Term Premia and Credit Risk in Emerging Markets: The Role of U.S. Monetary Policy *

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October 2020

Abstract

This paper documents the channels through which U.S. monetary policy impacts the sovereign bond yields of emerging markets. Traditional decompositions of sovereign yields are not suitable for emerging markets because they rely on a default-free assumption. Instead, I decompose the yields of 15 emerging markets into average expected future short-term interest rates, a term premium and compensation for credit risk. I use this decomposition to analyze the transmission channels of U.S. monetary policy surprises identified with intraday data. I find that the response of emerging market yields to target, forward guidance and asset purchase surprises is economically significant, yet delayed over days. In addition, unanticipated U.S. monetary policy decisions lead to a reassessment of policy rate expectations and a repricing of interest and credit risks in emerging markets. Finally, U.S. unconventional monetary policies limit the monetary autonomy of emerging markets along the yield curve.

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

JEL Classification: E43, F34, G12, G15, H63.

*I am deeply grateful to Jonathan Wright for his invaluable advice and guidance, and to Greg Duffee and Olivier Jeanne for insightful discussions and suggestions. I also thank Derin Aksit, Laurence Ball, Bob Barbera, Christopher Carroll, Lalit Contractor, Jon Faust, Daniel Millimet, Alessandro Rebucci, Tatjana Schulze, Fabian Valencia and seminar participants at Johns Hopkins University for their helpful comments and suggestions. All remaining errors are mine. This paper's appendix is available in the following website `https://pavelsolis.github.io/research`.

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1 Introduction

U.S. monetary policy has worldwide consequences, yet the channels through which it affects the sovereign bond yields of emerging markets are not well understood. The ability of emerging markets to effectively mitigate any undesired domestic impact relies on understanding those transmission channels. Decomposing the yields and analyzing the effects of U.S. monetary policy on the components is a sensible approach. However, traditional decompositions of sovereign yields are not suitable for emerging markets because they assume that the yields are free of credit risk.

The main contribution of this paper is to empirically quantify the transmission channels of U.S. monetary policy to the sovereign yields of emerging markets. To achieve this, the paper first proposes to decompose the yields into an average expected future short-term interest rates, a term premium and compensation for credit risk, and then asks how U.S. monetary policy transmits to these components. Notwithstanding, the value of the decomposition goes beyond this particular application, others include the transmission of monetary policy domestically.

Investors holding local currency bonds of emerging markets bear two major risks. First, they bear the risk of not receiving the promised payments. Credit risk of sovereign debt differs across emerging and advanced economies. Over the last decades, the role of emerging markets in the global economy has increased as well as their reliance on local currency bonds as a stable source of funding (IMF-WB, 2020).[1] But, even though they have the ability to print their own currency to avoid defaulting on their debt, emerging markets are prone to default (Reinhart and Rogoff, 2011).[2] Second, investors also bear the risk that they may receive the promised payments but find that inflation has eroded their real value. The compensation for this risk is the standard term premium. Therefore, the credit risk compensation addresses the risk of not receiving the promised payments, whereas the term premium compensates investors for bearing interest rate risk.

[1]Before 2000, several emerging markets issued bonds at short maturities and in foreign currency. Now, it is more common for them to issue bonds with longer maturities and in local currency.

[2]Examples of overt defaults in local currency debt include Barbados (2018), Jamaica (2013, 2010), Nicaragua (2008, 2003), Argentina (2001), Turkey (1999), Russia (1998).

To account for credit risk, I use synthetic local currency yield curves. They essentially swap the U.S. yield curve into a local currency one, something akin to the U.S. issuing bonds in that currency. Synthetic yields can be seen as free of credit risk,[3] and so traditional decompositions can be applied to them. I use a standard affine term structure model augmented with survey data because it provides robust decompositions of (default-free) yields (Guimarães, 2014). Synthetic yields have been widely used recently to study deviations from covered interest parity (CIP) but, instead of concentrating on the CIP deviations, I focus on the synthetic yields themselves.[4] To the best of my knowledge, this is the first application of affine terms structure models to synthetic yields.

