Phi^{\mathbb{P}} X_t + \Sigma \nu^{\mathbb{P}}_{t+1}. \tag{10}$$

where $\mu^{\mathbb{Q}} = \mu^{\mathbb{P}} - \Sigma\lambda_0$, $\Phi^{\mathbb{Q}} = \Phi^{\mathbb{P}} - \Sigma\lambda_1$, $\nu^{\mathbb{P}}_{t+1}|X_t \sim \mathcal{N}_{\mathrm{K}}(0, I)$. Note that the covariance matrix of the shocks is the same under both measures; that is, it is measure independent. Finally, the SDF is conditionally lognormal:[19]

$$M_{t+1} = \exp\left(-i_t - \frac{1}{2}\lambda_t'\lambda_t - \lambda_t'\nu^{\mathbb{P}}_{t+1}\right). \tag{11}$$

The yields consistent with the expectations hypothesis of the yield curve—as if investors were actually risk-neutral ($\lambda_0 = \lambda_1 = 0$)—are obtained as:

$$y^{\mathbb{P}}_{t,n} = A^{\mathbb{P}}_n + B^{\mathbb{P}}_n X_t,$$

where $A^{\mathbb{P}}_n = -\frac{1}{n}A_n$, $B^{\mathbb{P}}_n = -\frac{1}{n}B_n$, and the loadings $A_n = \mathcal{A}(\delta_0, \delta_1, \mu^{\mathbb{P}}, \Phi^{\mathbb{P}}, \Sigma, n)$ and $B_n = \mathcal{B}(\delta_1, \Phi^{\mathbb{P}}, n)$ satisfy the same recursions as those above but using the parameters of the law of motion of the pricing factors under the $\mathbb{P}$ rather than the $\mathbb{Q}$ measure.[20]

The expected yield over the life of an n-period bond equals the conditional expectation under $\mathbb{P}$ of the average short rate over the period, thus:

$$y^e_{t,n} = A^e_n + B^e_n X_t,$$

where $A^e_n = -\frac{1}{n}A_n$, $B^e_n = -\frac{1}{n}B_n$, where in turn $A_n = \mathcal{A}(\delta_0, \delta_1, \mu^{\mathbb{P}}, \Phi^{\mathbb{P}}, 0, n)$ and $B_n = \mathcal{B}(\delta_1, \Phi^{\mathbb{P}}, n)$; that is, A^e_n and B^e_n also satisfy the recursions under the $\mathbb{P}$ measure but setting $\Sigma = 0$ (see Appendix C of Guimarães (2014)).[21] In this sense, information about $y^e_{t,n}$ could help in identifying the parameters under the $\mathbb{P}$ measure, $\{\mu^{\mathbb{P}}, \Phi^{\mathbb{P}}\}$.

Since the long-term forecasts are the expectation between 6 and 10 years ahead, it is matched to the 5-year forward rate starting 5 years hence. The forward rate from n to

[19]The law of motion of the vector of pricing factors in equation (10) and the SDF in equation (11) can be formalized separately or jointly, see Gürkaynak and Wright (2012). For instance, in a utility maximization framework, the SDF is usually interpreted as the intertemporal marginal rate of substitution.

[20]See Lloyd (2018) for a derivation of the loadings under both measures.

[21]The difference between $y^{\mathbb{P}}_{t,n}$ and $y^e_{t,n}$ is a convexity term due to Jensen's inequality, which increases with maturity. In practice, however, this term usually becomes relevant for maturities beyond ten years. Further, the term is constant across maturities in homoskedastic models like the ones used in this paper.

m periods hence given by $y_{t,n|m} = (my_{t,m} - ny_{t,n}) \,/\, (m-n)$ becomes

$$y^e_{t,n|m} = A^e_{t,n|m} + B^e_{t,n|m} X_t.$$

where $A^e_{t,n|m} = (mA^e_m - nA^e_n) \,/\, (m-n)$ and $A^e_{t,n|m} = (mB^e_m - nB^e_n) \,/\, (m-n)$.

Finally, the term premium for maturity n at time t, $\tau_{t,n}$, can then be estimated as the difference between the yields obtained under the $\mathbb{Q}$ and $\mathbb{P}$ measures:[22]

$$\tau_{t,n} = y^{\mathbb{Q}}_{t,n} - y^{\mathbb{P}}_{t,n}. \tag{12}$$

A key assumption behind this model is that the yield $y_{t,n}$ is free of credit risk, a reasonable assumption for advanced but not for emerging countries since investors demand a credit risk premium from them (Du and Schreger, 2016a). This implies that while the nominal yield curve $y^{LC}_{t,n}$ is the relevant one for advanced countries, it is not so for emerging markets because it is not free of credit risk. In that case, the synthetic yield curve $\widetilde{y}^{LC}_{t,n}$ better aligns with the risk-free assumption and, in turn, with the affine model.

3.2 Identification Problem [Go2ToC]

In principle, the estimation of the parameters in the affine term structure model only requires zero-coupon bond yields as an input. This is enough to estimate the pricing coefficients under the $\mathbb{Q}$ measure, $\{\mu^{\mathbb{Q}}, \Phi^{\mathbb{Q}}\}$, but not to identify the parameters under the $\mathbb{P}$ measure, $\{\mu^{\mathbb{P}}, \Phi^{\mathbb{P}}\}$, which are necessary to estimate the term premium in equation (12).

This identification problem owes to the high persistence of bond yields, which results in small sample bias (Kim and Orphanides, 2012). In fact, there might be too few interest rate cycles per country. In that case, the dynamics of the pricing factors will tend to mean-revert too quickly, overestimating the stability of the expected path of the short rate and attributing much of the variability in yields to term premium fluctuations. The instability in the decomposition of the yield curves of advanced countries is a well-known phenomenon (Cochrane, 2007).[23]

[22] Note that $\tau_{t,n}$ can also be written as $(A^{\mathbb{Q}}_n - A^{\mathbb{P}}_n) + (B^{\mathbb{Q}}_n - B^{\mathbb{P}}_n)X_t$; that is, the term premium is also an affine function of the pricing factors.

[23] Different solutions have been proposed in the literature, including restrictions on parameters (Duffee,

Guimarães (2014) shows that incorporating survey data on interest rate forecasts in the estimation provides robust decompositions of the U.S. and U.K. yield curves.[24] The importance of survey data is particularly relevant to get reliable decompositions for emerging markets. Surveys help to address two common concerns when working with emerging market data, namely small sample sizes and regime changes. First, the sample size for these countries is relatively shorter, compared with data from advanced countries. Second, since the early 2000s there has been a considerable reduction in the inflation rates of many emerging markets, which could be considered as a regime change. Structural breaks is actually one of the reasons U.S.-focused studies use different sample periods. In addition, surveys can also be used to obtain a model-free estimate of the term premium, which serves as a robustness check for the one obtained from the model.

Although surveys have good forecasting properties, it is important to acknowledge that they are not a panacea. Surveys, for instance, might not represent the market expectations or the expectations of the marginal investor.

3.3 Survey Data [Go2ToC]

Long-term forecasts are particularly helpful for the model to pin down the parameters under the $\mathbb{P}$ measure. Twice a year Consensus Economics provides 5-year ahead and long-term (between 6 and 10 years ahead) forecasts for consumer inflation and real GDP growth for most of the emerging countries in the sample. For this paper, the data is available from March 2001 to October 2017.[25] Figures 1 and 2 respectively plot the long-horizon forecasts for inflation and real GDP growth. With the exception of Brazil and Turkey, inflation expectations in emerging markets have been stable or even declining, and are generally within the upper and lower bounds for the domestic inflation target.[26]

2010) (Bauer 2018), bias-corrected estimators (BRW 2012) and complementing bond yield data with survey forecasts of future interest rates (Kim and Wright, 2005; Kim and Orphanides, 2012).

[24]He finds that the term premium estimated with the aid of surveys remains essentially the same after varying the number of pricing factors (from 3 to 5) and the sample periods, even with a sample starting in 1972, which includes the U.S. Great Inflation period.

[25]Data availability varies by country; for example, data for the Philippines starts in 2009, whereas it ends in October 2013 for Latin American countries.

[26]For Israel and South Africa, figure 1 shows the inflation trend, see below for more information. The

Notice that the 5-year ahead and long-term forecasts are highly correlated.

Although there is no source for long-term forecasts for the short rate of emerging markets, they can be inferred from existing data. Since emerging markets are small open economies, I assume that the real interest rate is determined abroad. The implied forecast for the domestic nominal short rate is then equal to the forecast for the international real short-term rate plus the domestic inflation forecast for the same maturity. This approach requires to define the international real interest rate and long-term forecasts for it. As with synthetic yields, the U.S. is taken as the benchmark for emerging markets. Forecasts for the U.S. real interest rate are obtained as the difference between the forecast for the three-month Treasury bill (T-bill) rate and the inflation forecast for the same maturity. The required data is available quarterly from the Survey of Professional Forecasters. Specifically, I use the 5- and 10-Year CPI inflation forecasts and, for the T-bill rate, the 10-year forecast and the second longest available one since there is no 5-year forecast for the T-bill rate.[27] Figure 3 shows that the implied long-term forecasts for the short rates are sensible, their level is in line with the synthetic 10-year yield in each country.

An alternative way to infer the embedded expectations for the policy rate is to use Taylor rule-type regressions, and assume that the estimated parameters for inflation and real GDP growth apply at each of the survey maturities.[28] The two approaches yield similar values for the implied forecasts for the domestic short-term rates. The correlation between the two approaches is 0.75 and 0.83 for the 5- and 10-year tenors, respectively.

An advantage of the small open economy approach is that it only requires forecasts

upper and lower bounds are the most recent ones for each country. Russia has updated its target range almost every year since early 2000s; the plotted band are the highest and lowest bounds since 2009.

[27] The specific series are CPI5YR, CPI10, BILL10 and TBILLD. The BILL10 series is released in the first-quarter surveys only, so I use linear interpolation for the second to fourth quarters in the respective year. Consensus Economics forecasts are considered at the end of the month in which they are published, at that time the most recent value for the U.S. real interest rate forecast is used to calculate the implied forecast for the domestic short rate.

[28] I regress the policy rate on its lag, the year-on-year consumer price inflation and the year-on-year real GDP growth for all the countries except Israel and South Africa. The coefficient for the lag of the policy rate is a smoothing parameter that improves the fit of the model to the data. A potential drawback of this approach is precisely that it requires to know the expectation of the policy rate for the previous forecast horizon. Nevertheless, it is reasonable to assume stationarity for the long-term forecasts (5 and 10 years), in which case only survey data for inflation and GDP growth are needed after dividing their coefficients by 1 minus the coefficient for the lag of the policy rate (due to stationarity). Data from the policy rate statistics of the Bank for International Settlements is used for the dependent variable.

for inflation, or a proxy in the case of countries with no long-term forecasts available as is the case for Israel and South Africa. Inflation expectations are hoped to match measures of inflation that exclude unexpected shocks and better reflect the inflation environment. Different measures of core inflation exist. I use the inflation trend obtained by applying the Hodrick-Prescott filter to the series of realized inflation of each country. Of course, the filter is sensitive to the sample period used. The resulting trend can also be outside of the target inflation band due to the innate dynamics of the series, which would be at odds with survey data (see figure 1). Fortunately, unlike other countries, there is no marked upward or downward trend in the inflation of the two countries during the sample period. For each country, trend inflation is calculated for the whole period but only considered within the time range for which survey data is available for the rest of the countries, and as long as the trend is within the inflation target band. Figure 4 shows the realized and trend inflation for Israel and South Africa, and compares them with those of Malaysia and Thailand, two countries with a similar pattern for inflation (i.e. no marked trend) and for which survey data is available. Trend inflation seems to be a good proxy for the long-term inflation forecasts of Israel and South Africa. Finally, since the 5-year and long-term forecasts closely follow each other (see figure 1), I use trend inflation for both tenors.

3.4 Estimation [Go2ToC]

Affine term structure models can be estimated by maximum likelihood, but the convergence to the global optimum has been traditionally subject to computational challenges and multiple local optima. Joslin, Singleton, and Zhu (2011) (hence JSZ) propose a normalization of the affine model that improves the convergence to the global optimum of the likelihood function.

The JSZ normalization allows for the near separation of the model's likelihood function into the product of the $\mathbb{P}$ and $\mathbb{Q}$ likelihood functions, and reduces the dimension of the parameter space from $(\delta_0, \delta_1, \mu^{\mathbb{Q}}, \Phi^{\mathbb{Q}}, \Sigma)$ to $(i^{\mathbb{Q}}_{\infty}, \lambda^{\mathbb{Q}}, \Sigma)$, where $i^{\mathbb{Q}}_{\infty}$ is the short rate under $\mathbb{Q}$ in the long-run and $\lambda^{\mathbb{Q}}$ is a K $\times$ 1 vector of ordered eigenvalues of $\Phi^{\mathbb{Q}}$.

The affine model can be estimated using the JSZ normalization following a two-step procedure. First, the $\mathbb{P}$ parameters are estimated by OLS of the VAR in equation (10) using the K principal components of the yield curve. This provides initial values for the maximum likelihood estimation of the matrix Σ. Then, taking $\hat{\mu}^{\mathbb{P}}$ and $\hat{\Phi}^{\mathbb{P}}$ as given, the $\mathbb{Q}$ parameters can be estimated by maximum likelihood.

To estimate the affine model, the relevant (risk-free) yield curve for advanced countries is the nominal one $y_{t,n}^{LC}$, whereas for emerging markets it is the synthetic one $\widetilde{y}_{t,n}^{LC}$. For advanced countries, the model is estimated only with yield data. For emerging markets, the model is augmented with survey data on the last day of the month for which the data was published.[29] The parameters of the model are estimated using end-of-month data. Since yield curve data is monthly and survey data is available twice a year, the latter can be considered as missing in non-release dates.

The survey-augmented model is estimated by maximum likelihood using the Kalman filter, which is well-suited to handle missing data. The transition equation is the law of motion of the pricing factors under the $\mathbb{P}$ measure given in equation (10). The dimension of the observation equation varies depending on the availability of survey data.

On months in which there is no data on survey expectations, the observation equation adds measurement error to the fitted yields in equation (6) for each of the N maturities:

$$\mathbf{y}_t = \mathbf{A} + \mathbf{B}X_t + \mathbf{\Sigma}_Y \mathbf{u}_t, \tag{13}$$

where $\mathbf{y}_t$ is an $\mathrm{N} \times 1$ vector of observed bond yields, $\mathbf{A}$ is an $\mathrm{N} \times 1$ vector with elements $A_n^{\mathbb{Q}}$, $\mathbf{B}$ is an $\mathrm{N} \times \mathrm{K}$ matrix with rows equal to $B_n^{\mathbb{Q}}$ for $n = 1, \ldots, \mathrm{N}$, $\mathbf{u}_t \sim \mathcal{N}_{\mathrm{N}}(0, I)$ and $\mathbf{\Sigma}_Y$ is a lower triangular $\mathrm{N} \times \mathrm{N}$ matrix with positive elements on the diagonal.

On months when survey data is available, the observation equation increases by the

[29] From 2001 to 2014, data for countries covered in the Eastern European release is available in March and September; starting in October 2014, it is released on April and October. For the rest of emerging markets the forecasts have always been released on April and October. The model for advanced countries in the sample is not augmented with survey data because I do not have access to it. They are, however, not the main focus of this paper, the affine model is estimated for them just for comparison purposes. Moreover, the results reported later for them are more comparable with other studies that do not use survey data. Finally, there are less concerns about small sample sizes for advanced countries and, for some of them, even for a regime change during the sample period.

number of survey forecasts S as follows:

$$\begin{bmatrix} \mathbf{y}_t \\ \mathbf{y}_t^S \end{bmatrix} = \begin{bmatrix} \mathbf{A} \\ \mathbf{A}^S \end{bmatrix} + \begin{bmatrix} \mathbf{B} \\ \mathbf{B}^S \end{bmatrix} X_t + \begin{bmatrix} \mathbf{\Sigma}_Y \mathbf{u}_t & \mathbf{0} \\ \mathbf{0} & \mathbf{\Sigma}_S \mathbf{u}_t^S \end{bmatrix} \tag{14}$$

where $\mathbf{y}_t^S$ is a S$\times$1 vector of survey forecasts with elements $i_{t,n}^{survey}$, $\mathbf{A}^S$ is a S$\times$1 vector with elements A_n^e, $\mathbf{B}^S$ is a S $\times$ K matrix with rows equal to B_n^e for $n = 1, \ldots, \mathrm{S}$, $\mathbf{u}_t^S \sim \mathcal{N}_{\mathrm{S}}(0, I)$ and $\mathbf{\Sigma}_S$ is a lower triangular S $\times$ S matrix with positive elements on the diagonal.

To estimate the survey-augmented model, I follow Guimarães (2014) and Lloyd (2018) in two aspects. First, I use the estimated parameters from the JSZ normalization as initial values for the Kalman filter. Second, I assume homoskedasticity in yields and survey errors, so that $\mathbf{\Sigma}_Y = \sigma_y I_{\mathrm{N}}$ and $\mathbf{\Sigma}_S = \sigma_s I_{\mathrm{S}}$, where I_{N} and I_{S} are N $\times$ N and S $\times$ S identity matrices, respectively. This reduces the number of parameters to be estimated.

Finally, although survey data helps to discipline the model, relying too much on it can be counterproductive due to, for instance, measurement error[30] and overfitting. To strike a balance between these two considerations, I follow Kim and Orphanides (2012) in fixing σ_s at a conservative level of 75 basis points. In this sense, survey data is seen as a noisy measure of expectations for the short rate.[31]

3.4.1 Estimation with Daily Data [Go2ToC]

The parameters of the model are estimated using end-of-month data because at the daily frequency there is noise that can undermine the estimation. However, once the parameters are estimated with monthly data, they can be used to estimate the model at the daily frequency (Adrian et al., 2013).

The estimation procedure explained above gives estimates for both the parameters and the pricing factors. Principal component analysis on the bond yields generates a matrix of weights or loadings for the different maturities to construct each principal component, which could be used to estimate the daily pricing factors. However, the pricing factors for the survey-augmented model are not necessarily the same as the principal components, so

[30]Recall that Consensus Economics does not report long-term forecasts for the short rate of emerging markets, so they need to be inferred.

[31]When σ_s is allowed to be estimated, its average value among all emerging markets is 29 basis points. In this case, the estimated term premia remains largely the same for most of the countries in the sample.

I obtain the matrix of loadings implied by those pricing factors using OLS. I regress the monthly pricing factors on the end-of-month observed yields. The weights so obtained are then applied to the daily yields to estimate the daily pricing factors. Finally, the parameters estimated with monthly data along with the daily pricing factors are used to fit—and decompose—the yields at the daily frequency.

4 Decomposing the Yields of Emerging Markets [Go2ToC]

This section argues that the yield decomposition obtained with the survey-augmented model is sensible. It highlights the benefits of using synthetic curves and survey data when analyzing the yields of emerging markets. The next section will use the decomposition to characterize the response of their yields to U.S. monetary policy.

4.1 Model Fit [Go2ToC]

As is common in the literature (see Joslin et al., 2011), the pricing factors for all countries are the first three principal components of the respective yield curves. They are commonly known as level, slope and curvature since Litterman and Scheinkman (1991). On average, they explain more than 99.5% of the variation in the synthetic yields of emerging markets and in the nominal yields of advanced countries. Interestingly, the level factor plays a relatively bigger role in advanced countries than in emerging markets (96% vs 88%), so that the slope (4 vs 10%) and curvature (0 vs 2%) factors are relatively more important in emerging markets.

Figure 5 illustrates the fit of the model for the 10-year synthetic yields. The model fits the data reasonably well for most of the countries. The squared root of the average (across months and maturities) squared difference between the actual and the fitted yields is commonly used to summarize the fitting errors. For the advanced countries in the sample, those fitting errors are small at around 5 basis points in line with other studies (Wright, 2011; Adrian et al., 2019). The dynamics of emerging market yields, however, are relatively harder to capture, reflected in an average fitting error of 16 basis points.[32] In general, emerging market yield curves are not as smooth as those of advanced countries, partly due to a shallower investor base.

4.2 Assessing the Decomposition

[Go2ToC]

The analysis to assess the sensibility of the three-part decompositions of the nominal yields of emerging markets mainly focuses on the 10-year maturity for the sake of brevity. Figure 6 decomposes those yields.

Two patterns immediately emerge from the figure. First, the main component of the nominal yields of most countries is the expectation of the future short rate, for which a downward trend over the sample period can be seen for most of the countries, consistent with evidence for advanced economies (Adrian et al., 2019). Second, the credit risk premium and the term premium are time-varying and both play an important role in the dynamics of emerging market yields. Although the term premium plays a relatively bigger role in explaining yield variation for most countries, the relative importance of the two premia varies by country and can even change over time, as can be seen for Hungary and the Philippines.

4.2.1 Expected Future Short Rate

[Go2ToC]

Figure 7 shows that the model-implied expectation of the short rate for the 10-year maturity tracks the interest rate forecasts reasonably well, even though the model does not rely too much on them given the conservative value used for σ_s. An alternative model-free measure of the expected future short rate is the 2-year (synthetic) yield, the correlation between the two is 93%.

The long-term expectation for the short rate implied by the model can also be assessed in terms of real interest rates. Since the implied long-term forecast for the short rates

[32] For instance, the fitting errors for the short end of the yield curves of Indonesia and Philippines are on average larger than for the rest of the countries.

of emerging markets are based on the long-term U.S. real interest rate (see section 3.3), the expected long-term *real* interest rate—the difference between the model-implied long-term expected short rate and the long-term inflation forecast—should be similar. Figure 8 verifies this. Estimates for advanced countries show that real interest rates have converged toward zero over the past years (Holston, Laubach, and Williams, 2017), a phenomenon that is partly explained by the increase in savings from East Asian countries following the regional crises of the late-1990s (Obstfeld, 2020). The figure shows that, once correcting for credit risk and inflation, the real interest rates of emerging markets also fluctuate around zero.

4.2.2 Term Premium

[Go2ToC]

In advanced countries, the (bond) risk premium is usually associated with the term premium. For emerging markets, however, the two concepts are different. The purpose of leveraging on synthetic yields (and surveys) is to estimate a genuine term premium.

One of two commonly used model-free measures to assess the term premium obtained by the model is the survey-based term premium.[33] Since the model-implied expectations track the interest rate forecasts closely (see figure 7), the model-implied and the survey-based term premia are positively correlated. An alternative measure is the residual from regressing the 10-year yield on the 3-month yield (both synthetic); the average correlation between the two measures is close to 60%.

Wright (2011) documents a downward trend in the term premia of advanced countries. Figure 6 shows that the term premia in emerging markets also decreased over the sample period, even after correcting for credit risk. The pattern nevertheless is not equally widespread.[34] Wright (2011) furhter argues that the downward trend owes in part to a reduction in inflation uncertainty. Since inflation in emerging markets tends to be higher and more volatile than in advanced countries (Ha et al., 2019), one would expect the relationship between the term premia and inflation uncertainty to be stronger in emerging

[33] The difference between the synthetic yield and the forecast for the short rate over the same maturity.

[34] See, for instance, Malaysia, Turkey and South Africa whose term premia did decline earlier in the sample but increased afterwards.

markets than in advanced countries. To test this hypothesis, I run panel regressions of the model-implied term premium on a measure of inflation uncertainty, namely the standard deviation of the permanent component of inflation based on the unobserved components stochastic volatility (UCSV) model proposed by Stock and Watson (2007). The model assumes that inflation has permanent and transitory components subject to uncorrelated shocks that vary over time. Following Wright (2011), I fit the UCSV model to quarterly data for each country. Table 1 reports the coefficient estimates for different tenors. The significance of the standard deviation of the permanent component is relevant for medium- to long-term maturities. Moreover, its effect increases with maturity and becomes stronger after controlling for the business cycle (proxied by the real GDP growth in each country). Although the specification might be subject to econometric problems (since it involves persistent variables), the results align with the view that inflation volatility is closely related to the term premium.

Finally, figure 6 shows that a negative term premia—when investors see bonds as hedges and are therefore willing to give up some investment return—is not a phenomenon restricted to advanced countries. Specifically, some emerging Asian countries experienced episodes of negative term premia in the long end of their yield curves after the global financial crisis. Figure 9 compares the term premia across maturities for each country. It not only shows that, in general, term premia increases with maturity,[35] but that other countries also experienced negative term premia in the short end of their curves. International and domestic investors in LC bond markets seem to have had a particular preference for short-term LC bonds after the global financial crisis.

4.2.3 Credit Risk Premium [Go2ToC]

The dynamics of the credit risk premium are in line with the results reported by Du and Schreger (2016a) who, in particular, show that it is highly correlated with the CDS of the respective country. Unlike the term premium, no clear trend is visible for the credit

[35] Intuitively, investors require a higher compensation for holding long-term bonds if they are seen as riskier than short-term bonds.

risk premium. Also, no clear pattern is observed for it when looking across maturities.

It matters which curve is used (nominal or synthetic) when decomposing the yields of emerging markets because the role of the credit risk premium in explaining yield variation is non-negligible. Its unconditional mean is positive for all the countries. In fact, it is not realistic for it to be negative. Instances in which the premium actually turns negative are brief and can reflect financial market frictions (Du and Schreger, 2016a), including market segmentation between foreign and local investors and short selling constraints. Although far from perfect, the premium is a valid measure of credit risk, and definitely better than ignoring it. Otherwise, estimates of the term premium would be biased.

Given that both the term premium and the credit risk premium help explain yield variation in emerging markets, a natural question is whether and how they are related. In most countries, the correlation between the two premia is negative on average. Mechanically, if an event increases synthetic but not the nominal yields, the credit spread will decline. Intuitively, when emerging markets face difficulties servicing their bond payments, they can either default or inflate away their debt, which can be referred to as explicit and implicit defaults. An increase in the likelihood of the first option would lift the credit risk premium, whereas the second essentially generates inflation risk that would be reflected in a higher term premium. A trade-off between explicit and implicit defaults seems to exist for most emerging markets. In this sense, inflation and default would be seen as substitutes since choosing one of the two reduces the need for the other.

It is reasonable to expect the two premia to be related to measures of risk and uncertainty. Baker, Bloom, and Davis (2016) construct a news-based economic policy uncertainty (EPU) index that has been replicated for different countries. Unfortunately, it is only available for five of the emerging markets in the sample.[36] In principle, the EPU index could be correlated with either the term and/or the credit risk premium. Among those five countries, the correlation of the EPU index with the term premium decreases with maturity, but increases in the case of the credit risk premium. Again, pointing towards a trade-off between explicit and implicit defaults. Notwithstanding, the data is

[36] Brazil, Colombia, Mexico, Russia and South Korea.

limited to reach meaningful conclusions.[37]

4.3 Comovement [Go2ToC]

The response of emerging market yields to U.S. monetary policy shocks in part depends on the extent to which LC bonds are integrated to the global financial markets. This requires to answer the question of how connected are the sovereign yields of emerging markets. One way to address this question is to pool all yields together and see whether there is a global-level factor, associated with the first principal component. For advanced countries, a global factor explains more than 90% of the variation in their yields, consistent line with Dahlquist and Hasseltoft (2016). In contrast, a global factor explains only around 50% of the variation in emerging market yields or their components.

A more formal way to answer the question is to measure the degree of connectedness among emerging market yields. Diebold and Yilmaz (2014) propose a system-wide measure of connectedness that assesses shares of forecast error variation in a country's bond market due to shocks arising elsewhere. Following Adrian et al. (2019) and Bostanci and Yilmaz (2020), I obtain the connectedness index using a vector autoregression of order 1, with a forecast horizon of 10 days and a rolling window of 150 days for the 10-year nominal yields and each of its components. Figure 10 displays the connectedness index for emerging and advanced countries.[38] The index for emerging markets (figure 10a) captures some developments of the European sovereign debt crisis in 2012 and the Greek debt crisis in 2015. Notably, it spiked above 55% around the taper tantrum episode in 2013.[39] The second biggest spike occurred after the 2016 U.S. presidential election. By mid-2017, the index was back to its pre-taper tantrum levels of around 30% compared to an average value of the index for advanced countries of close to 70%.

[37] The relationship is mainly driven by South Korea and Mexico. Moreover, their two premia correlate with the EPU index in opposite directions.

[38] The index for emerging markets has a shorter history because its computation requires a balanced panel. Also, since the construction of the synthetic curve does not involve nominal yields, the history of the components do not start on the same date.

[39] During the episode, financial markets feared an earlier than expected withdrawal of the Fed's unconventional stimulus measures.

The difference between the highly connected yields of advanced countries and the low connected yields of emerging markets might seem at odds with the idea of a global financial cycle (Rey, 2013). The level of the index for emerging markets is about half the level of the index for advanced countries, it shows no upward trend for either their nominal yields or their components.[40] These results, however, are consistent with the global financial cycle in which the global bond markets operate under a core-periphery structure, in which the bond markets of advanced countries constitute the (highly interconnected) core and those of emerging markets represent the (less connected) periphery. Countries in the periphery are in turn connected to the network mainly through countries in the core.[41] According to this, figures 10a and 10b are measuring the connectedness of the periphery and the core, respectively. Therefore, what matters for emerging market yields are not spillovers originating in other emerging markets but in advanced countries, which makes the argument of a global financial cycle stronger, not weaker.

A related question is whether the connectedness of yields is the same throughout the term structure or whether some sections of the curves are more connected than others. Obstfeld (2015) argues that long-term bonds are more globally connected than short term ones. On the other hand, Kalemli-Özcan (2019) argues that short-term yields suffer more the effects of global influences. Figure 11 plots the connectedness index for different maturities. It shows that the long end is relatively more connected than the short end, similar to what is observed for advanced countries, although this pattern became relevant for emerging markets after the taper tantrum episode. The figure also shows that the connectedness of the short end of the yield curves is similar between advanced and emerging markets. The difference in connectedness between two groups of countries is therefore driven by the medium and long end of their yield curves. Although foreign participation in LC bond markets has increased, it is still mostly held by local investors, especially medium- and longer-term bonds as suggested by figure 11, and are therefore

[40] Adrian et al. (2019) already document that the increase in the connectedness of the yields of advanced countries has been driven by an increase in the connectedness of their term premia.

[41] The core-periphery structure has been shown to be a good description of different networks in economics and finance. For example, Craig and von Peter (2014) show that the interbank market operates under such a structure.

more responsive to local factors.

5 U.S. Monetary Policy Spillovers [Go2ToC]

This section documents a strong and persistent response of the sovereign yields of emerging markets to U.S. monetary policy shocks. It also analyzes how each component of the yields reacts to the news, and highlights that the response depends on the type of shock.

5.1 Drivers of Yields [Go2ToC]

I start by studying the role of the components of the U.S. yield curve as drivers of emerging market yields and their components. To do this, I use the decomposition based on the Kim and Wright (2005) model, who address the small sample problem with survey forecasts of future interest rates.

To understand the potential drivers of emerging market yields in general, I run the following regressions

$$y_{i,t} = \alpha_i + \beta' z_{i,t} + u_{i,t}, \tag{15}$$

for country i in month t, where α_i are country fixed effects, $z_{i,t}$ is a vector of global and domestic variables that are likely to drive emerging market yields, and $u_{i,t}$ is the error term. The dependent variables $y_{i,t}$ the nominal and synthetic yields, the three components of the nominal yields and the forward premium[42] for the 2- and 10-year maturities.

Other potential drivers of the yields include the Cboe's volatility index (Vix) and the S&P 500 stock market index. The Vix reflects the implied volatility in option prices and is usually considered as a measure of risk aversion and economic uncertainty; given the sudden spikes in the index, it is common to use it in logs. The global version of the EPU index by Baker et al. (2016) is used as an alternative measure of global uncertainty.

[42]Remember that synthetic yields add the forward premium to the U.S. yield curve.

Variables reflecting global real economic activity are the price of oil and the index of economic activity based on world industrial production proposed by Hamilton (2019). Inflation and unemployment rates capture domestic macroeconomic conditions in each country. Finally, the exchange rate (LC per USD) is included to rule out explanations of changes in yields based on currency movements. Monthly returns for the stock market index, the oil price and the exchange rate are calculated as the log difference of the series, and expressed in basis points.

Tables 2 and 3 report the results for the full specification of the model.[43] The role of the components of the U.S. yield curve already indicate potential spillover effects from the Fed's policy decisions to emerging market yields. Increases in the future expected short rate in the U.S. are positively associated with future expected policy rates in emerging markets, whereas increases in the U.S. term premium relate to increments in the term premia of emerging markets. Moreover, the association between the U.S. components and the synthetic yields is larger than with the nominal yields. This in turn explains the negative association of the U.S. components with the credit risk premium. Larger increases in synthetic relative to nominal yields, mechanically decrease the credit risk premium. Therefore, the trade-off between explicit and implicit defaults highlighted before can be seen in table 3 through the connection between the U.S. term premium and the credit risk premium. In addition, there are also cross effects. The expected short rate in emerging markets reacts to changes in the U.S. term premium. This is consistent with the U.S. risk spillovers channel described by Kalemli-Özcan (2019). The signs for the rest of the drivers are correct.

The results shows that inflation and unemployment are key domestic variables. The evidence in table 3 suggests that the term premia in emerging markets is countercyclical. Investors demand a higher term premium during recessions, when the unemployment rate increases. Moreover, the positive association between inflation and the term premium conforms with the idea that inflation erodes the value of nominal bonds and so, in periods of rising inflation investors expect the central bank to tighten its monetary stance going

[43]The effects of the variables remain broadly similar across specifications of the model that exclude some of the regressors for each dependent variable.

forward (coefficient on the third column) and demand a higher term premium (coefficient on the fourth column). More generally, changes in inflation are associated with changes in all of the dependent variables except for the credit risk premium. In particular, the magnitudes are similar for nominal and synthetic as well as for the forward premium.

Lastly, there is evidence on the risk-taking channel of exchange rates documented by Hofmann et al. (2019).[44] Accordingly, a currency appreciation is associated with easier financial conditions and compressed sovereign bond spreads. However, here it works through the term premium instead of the credit risk premium as they argue.

In closing, the yield decompositions provide valuable information on the driving forces behind the sovereign yields of emerging markets. Nevertheless, it is important to acknowledge that the model in equation (15) may suffer from econometric problems such as endogeneity as well as the use of persistent the variables. These issues are addressed next.

5.2 U.S. Monetary Policy Shocks [Go2ToC]

Gürkaynak et al. (2005) and Swanson (2018) show that monetary policy has more than one dimension since asset prices respond to different types of news about monetary policy. This paper considers three types of U.S. monetary policy shocks, namely unexpected changes to the current policy rate (Kuttner, 2001), surprise changes to the future path of the policy rate (Gürkaynak et al., 2005), and unanticipated announcements about the Fed's LSAP programs (Swanson, 2018). They will be referred to hereinafter as target, path and LSAP shocks, respectively.

The shocks are identified using high-frequency data around Fed's monetary policy announcements. These shocks are essentially surprises in monetary policy decisions that represent a change in the information set of market participants (Gürkaynak and Wright, 2013; Nakamura and Steinsson, 2018). The construction of the shocks therefore requires to calculate the change in asset prices that capture market expectations of monetary

[44]According to the standard view based on the trade-channel effect, a depreciation is expansionary because it stimulates exports and discourages imports, increasing the trade balance.

policy decisions. These changes are measured in windows containing monetary policy decisions starting 15 minutes before to 1 hour and 45 minutes after each Federal Open Market Committee (FOMC) meeting since 2000 giving a total of 162 events.[45] In days with no FOMC meeting, the shocks are set to zero. The dataset only includes monetary policy announcements. The dataset by Ferrari et al. (2017) also includes the release of minutes and speeches by Fed officials.

The assets used to measure the monetary policy shocks are the current federal funds rate future (FF0) contract, the 8-quarters ahead eurodollar future (ED8) contract and the yield of the 10-year U.S. Treasury bond. The target shock uses rescaled changes in the price of the FF0 contract; I follow Gürkaynak et al. (2005) who implement an intraday version of the daily measure proposed by Kuttner (2001). The price change in the ED8 contract is a measure of surprises in the federal funds rate two years into the future. The path shock is the residual of a regression of the intraday change in the ED8 contract on the target shock; this shock is highly correlated with the path factor in Gürkaynak et al. (2005).[46] Finally, I follow Swanson (2018) for measuring the last type. The LSAP shock is the residual of a regression of the intraday change in the 10-year yield on the target and path shocks. A positive value in any of the shocks represents a tightening of the monetary policy stance, whereas a negative shock indicates an easing.

The relevance of the shocks has varied over time. After 2008 the target shocks are essentially zero, since then there was no surprise changes in the current policy rate. By contrast, the meaning of LSAP shocks is unclear before 2008. Path shocks, nevertheless, have been relevant before and after the GFC. As a result, target shocks are considered from 2000 to 2008, LSAP shocks are considered starting in 2009, and path shocks span the whole sample period. Figure 12 plots all three monetary policy shocks.

5.3 The Response of Yields to U.S. Monetary Policy

[45] It is common to exclude from the analysis the meeting of September 2001 that followed the terrorist attacks earlier in the month, see Gürkaynak et al. (2005) and Nakamura and Steinsson (2018).

[46] The change in the 4-quarters ahead eurodollar future (ED4) contract could also be used to measure the path shocks. However, after 2011 intraday changes in ED4 became essentially zero since market participants expected the policy rate to remain at zero for at least a year.

The impact of U.S. monetary policy on emerging market yields is estimated using panel local projections for the daily changes in the yields and their components. These regressions are useful to understand not only how the yields respond to the policy surprise at the time of the shock but over subsequent periods, see Hofmann et al. (2019) and Adrian et al. (2019) for recent applications.

Following Jordà (2005) and Adrian et al. (2019), the panel local projections are:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i + \beta_h \epsilon_t + \gamma_h y_{i,t-2} + \phi_h f_{i,t-1} + u_{i,t+h}, \tag{16}$$

where i and t are respectively the country and time indexes, h indicates the horizon (in days) with $h = 0, 1, \ldots, 90$, α_i is a country fixed effect, ϵ_t represents a type of monetary policy shock, $f_{i,t-1}$ is a one-day lag of the exchange rate (LC per USD) and $u_{i,t+h}$ is the error term. The regressions are done for the 2- and 10-year yields and each of their components (the expected short rate, the term premium and the credit risk premium) for every type of monetary policy shock.[47]

The parameters of interest, β_h, measure the average response of the yield (or one of its components) to a monetary policy shock at a particular horizon. The contemporaneous effects of the shocks are obtained by setting $h = 0$ in equation (16). All responses are assessed relative to a one basis point increase (a tightening) in any of the shocks.

The response of the U.S. yields and its components to the three shocks are used as a benchmark to assess the responses of the yields of emerging markets.[48] The first column of figures 13 and 14 shows the responses of the 2- and 10-year yields, respectively, to all three shocks. The on-impact effect of the 2-year yield to any of the three shocks is similar at around 5 basis points for a 10 basis point increase in any of the shocks. By contrast, the 10-year yield only increases in response to path and LSAP shocks contemporaneously,

[47]By definition, the shocks are unanticipated by the market and thus there is no need to control for past or future shocks. Also, by construction, the shocks are not correlated among themselves so, there is no need to control for the other types of shocks.

[48]As before, the yields are from the dataset of Gürkaynak et al. (2007), the components come from the decomposition proposed by Kim and Wright (2005).

with LSAP shocks having a more than one-to-one impact. The magnitudes are in line with previous literature. The duration of the effects ranges from a couple of days up to a few days past a month, where the delayed response can be larger that the initial reaction, consistent with the evidence in Brooks et al. (2019). The decomposition allows for a better characterization of the response. For instance, one of the goals of the unconventional monetary policy tools was to influence (decrease) long-term bond yields and, in particular, the term premium (see Kuttner, 2018). The right hand panels in figures 14b and 14c confirm this. Meanwhile, the main effects of target shocks are seen on the expected short rate, especially at the 2-year maturity (middle panel of figure 13a). Fed's decisions therefore impact both expectations about its policy rate in the future and the compensation required by investors to hold long-term bonds.

I now turn to analyze how the sovereign yields of emerging markets respond to U.S. monetary policy. The first column of figures 15 and 16 shows the responses of their 2- and 10-year nominal yields, respectively, to all three shocks. Those yields go up by about 2 basis points on-impact for a 10 basis point increase in any of the shocks. Thus, the magnitude of the initial response is lower than the response of U.S. yields. However, the response increases over time, it can last for up to 2 months and intensify to such an extent so as to become a one-to-one response, or even more in the case of LSAP shocks. The response of the yields of emerging markets therefore lasts relatively longer than the response of U.S. yields. Adrian et al. (2019) documents a similar finding for a sample comprised mostly by advanced countries. For the U.S., Brooks et al. (2019) attribute this delayed response to a portfolio rebalancing channel.

To better understand the spillover effects of the Fed's decisions on emerging markets, I leverage on the yield decompositions at the daily frequency. The responses of each component are displayed in the second to last column of figures 15 and 16. Several things are worth pointing out about the response of the 2-year yield. First, no shock impacts the term premium. Second, the expected short rate only responds on-impact to LSAP shocks, but it has a substantial delayed response to target and path shocks. Third, although the expected short rate and the term premium do not respond on impact to target and path shocks, nominal yields do respond but as a result of an increase in the credit risk premium. Fed policies can therefore influence the compensation for credit risk in emerging markets.

Before analyzing the response of the 10-year yield decomposition, it is helpful to first look at the response of the forward premium to the shocks. Remember that synthetic yields add a forward premium to the U.S. yield curve. Since exchange rates are expressed in LC per USD, a decrease in the premium implies that the forward exchange rate is lower than the spot. Figures 17 and 18 show the responses of the forward premium for emerging and advanced countries, respectively. In all cases, the forward premium declines (sometimes even one-to-one) on impact in response to a shock but it remains below zero in subsequent days only for advanced countries, whereas there is only an on-impact response for emerging markets in general. It is well documented that following a monetary tightening the dollar appreciates (Ferrari et al., 2017). This is consistent with a decline in the forward premium (when the spot is higher than the forward), which implies a future expected appreciation of the domestic currency.

It can now be seen how the the 10-year yield respond to monetary policy decisions by the Fed. By construction, the effects on synthetic yields are linked to the responses of the U.S. yield curve and the forward premium for corresponding maturities. Such responses have already been discussed above (see figures 14 and 17). The response of the synthetic yields is the net result of those two individual effects, which in turn will be reflected in the components of those synthetic yields, namely the expected short rate and the term premium. The expected short rate does not respond on-impact for target or path shocks; the term premium also does not respond on-impact to path shocks, only to target shocks. But their responses are sluggish a amplify over time.

The analysis of the 10-year yield shows that Fed's decisions not only impact the credit risk premium but that it can affect them in both directions. The credit risk premium increases in response to target and path shocks, while decreases in response to LSAP shocks. But why does the credit risk premium increase in response to target and path shocks? Because synthetic yields *decline* on-impact. The reason is that a lower forward premium means a lower compensation for a future currency depreciation, reducing the cost of borrowing in LC at the risk-free rate.[49] With an increase in the nominal yield and a decrease in the synthetic yield in response to a monetary tightening, the credit risk premium goes up (see the right panels of figures 15a and 15b).[50] That is, target and path shocks have opposite effects on the synthetic yield and on the credit risk premium on impact. Similarly the credit risk premium decreases in response to LSAP shocks because synthetic yields increase on impact. Even though the forward premium still declines following a path shock (see figure 17c), since the U.S. yield increases by more (see figure 14), the synthetic yield increases on impact, decreasing the credit risk premium. Therefore, the direction of the response of the credit risk premium depends on the type of shock, but in particular on the relative responses of the forward premium and U.S. yields. In any case, unlike the delayed response in nominal yields and the components of synthetic yields, the reaction by the credit risk premium is short lived. Given that the forward premium for emerging markets only reacts on-impact, the effects on the nominal yields in the subsequent days are essentially driven by the responses of the expected short rate and the term premium. Finally, notice that the effects on the credit risk premium can revert over time, which would explain the negative correlation reported in section 5.1.

6 Concluding Remarks

[Go2ToC]

This paper studies how emerging market sovereign bond yields respond to U.S. monetary policy shocks. I characterize the response based on a novel decomposition of the yields into an expected future short-term interest rate, a credit risk premium and a (pure) term premium. I show that U.S. monetary policy influences each of the components of emerging market yields.

[49]Mechanically, synthetic yields decline because the forward premium declines by more than the increase in U.S. yields, see figures 14 and 17.

[50]The exchange rate risk channel proposed by Hofmann et al. (2019) can be indirectly seen here. A monetary tightening in the U.S. would appreciate the dollar and depreciate the domestic currency. A currency appreciation would associated with an increase in the credit risk premium and vice versa.

The responses of the yields and their components have several implications. Although the contemporaneous impact seems moderate relative to the response of U.S. yields, Fed's monetary policy decisions can have ripple effects depending on the type of shock. The effects on the expected short rate and on the term premium are sluggish and the spillover effects afterwards are substantial, whereas the effect on the credit risk premium is short lived. Surprises in Fed's policy decisions give rise to a reassessment of policy rate expectations in emerging markets, and lead to a repricing in their interest and credit risks. Investors expect central banks in emerging markets to follow the U.S. monetary stance (loosening or tightening) in response to decisions by the Fed. Investors also adjust the compensation they demand to hold long-term bonds as well the compensation against default. U.S. monetary policy has therefore not only monetary but also fiscal implications for emerging markets.

Table 1. Term Premia and Inflation Volatility

	3M	3M	1Y	1Y	2Y	2Y	5Y	5Y	10Y	10Y
UCSV-Perm	91.6	63.6	85.7	83.2	88.7*	97.8**	103.1*	124.2***	121.9*	151.3***
	(62.3)	(37.1)	(43.4)	(38.6)	(34.5)	(31.7)	(35.1)	(23.5)	(41.5)	(23.0)
GDP Growth		-1.73		-2.62		-1.91		-2.14		-3.97
		(1.56)		(3.06)		(3.16)		(2.90)		(3.23)
Observations	870	796	870	796	870	796	870	796	870	796
R^2	0.04	0.02	0.04	0.03	0.05	0.05	0.10	0.11	0.11	0.15

Note: Variables in basis points.

Table 2. Drivers of the 2-Year Nominal Yield and Its Components

	YLD	SYN	ER	TP	CRP	FWD
US ER	0.29**	0.44*	0.31	0.14*	-0.07*	-0.56**
	(0.093)	(0.174)	(0.155)	(0.059)	(0.031)	(0.173)
US TP	2.12*	3.37***	2.52***	0.89	-0.92**	2.40**
	(0.786)	(0.765)	(0.561)	(0.467)	(0.293)	(0.759)
Log(Vix)	67.70*	-16.06	1.93	-22.36	103.31***	-18.76
	(31.051)	(30.075)	(25.425)	(16.038)	(23.154)	(30.217)
EPU	-0.27	-0.28	-0.28	0.02	-0.12	-0.28
	(0.278)	(0.264)	(0.200)	(0.110)	(0.107)	(0.265)
S&P	0.01	-0.02	-0.01	-0.01	0.03***	-0.02
	(0.007)	(0.009)	(0.010)	(0.005)	(0.005)	(0.009)
Global IP	1.33	-1.86	-0.05	-1.80	4.31**	-1.93
	(1.373)	(1.589)	(1.279)	(1.616)	(1.358)	(1.585)
Oil	-0.00	-0.00	0.00	-0.00**	-0.00	-0.00
	(0.004)	(0.003)	(0.002)	(0.001)	(0.001)	(0.003)
Inflation	44.28***	44.87***	30.40**	14.64***	-0.89	44.89***
	(6.426)	(7.843)	(8.066)	(2.323)	(3.165)	(7.824)
Unempl.	21.30*	8.20	7.26	1.23	9.80	7.94
	(9.780)	(10.055)	(7.321)	(3.932)	(5.618)	(10.014)
FX	0.02	0.01	0.00	0.01	0.01	0.01
	(0.016)	(0.016)	(0.015)	(0.008)	(0.009)	(0.016)
Obs.	2333	2257	2257	2257	2197	2257
R^2	0.60	0.52	0.49	0.28	0.25	0.37

Note: Dependent variables in basis points. EPU Global, returns for: S&P, oil, FX.

Table 3. Drivers of the 10-Year Nominal Yield and Its Components

	YLD	SYN	ER	TP	CRP	FWD
US ER	0.56**	0.86**	0.69***	0.22	-0.19	-0.15
	(0.155)	(0.223)	(0.153)	(0.140)	(0.115)	(0.223)
US TP	0.90***	1.34***	0.46*	0.81***	-0.48**	0.36
	(0.147)	(0.220)	(0.213)	(0.170)	(0.120)	(0.220)
Log(Vix)	23.22	-19.63	-41.30*	11.91	59.29***	-30.06
	(20.649)	(20.603)	(17.511)	(12.125)	(14.226)	(20.665)
EPU	0.00	0.01	-0.03	0.05	-0.05	0.02
	(0.206)	(0.169)	(0.127)	(0.053)	(0.111)	(0.170)
S&P	-0.00	-0.02**	-0.02**	-0.01	0.02***	-0.03**
	(0.007)	(0.008)	(0.007)	(0.007)	(0.006)	(0.008)
Global IP	-1.32	-1.93	-1.18	-1.38	0.83	-2.16*
	(1.276)	(1.000)	(0.750)	(0.858)	(1.314)	(1.005)
Oil	0.00	0.00	0.00	-0.00	0.00	0.00
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Inflation	29.12***	27.19***	18.79***	8.22***	2.50	26.87***
	(4.124)	(3.990)	(3.715)	(1.870)	(3.414)	(4.051)
Unempl.	29.87**	16.79	6.08	10.12*	10.07	16.45
	(9.600)	(8.824)	(5.611)	(4.145)	(6.623)	(8.793)
FX	0.03**	0.02	0.01	0.02*	0.01	0.02
	(0.011)	(0.013)	(0.008)	(0.007)	(0.008)	(0.013)
Obs.	2333	2257	2257	2257	2197	2257
R^2	0.61	0.60	0.51	0.45	0.18	0.29

Note: Dependent variables in basis points. EPU Global, returns for: S&P, oil, FX.

Figure 1. Long-Horizon Forecasts of Inflation

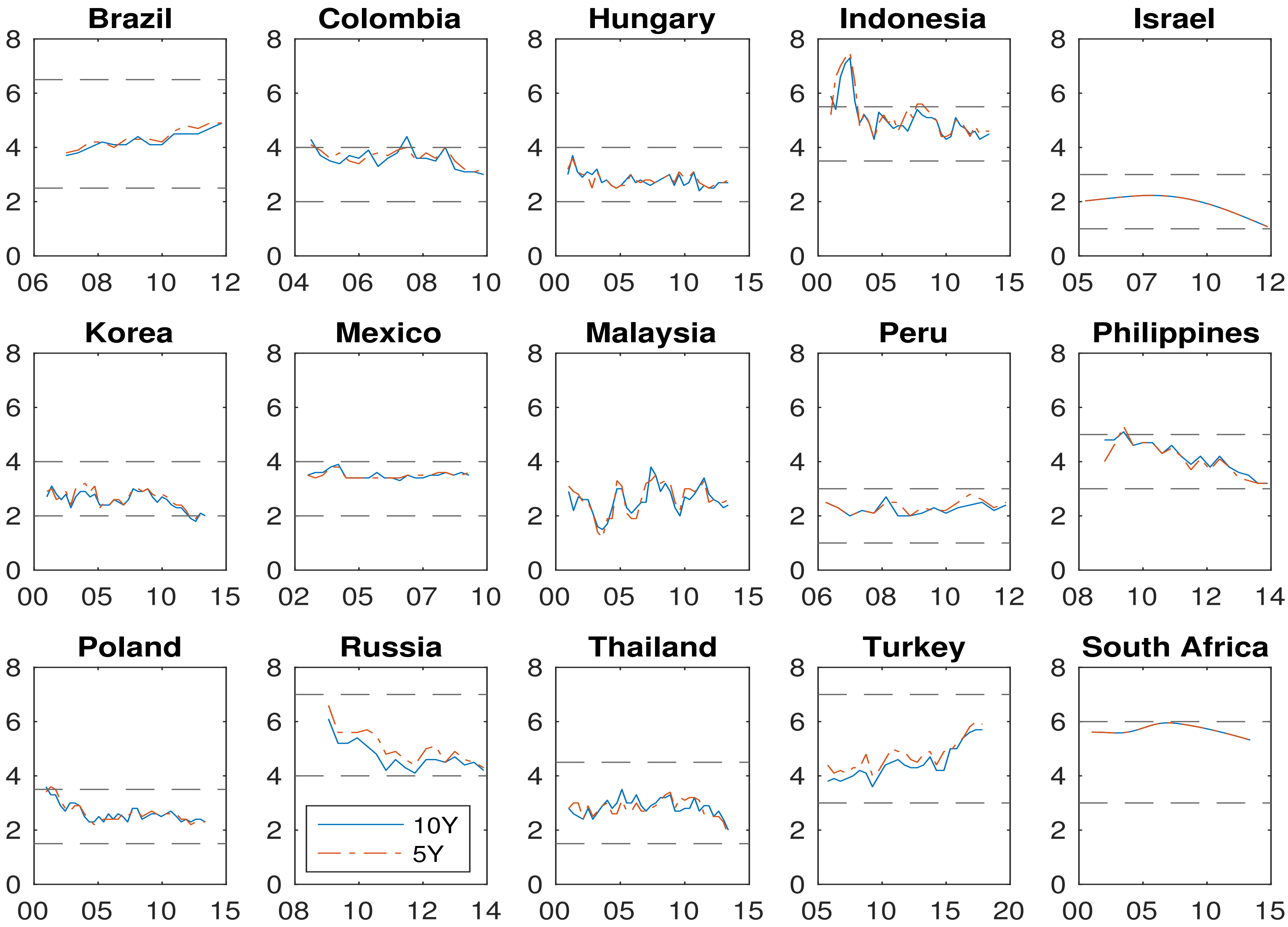


Figure 2. Long-Horizon Forecasts of Real GDP Growth

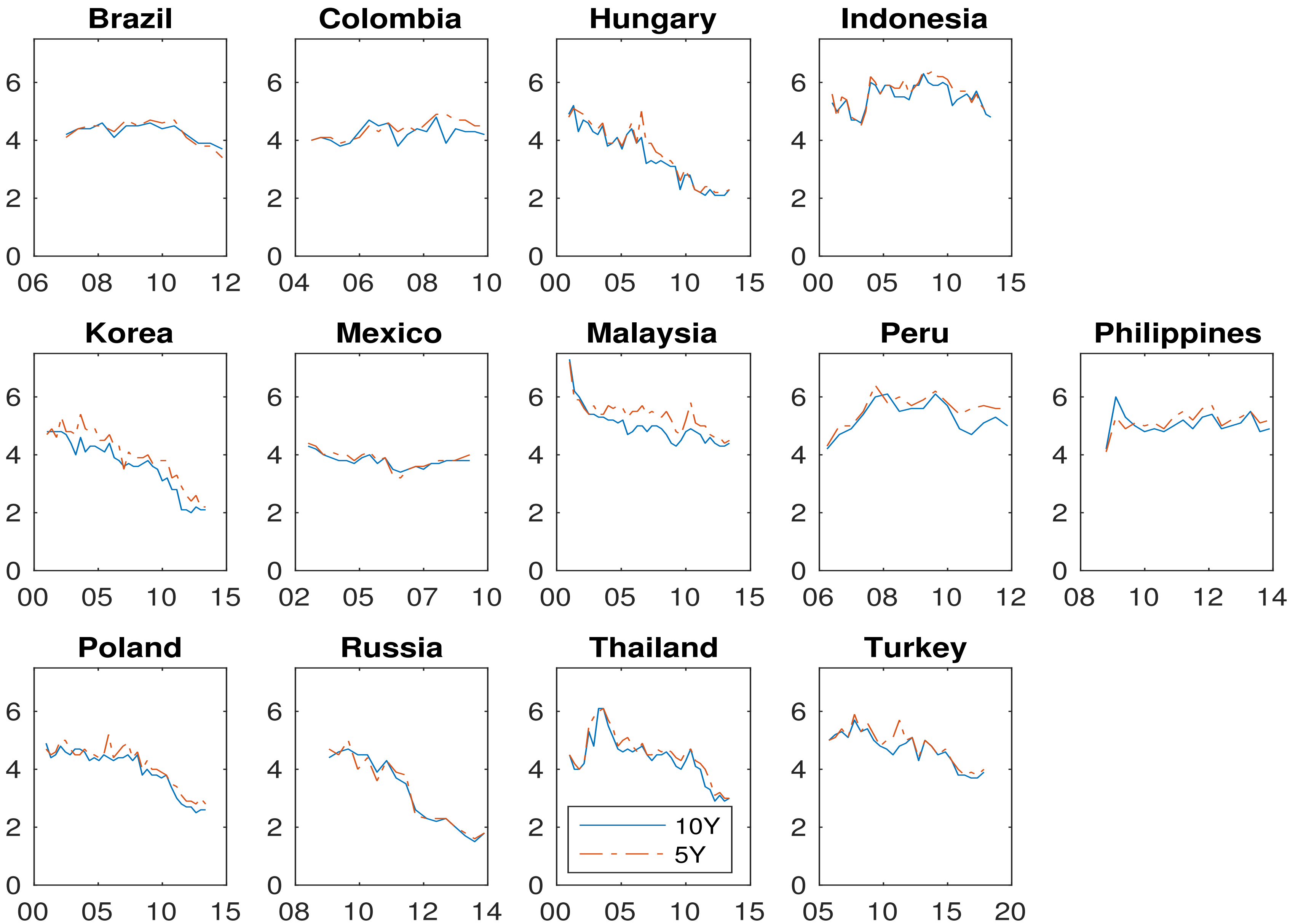


Figure 3. 10-Year Synthetic Yield and Long-Horizon Implied Forecasts for the Short Rate

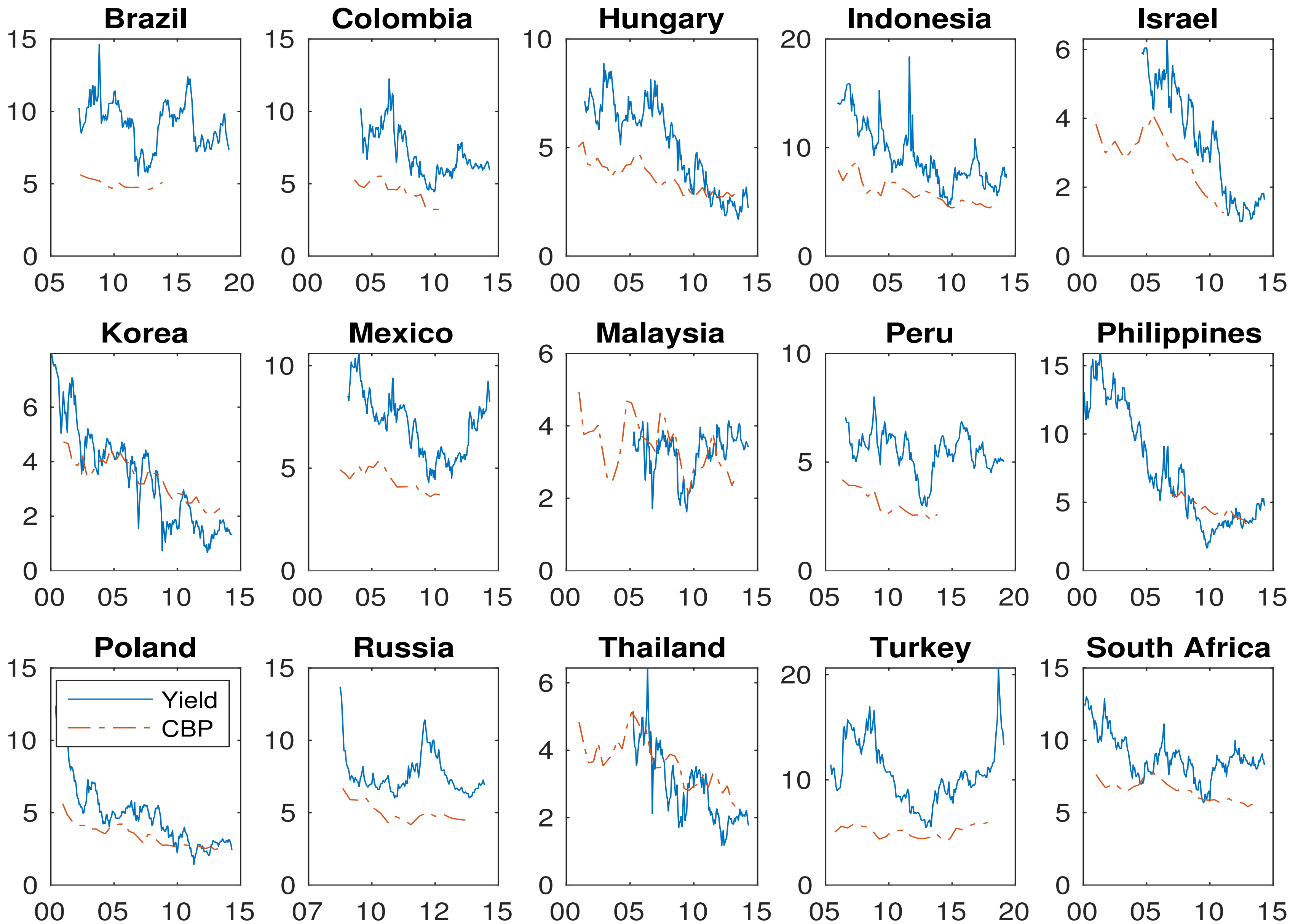


Figure 4. Trend versus Long-Horizon Forecasts of Inflation

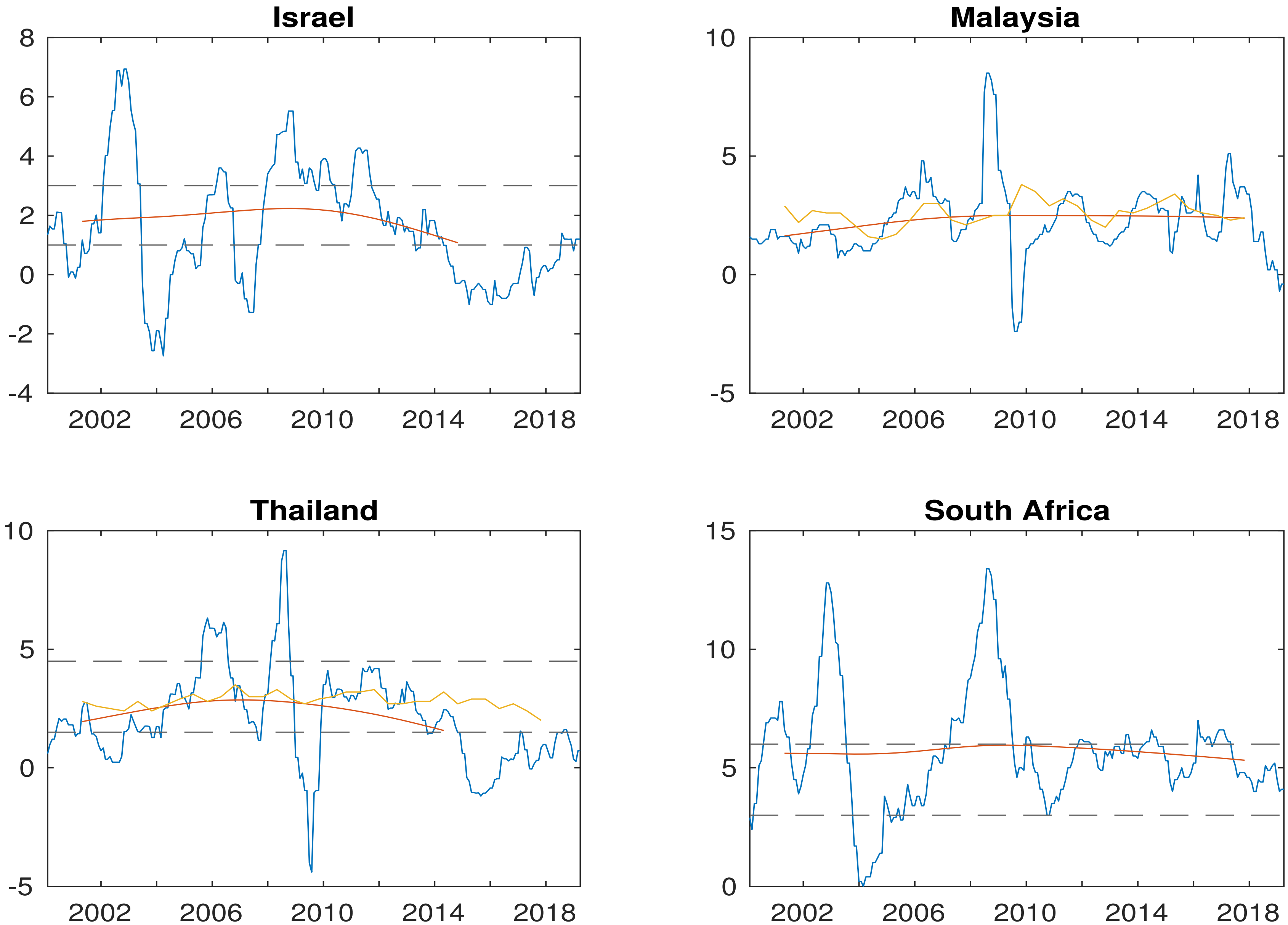


Figure 5. Model Fit for Emerging Markets: 10-Year Synthetic Yields

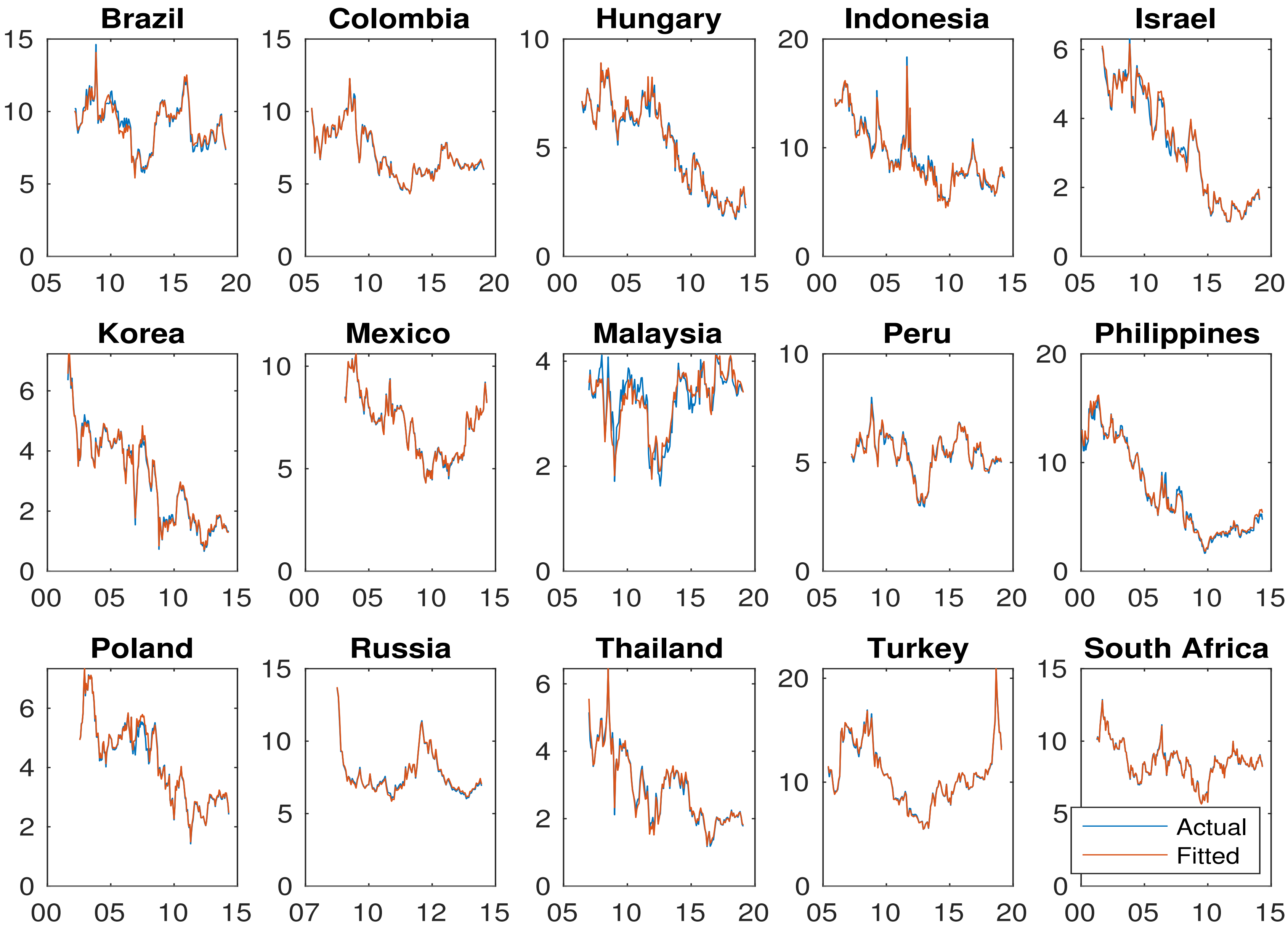


Figure 6. Decomposition of EM Nominal 10-Year Yields

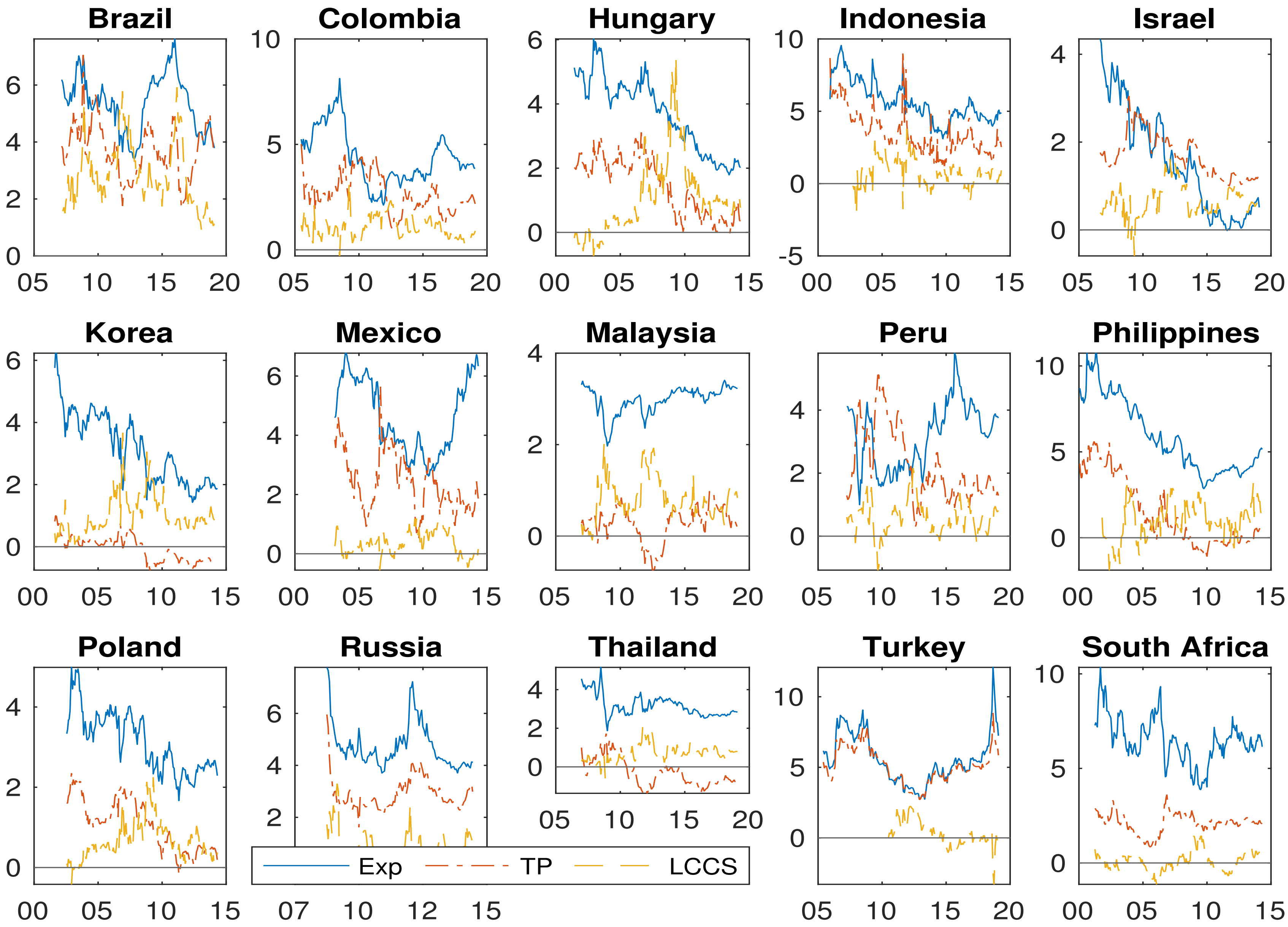


Figure 7. Interest Rate Forecasts vs Model-Implied Expectation: 10-Year Yields

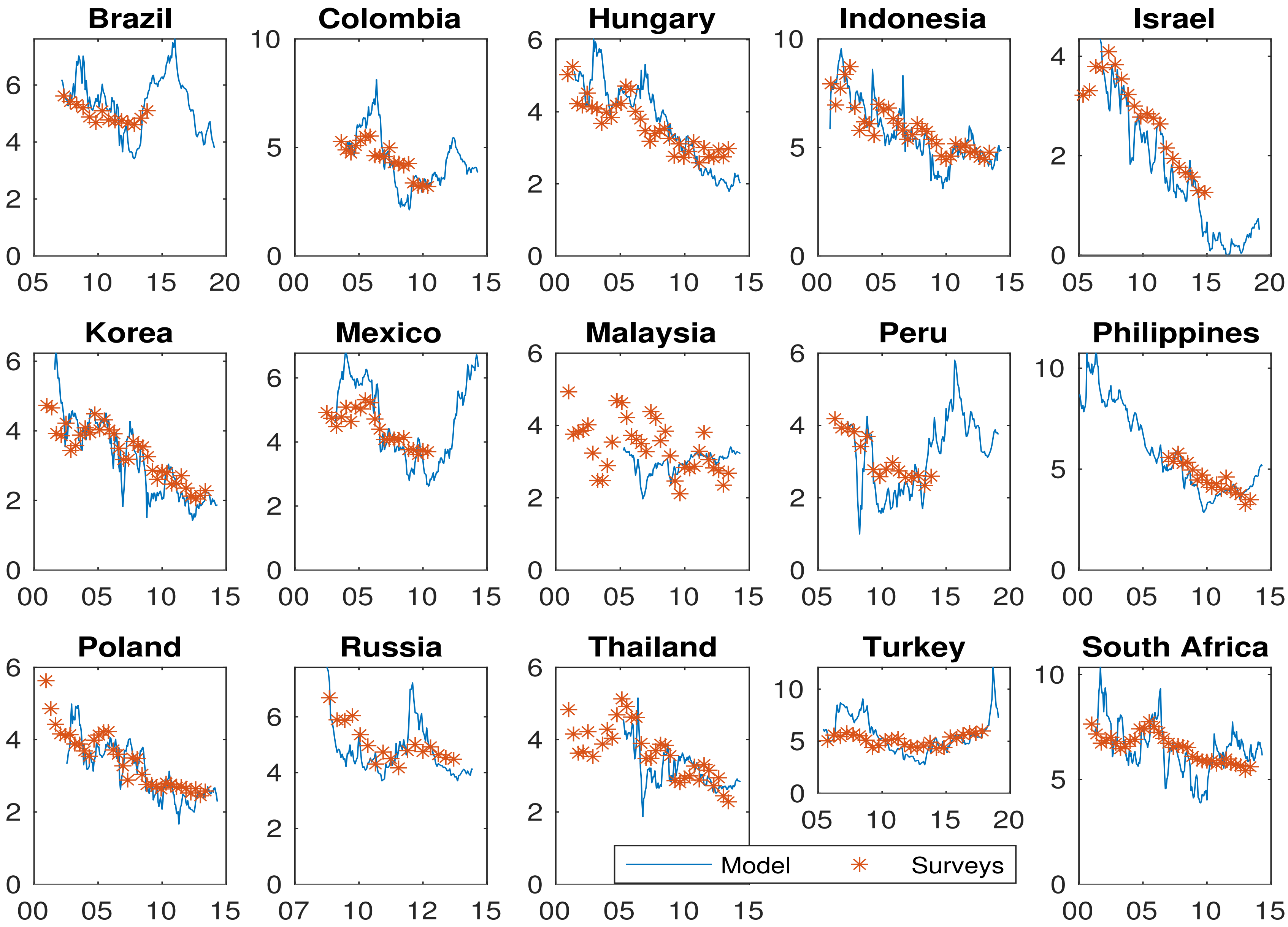


Figure 8. 10-Year Expected Real Interest Rate

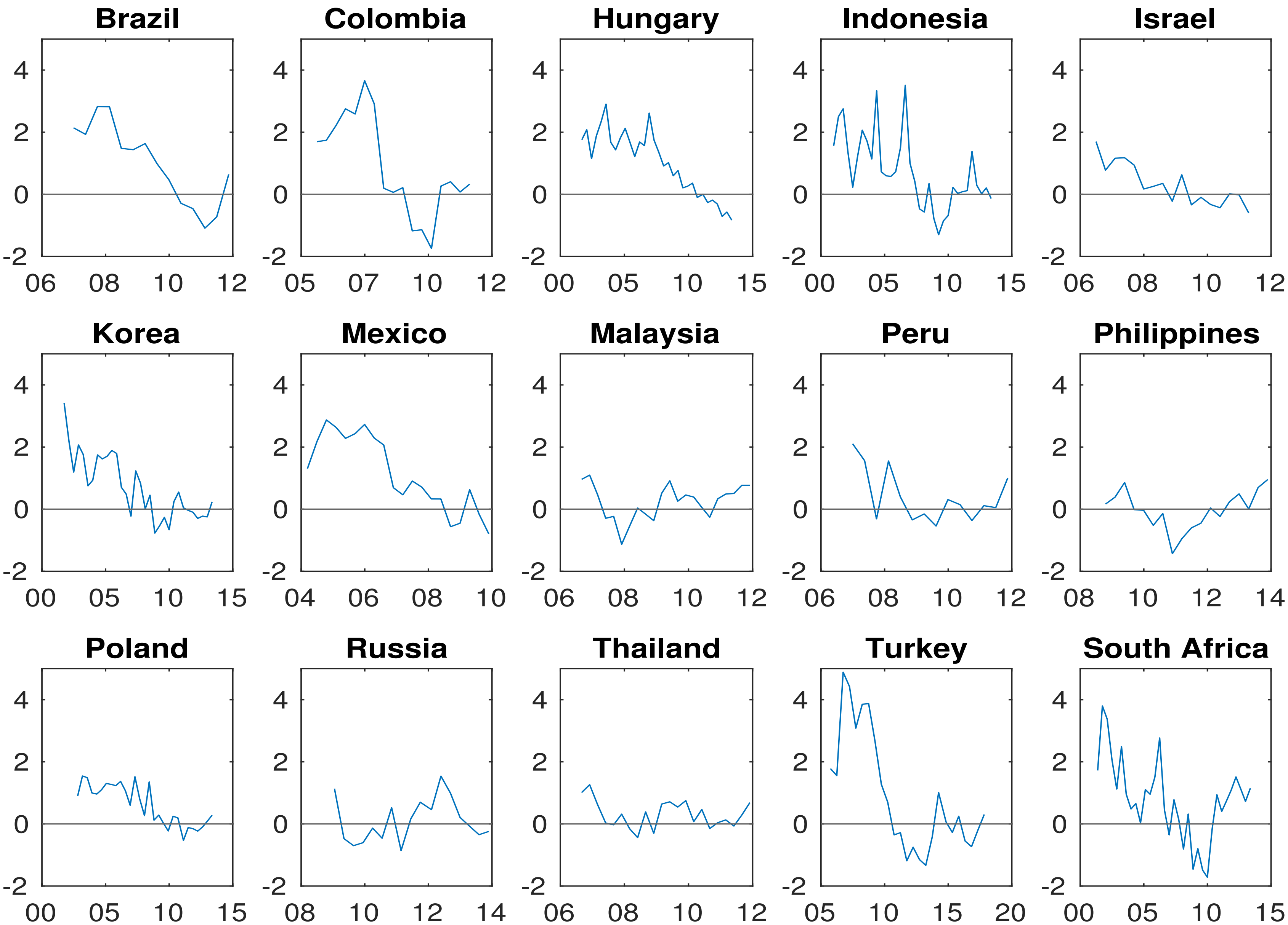


Figure 9. Term Structure of Term Premia

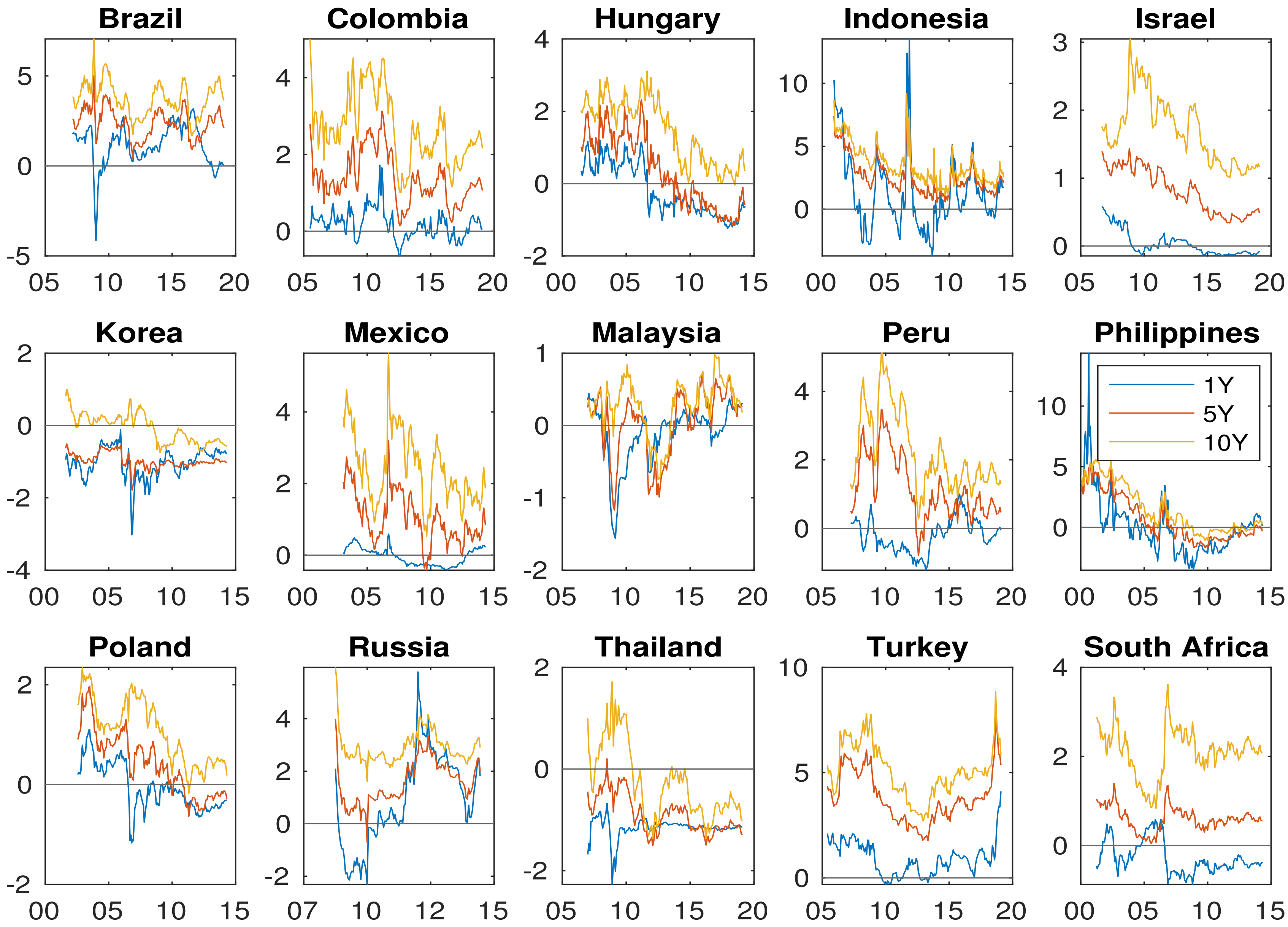
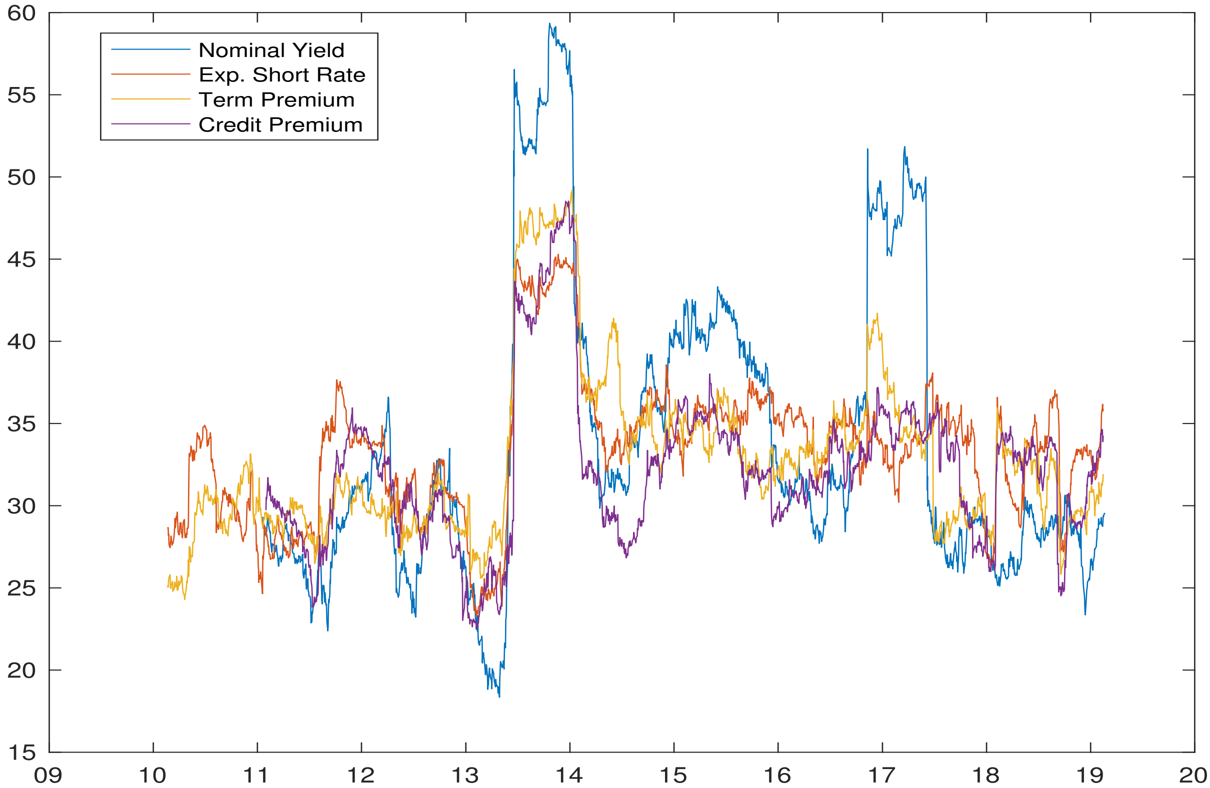
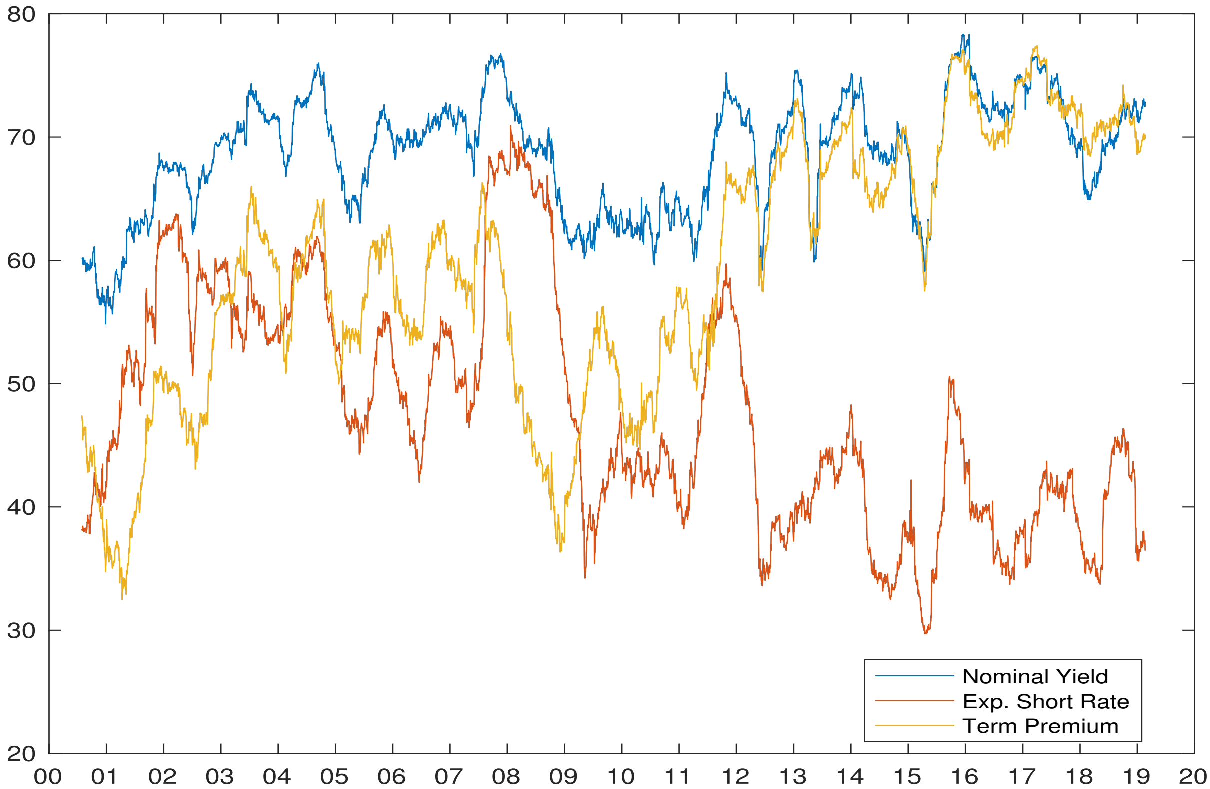


Figure 10. Connectedness of Sovereign 10-Year Yields

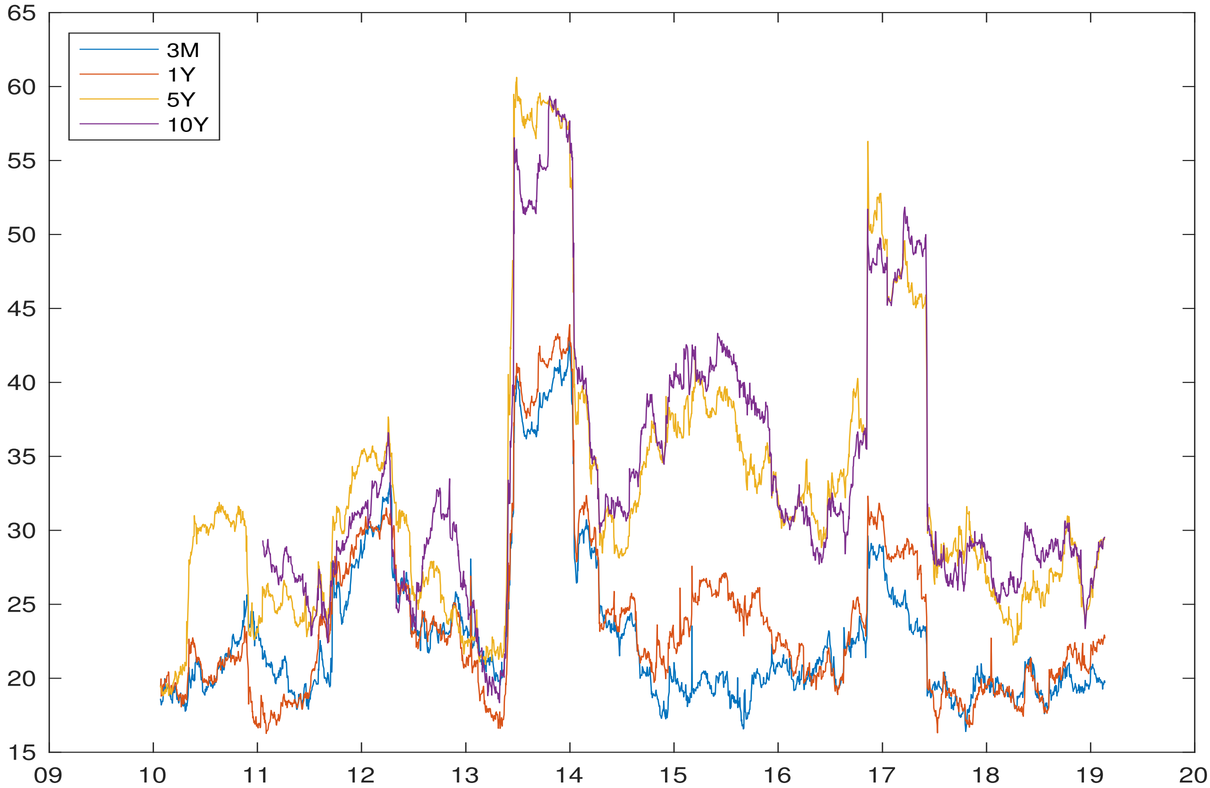


(a) Emerging Markets

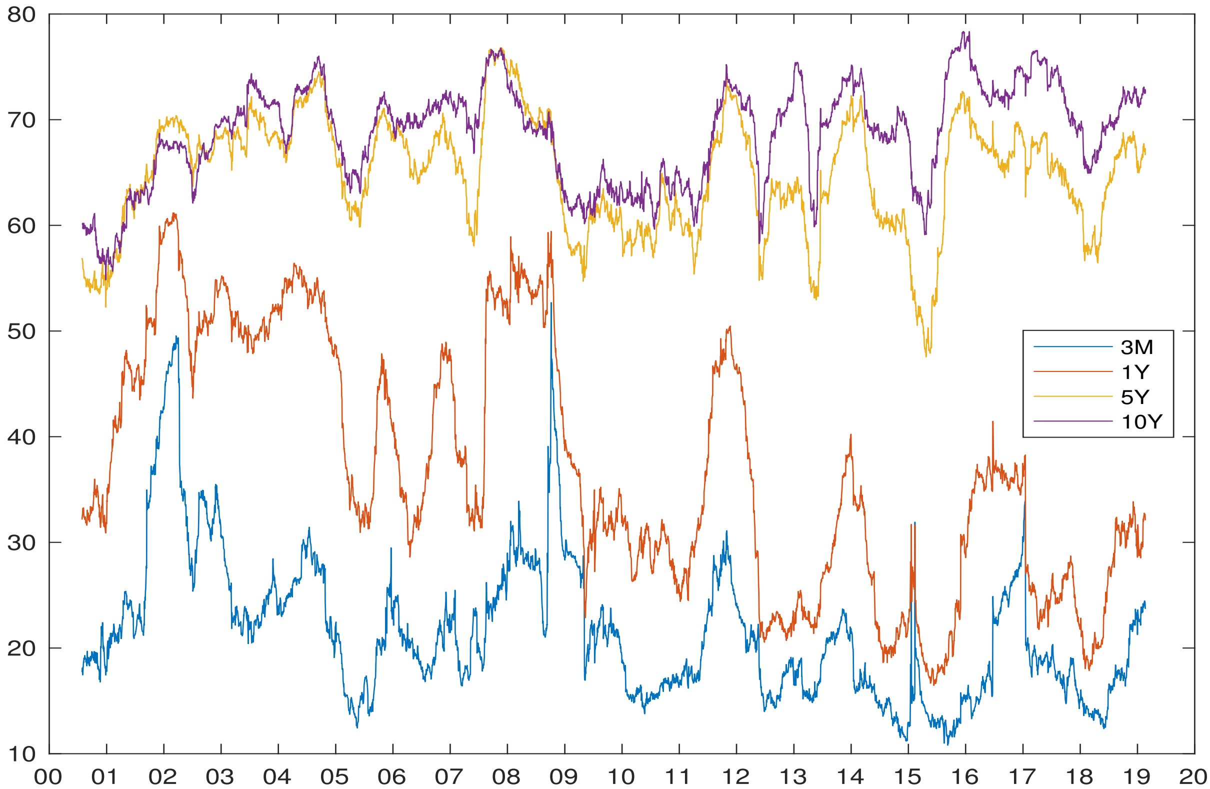


(b) Advanced Countries

Figure 11. Connectedness of the Term Structure



(a) Emerging Markets



(b) Advanced Countries

Figure 12. U.S. Monetary Policy Shocks

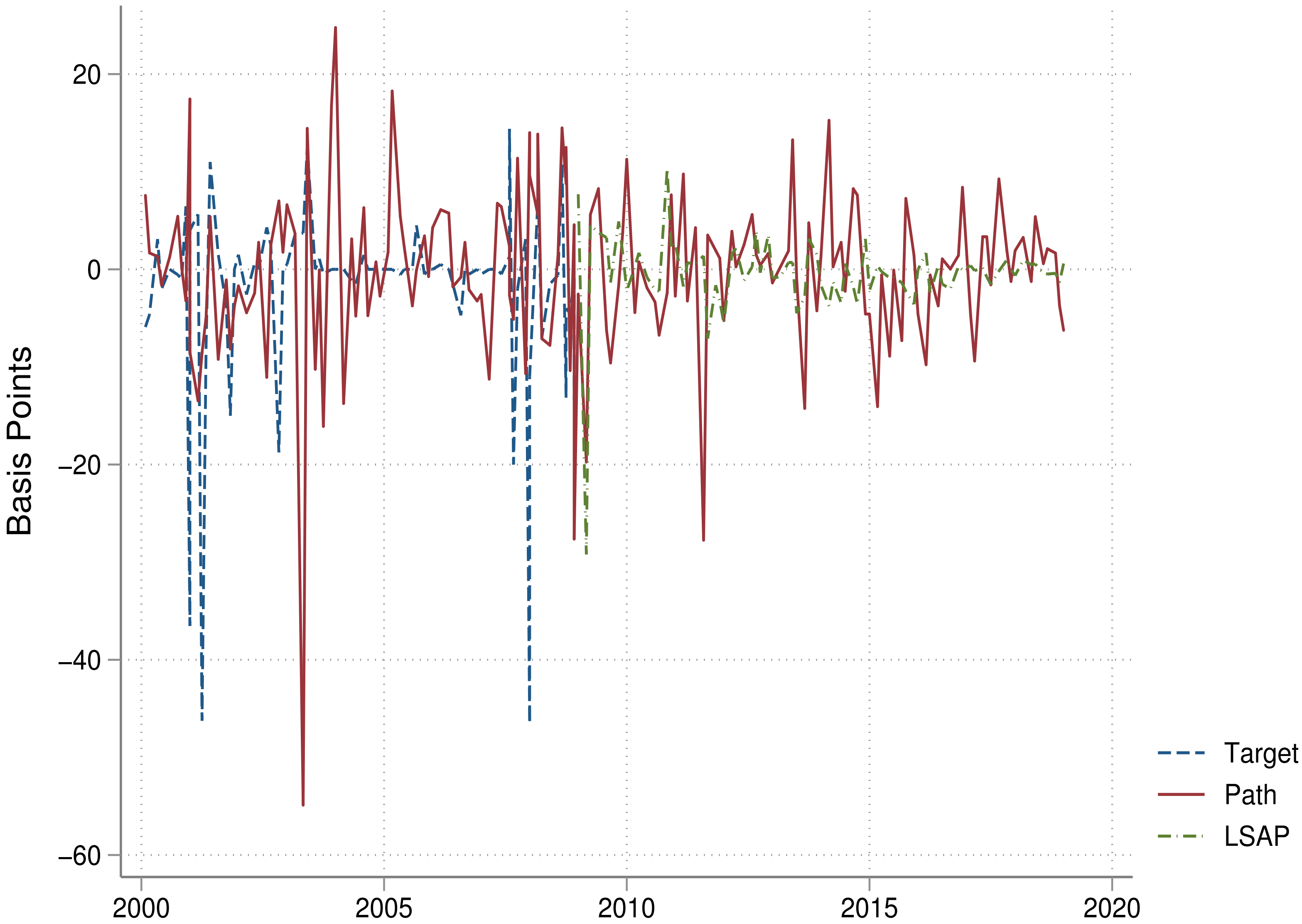
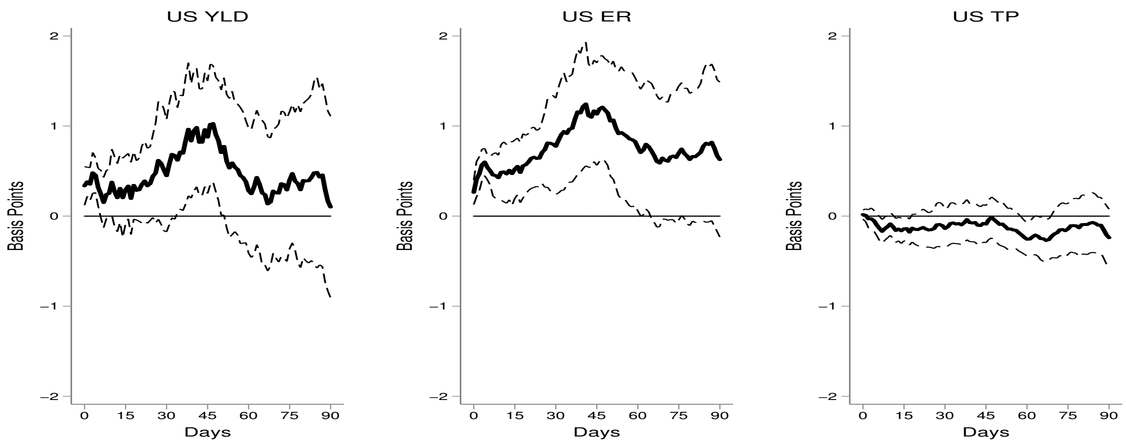
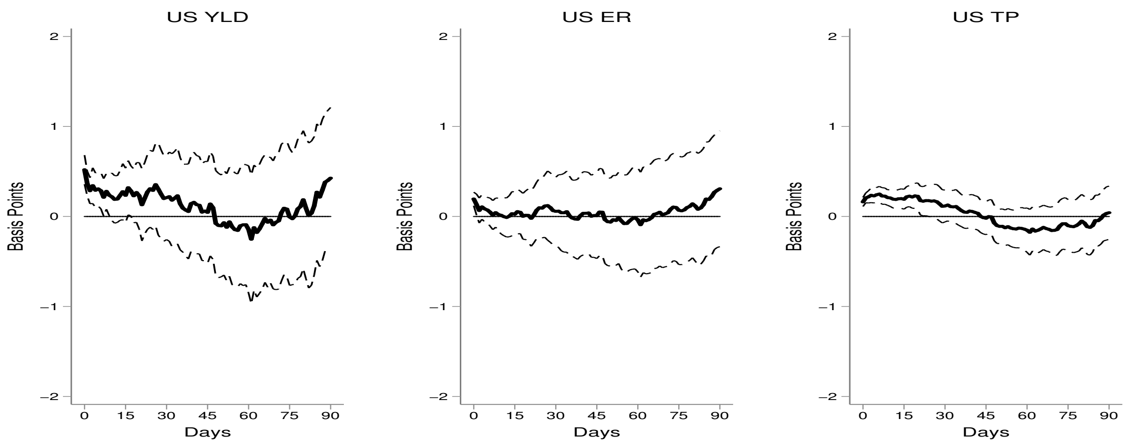


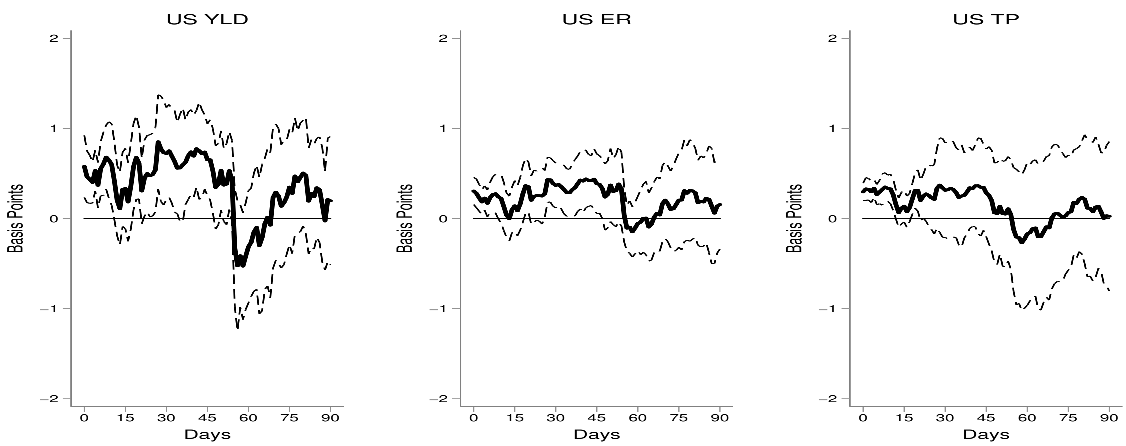
Figure 13. Response of 2-Year U.S. Yield to U.S. Monetary Policy Shocks



(a) Target Shock: 2000-2008

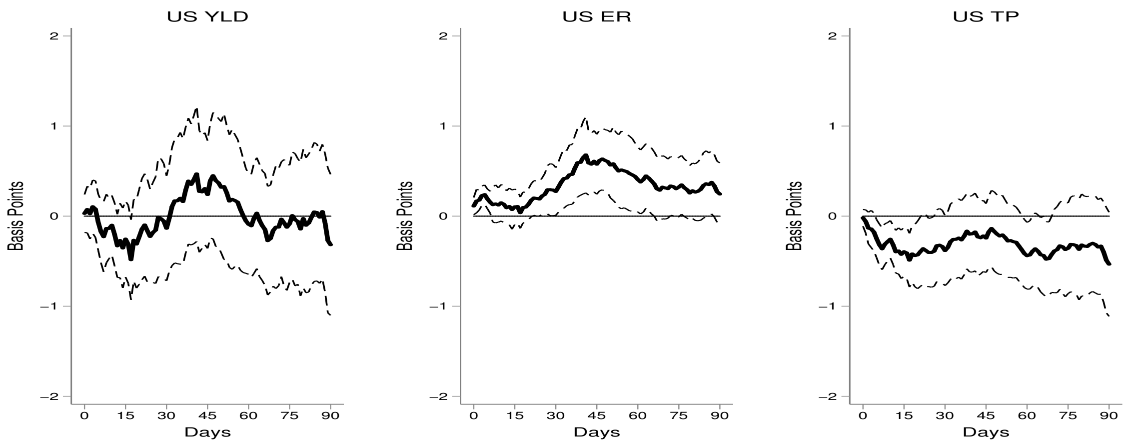


(b) Path Shock: 2000-2019

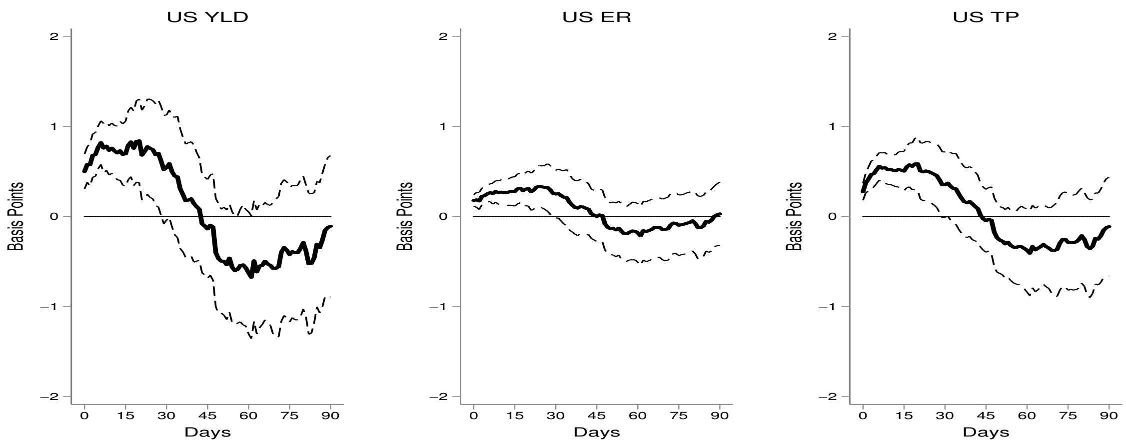


(c) LSAP Shock: 2009-2019

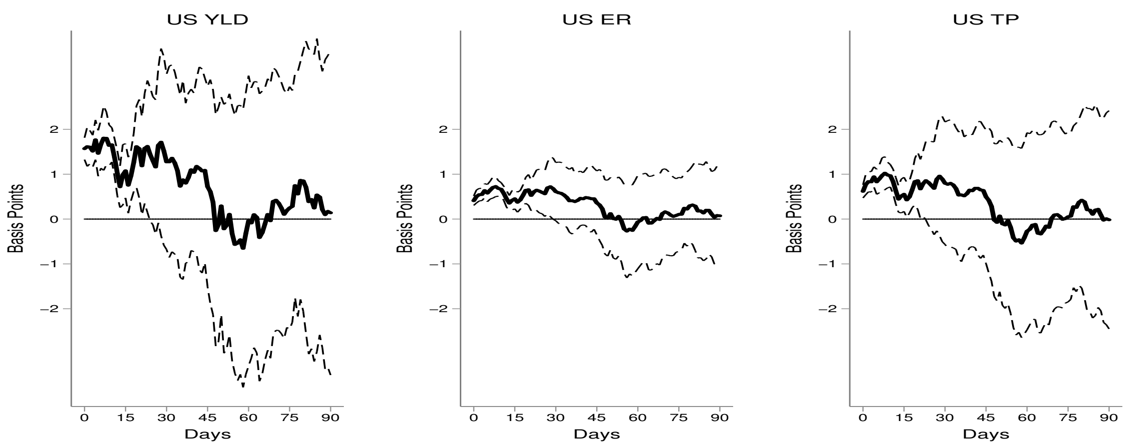
Figure 14. Response of 10-Year U.S. Yield to U.S. Monetary Policy Shocks



(a) Target Shock: 2000-2008

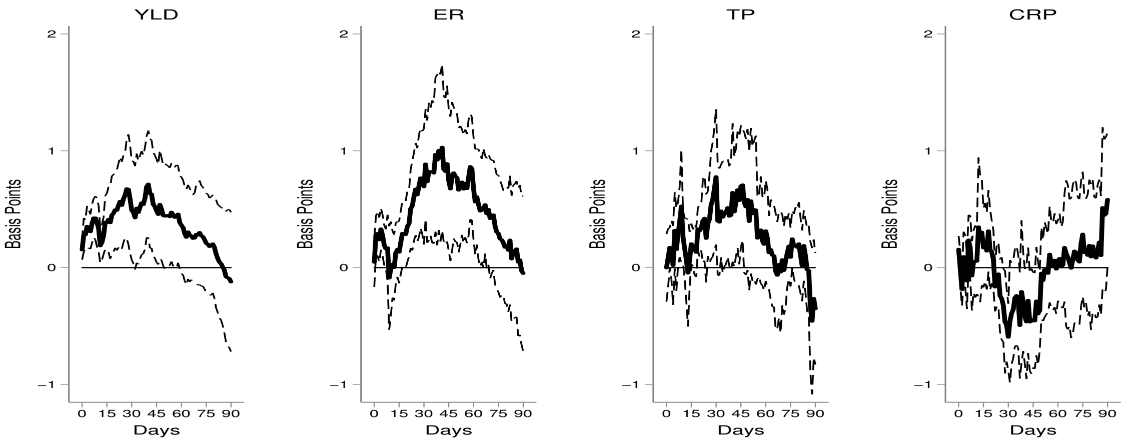


(b) Path Shock: 2000-2019

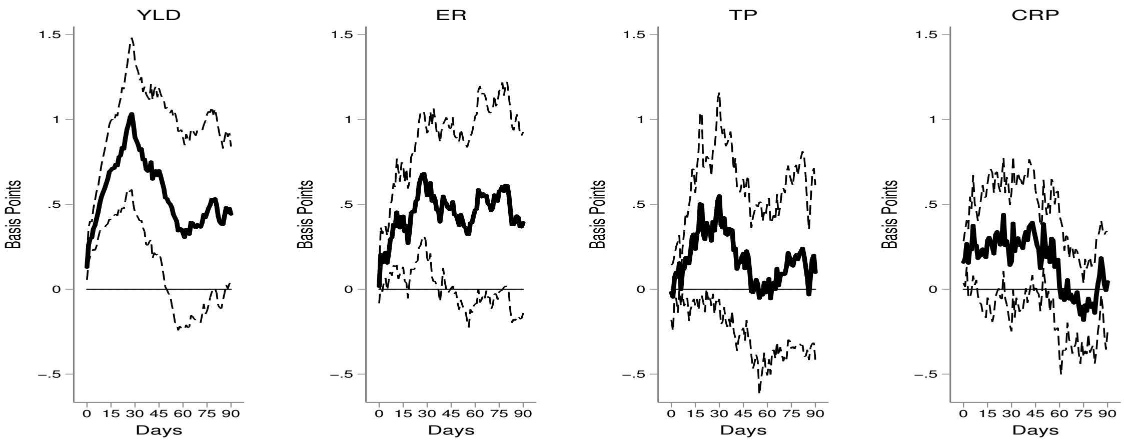


(c) LSAP Shock: 2009-2019

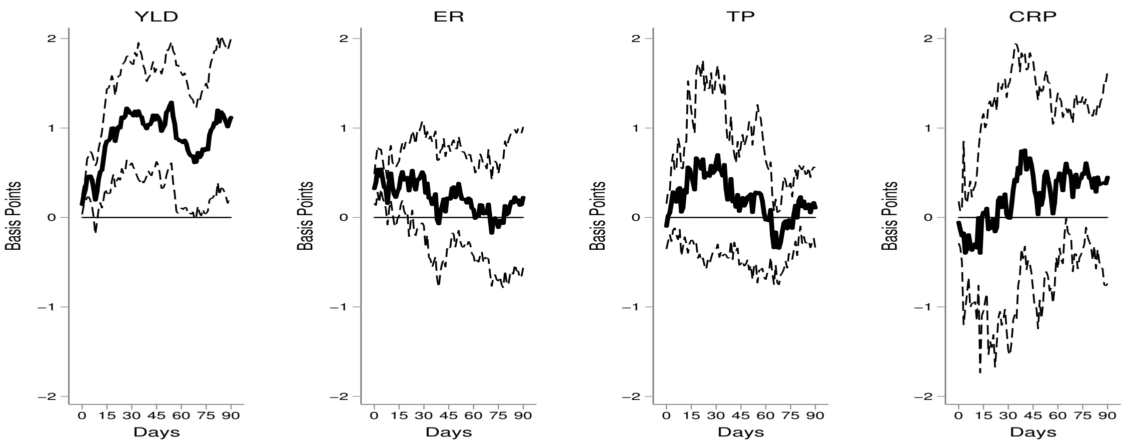
Figure 15. Response of 2Y EM Yields to U.S. Monetary Policy Shocks



(a) Target Shock: 2000-2008

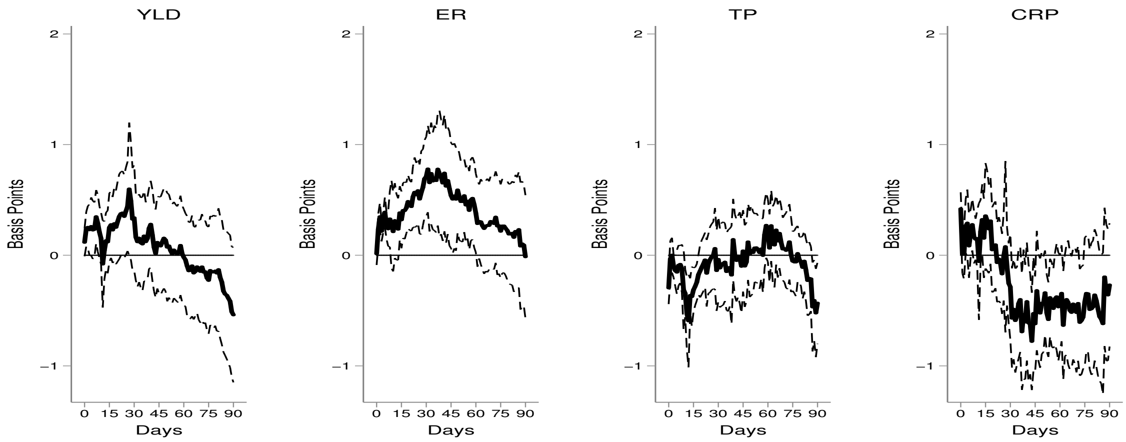


(b) Path Shock: 2000-2019

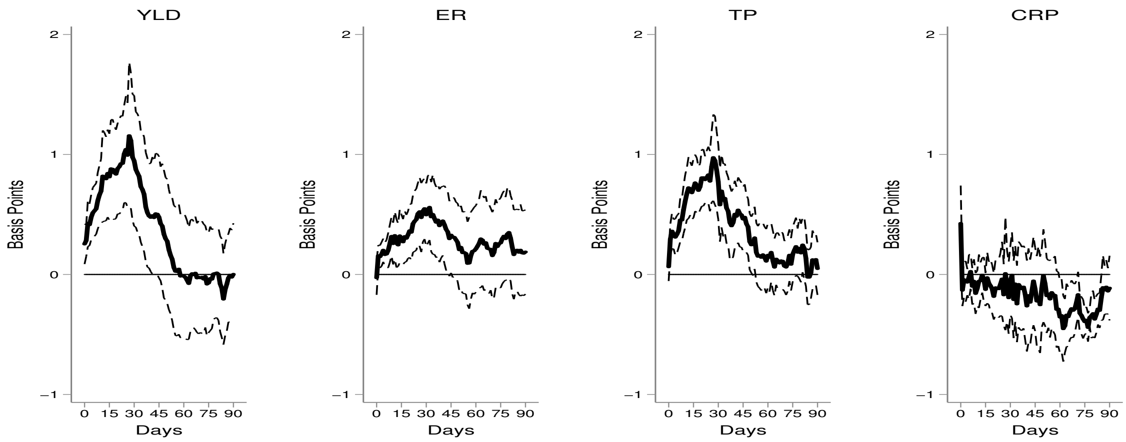


(c) LSAP Shock: 2009-2019

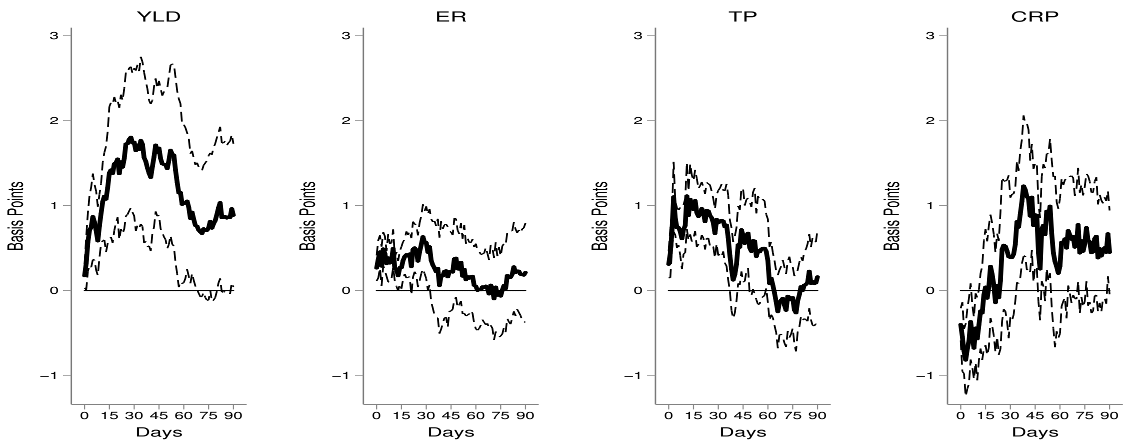
Figure 16. Response of 10Y EM Yields to U.S. Monetary Policy Shocks



(a) Target Shock: 2000-2008

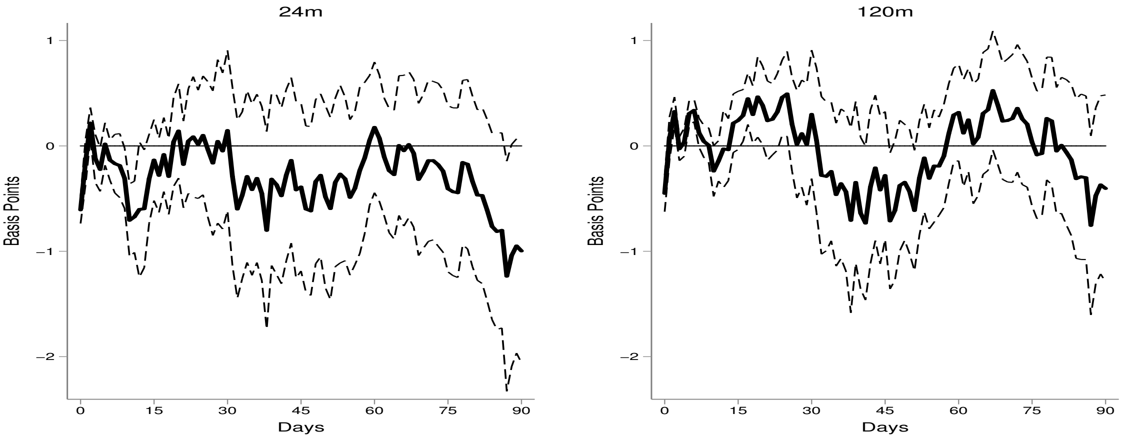


(b) Path Shock: 2000-2019

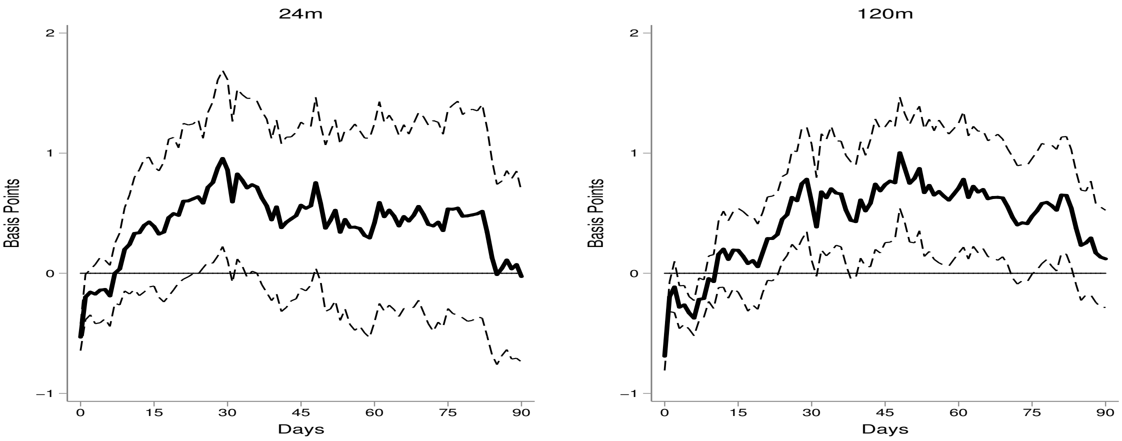


(c) LSAP Shock: 2009-2019

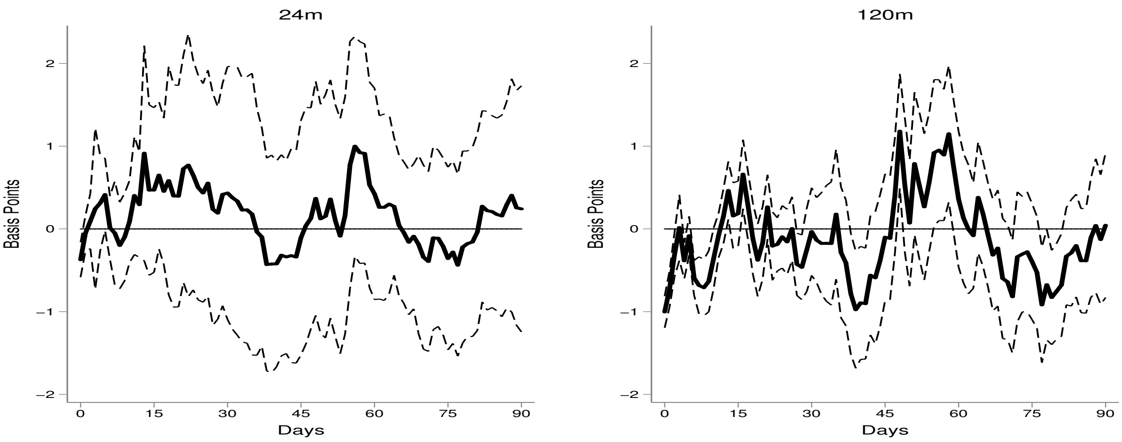
Figure 17. Response of the Forward Premium to U.S. Monetary Policy Shocks: EM



(a) Target Shock: 2000-2008

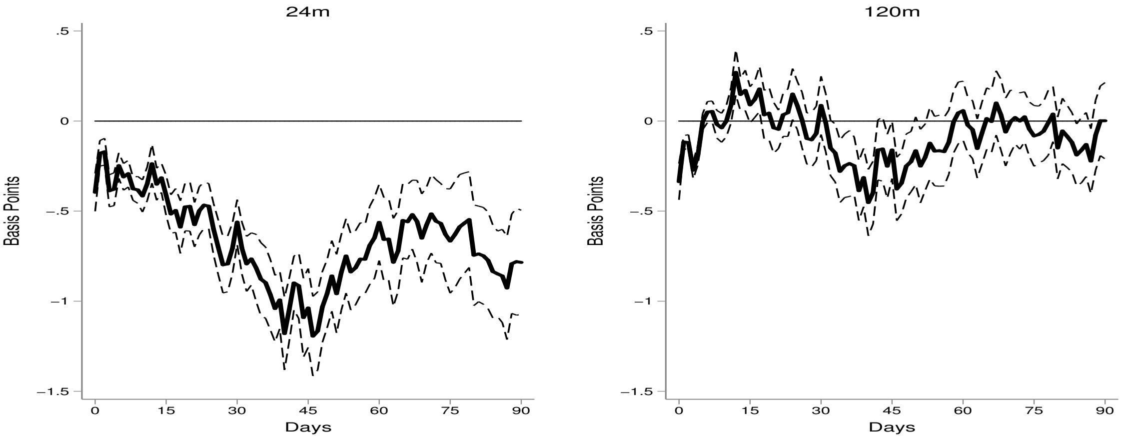


(b) Path Shock: 2000-2019

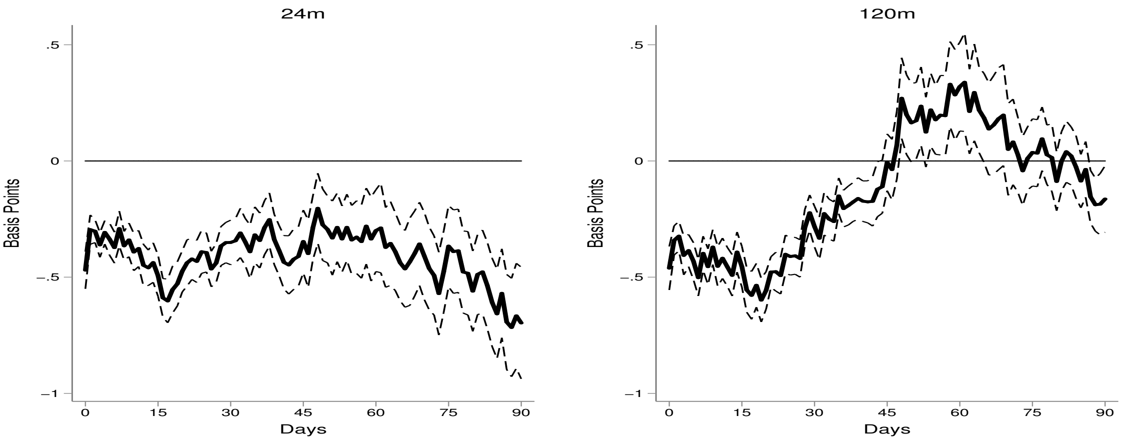


(c) LSAP Shock: 2009-2019

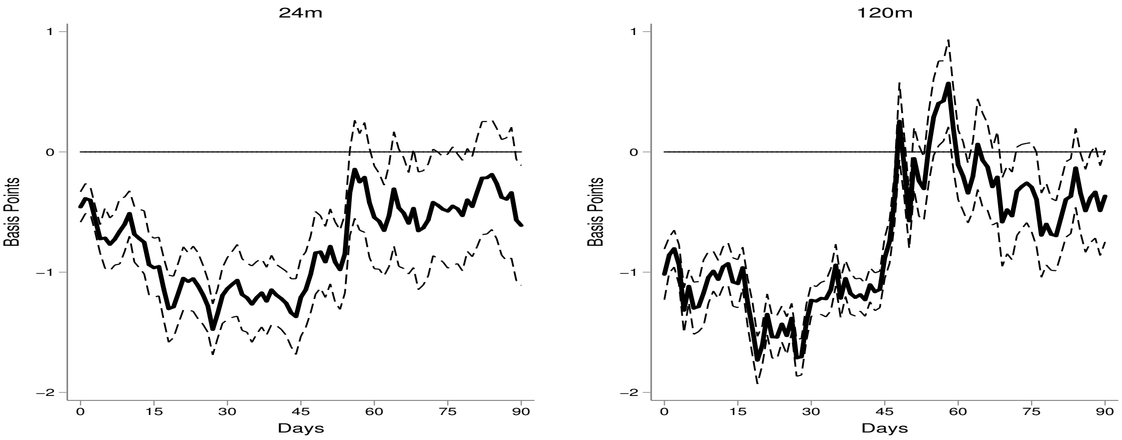
Figure 18. Response of the Forward Premium to U.S. Monetary Policy Shocks: AE



(a) Target Shock: 2000-2008



(b) Path Shock: 2000-2019



(c) LSAP Shock: 2009-2019

References

T. Adrian, R. K. Crump, and E. Moench. Pricing the Term Structure with Linear Regressions. *Journal of Financial Economics*, 110(1):110–138, 2013.

T. Adrian, R. K. Crump, J. B. Durham, and E. Moench. Sovereign Yield Comovement. *Working Paper*, 2019.

S. R. Baker, N. Bloom, and S. J. Davis. Measuring Economic Policy Uncertainty. *The Quarterly Journal of Economics*, 131(4):1593–1636, 2016.

G. Bostanci and K. Yilmaz. How Connected is the Global Sovereign Credit Risk Network? *Journal of Banking & Finance*, 113:105761, 2020.

J. Brooks, M. Katz, and H. N. Lustig. Post-FOMC Announcement Drift in U.S. Bond Markets. *NBER Working Paper*, (25127), 2019.

J. H. Cochrane. Commentary on "Macroeconomic Implications of Changes in the Term Premium". *FRB St. Louis Review*, 89(4):271–282, 2007.

B. Craig and G. von Peter. Interbank Tiering and Money Center Banks. *Journal of Financial Intermediation*, 23(3):322–347, 2014.

S. E. Curcuru, S. B. Kamin, C. Li, and M. Rodriguez. International Spillovers of Monetary Policy: Conventional Policy vs. Quantitative Easing. *International Finance Discussion Paper*, 2018(1234), 2018.

M. Dahlquist and H. Hasseltoft. International Bond Risk Premia. In *Handbook of Fixed-Income Securities*, pages 169–190. 2016.

F. X. Diebold and K. Yilmaz. On the Network Topology of Variance Decompositions: Measuring the Connectedness of Financial Firms. *Journal of Econometrics*, 182(1): 119–134, 2014.

W. Du and J. Schreger. Local Currency Sovereign Risk. *Journal of Finance*, 71(3): 1027–1070, 2016a.

W. Du and J. Schreger. Sovereign Risk, Currency Risk, and Corporate Balance Sheets. *HBS Working Paper*, No. 17-024, 2016b.

W. Du, J. Im, and J. Schreger. A Dataset for Covered Interest Rate Parity Deviations Between Government Bond Yields. In *NBER IFM Data Sources Project*, 2018a.

W. Du, J. Im, and J. Schreger. The U.S. Treasury Premium. *Journal of International Economics*, 112:167–181, 2018b.

W. Du, A. Tepper, and A. Verdelhan. Deviations from Covered Interest Rate Parity. *Journal of Finance*, 73(3):915–957, 2018c.

G. R. Duffee. Term Premia and Interest Rate Forecasts in Affine Models. *Journal of Finance*, 57(1):405–443, 2002.

G. R. Duffee. Sharpe Ratios in Term Structure Models. *Working Paper*, 2010.

A. Erce and E. Mallucci. Selective Sovereign Defaults. *Board of Governors of the Federal Reserve System Discussion Paper*, 1239, 2018.

M. Ferrari, J. Kearns, and A. Schrimpf. Monetary Policy's Rising FX Impact in the Era of Ultra-Low Rates. *BIS Working Paper*, 2017.

C. Galli. Inflation, Default Risk and Nominal Debt. *Working Paper*, 2020.

S. Gilchrist, V. Yue, and E. Zakrajšek. U.S. Monetary Policy and International Bond Markets. *Journal of Money, Credit and Banking*, 51(S1):127–161, 2019.

R. Guimarães. Expectations, Risk Premia and Information Spanning in Dynamic Term Structure Model Estimation. *Bank of England Working Paper*, 489, 2014.

R. S. Gürkaynak and J. H. Wright. Macroeconomics and the Term Structure. *Journal of Economic Literature*, 50(2):331–367, 2012.

R. S. Gürkaynak and J. H. Wright. Identification and Inference Using Event Studies. *The Manchester School*, 81(S1):48–65, 2013.

R. S. Gürkaynak, B. P. Sack, and E. T. Swanson. Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. *International Journal of Central Banking*, 1(1):55–93, 2005.

R. S. Gürkaynak, B. P. Sack, and J. H. Wright. The U.S. Treasury Yield Curve: 1961 to the Present. *Journal of Monetary Economics*, 54(8):2291–2304, 2007.

J. Ha, M. A. Kose, and F. Ohnsorge. *Inflation in Emerging and Developing Economies: Evolution, Drivers, and Policies*. The World Bank, 2019.

J. D. Hamilton. Measuring Global Economic Activity. *Journal of Applied Econometrics*, 2019.

B. Hofmann, S. Ilhyock, and H. S. Shin. Bond Risk Premia and the Exchange Rate. *BIS Working Paper*, 775, 2019.

K. Holston, T. Laubach, and J. C. Williams. Measuring the Natural Rate of Interest: International Trends and Determinants. *Journal of International Economics*, 108:S59–S75, may 2017.

Ò. Jordà. Estimation and Inference of Impulse Responses by Local Projections. *American Economic Review*, 95(1):161–182, mar 2005.

S. Joslin, K. J. Singleton, and H. Zhu. A New Perspective on Gaussian Dynamic Term Structure Models. *Review of Financial Studies*, 24(3):926–970, 2011.

S. Kalemli-Özcan. U.S. Monetary Policy and International Risk Spillovers. *Working Paper*, 2019.

D. H. Kim and A. Orphanides. Term Structure Estimation with Survey Data on Interest Rate Forecasts. *Journal of Financial and Quantitative Analysis*, 47(1):241–272, 2012.

D. H. Kim and J. H. Wright. An Arbitrage-Free Three-Factor Term Structure Model and the Recent Behavior of Long-Term Yields and Distant-Horizon Forward Rates. *Board of Governors of the Federal Reserve System Discussion Paper*, 33, 2005.

K. N. Kuttner. Monetary Policy Surprises and Interest Rates: Evidence from the Fed Funds Futures Market. *Journal of Monetary Economics*, 47(3):523–544, 2001.

K. N. Kuttner. Outside the Box: Unconventional Monetary Policy in the Great Recession and Beyond. *Journal of Economic Perspectives*, 32(4):121–146, 2018.

R. Litterman and J. Scheinkman. Common Factors Affecting Bond Returns. *Journal of Fixed Income*, 1(1):54–61, 1991.

S. P. Lloyd. Estimating Nominal Interest Rate Expectations: Overnight Indexed Swaps and the Term Structure. *Bank of England Working Paper*, 763, 2018.

E. Nakamura and J. Steinsson. Identification in Macroeconomics. *Journal of Economic Perspectives*, 32(3):59–86, 2018.

C. R. Nelson and A. F. Siegel. Parsimonious Modeling of Yield Curves. *Journal of Business*, 60(4):473–489, 1987.

M. Obstfeld. Trilemmas and Trade-Offs: Living with Financial Globalisation. *BIS Working Paper*, 2015.

M. Obstfeld. Global Dimensions of U.S. Monetary Policy. *International Journal of Central Banking*, 16(1):73–132, 2020.

P. Ottonello and D. J. Perez. The Currency Composition of Sovereign Debt. *American Economic Journal: Macroeconomics*, 11(3):174–208, 2019.

G. Palladini and R. Portes. Sovereign CDS and Bond Pricing Dynamics in the Euro-Area. *NBER Working Paper*, 17586, 2011.

S. Pennings, A. Ramayandi, and H. C. Tang. The Impact of Monetary Policy on Financial Markets in Small Open Economies: More or Less Effective During the Global Financial Crisis? *Journal of Macroeconomics*, 44:60–70, 2015.

C. M. Reinhart and K. S. Rogoff. The Forgotten History of Domestic Debt. *Economic Journal*, 121(552):319–350, 2011.

H. Rey. Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence. *Proceedings of the 2013 Federal Reserve Bank of Kansas City Economic Symposium at Jackson Hole*, pages 285–333, 2013.

J. H. Stock and M. W. Watson. Why Has U.S. Inflation Become Harder to Forecast? *Journal of Money, Credit and Banking*, 39(S1):3–33, 2007.

E. T. Swanson. Measuring the Effects of Federal Reserve Forward Guidance and Asset Purchases on Financial Markets. *Working Paper*, 2018.

J. H. Wright. Term Premia and Inflation Uncertainty: Empirical Evidence from an International Panel Dataset. *American Economic Review*, 101(4):1514–1534, 2011.

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