This paper decomposes the nominal (or actual) yields of 15 emerging markets from 2000 to 2019 into three parts. The first two components, average expected future short rates and the term premium, come from the decomposition of synthetic yields. The third component is the spread between the nominal and the synthetic yields, which captures the compensation for credit risk in the local currency debt of emerging markets (Du and Schreger, 2016).[5] Although credit risk is an important component of debt issued by those countries, the literature on term structures of emerging market yields does not examine it systematically.[6] By explicitly accounting for credit risk, the second component is a genuine term premium. In fact, I show that this term premium aligns with the view that it compensates investors for bearing inflation uncertainty (Wright, 2011), which is worth highlighting since inflation in emerging markets is more volatile than in advanced economies (Ha et al., 2019).

The three-part decomposition gives reasonable estimates for the components. The

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

[4]Du et al. (2018b) show that persistent and systematic deviations from CIP reflect a higher regulatory burden for financial intermediaries. Du et al. (2018a) argue that CIP deviations reflect a convenience yield in advanced economies, whereas Du and Schreger (2016) show that they capture a local currency credit spread for emerging markets, which is used by Hofmann et al. (2019) to explain the link between currency appreciations and the compression of the sovereign yield spreads of emerging markets.

[5]Credit risk here is broadly defined including, for example, (selective) default risk, currency convertibility risk, regulation risk, capital controls, and jurisdiction risk, so compensation for any of these risks is considered as compensation for credit risk even if the country does not default per se.

[6]The analysis of sovereign credit risk traditionally focuses on bonds denominated in foreign currency. For instance, Hilscher and Nosbusch (2010) report the relevance of domestic factors to explain sovereign credit risk, while Longstaff et al. (2011) document the importance of global factors. Bostanci and Yilmaz (2020) study the connectedness of the network of sovereign credit default swaps.

average expected short rates, the term premium and the credit risk compensation of the 10-year nominal yield average 4.30%, 2% and 0.8%, respectively. Further, each component reflects particular circumstances of the countries in the sample. For instance, the decline in the term premium of Eastern European countries shadows that of Eurozone countries.

The characterization of the transmission channels of U.S. monetary policy relies on the three-part decomposition. Nevertheless, understanding the impact of unanticipated Fed's policy decisions not only requires decomposing the yields but distinguishing among the different types of monetary policy surprises. Following the literature (Gürkaynak et al., 2005; Swanson, 2018), I consider three types, namely target, forward guidance and asset purchase surprises. They are identified using intraday data around 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.

Three main findings summarize the transmission channels of U.S. monetary policy surprises to emerging market yields. First, the responses to target, forward guidance and asset purchase surprises are economically significant but sluggish, and amplify over the month following the surprise. In particular, the effects of forward guidance and asset purchase surprises last longer in emerging markets relative to the U.S. This delayed response is consistent with the evidence for advanced economies, which Brooks et al. (2019) attribute to a portfolio rebalancing channel that translates into slow-moving capital.

Second, the surprises spill over to all yield components, so that unanticipated Fed policy decisions give rise to a reassessment of policy rate expectations and a repricing of risks in emerging markets. Target easing surprises eventually reduce the average expected future short rates but increase long-term credit risk compensation. Forward guidance easing surprises led to a parallel decline in the term premium before the global financial crisis; since then, they eventually reduce average expected short rates and the term premium but also increase long-term credit risk compensation. Asset purchase easing surprises eventually decrease all three components of the yields. Interpreting the transmission of these surprises to emerging markets requires one to understand their effects not only on the nominal yield curve (like in advanced economies) but also on the synthetic one. The surprises trigger (slow-moving) capital flows in or out of emerging markets. The relative effect they have on each curve in turn determines the effects on the yield components. In particular, the surprises alter the opportunity cost of lending to emerging markets in local currency, so investors adjust the compensation they require for credit risk. The potential fiscal implications for emerging markets of the Fed's monetary policies have thus far not been discussed in the literature.

Third, since the global financial crisis, U.S. monetary policy has spilled over to emerging markets through a yield curve channel. I show that the monetary autonomy of emerging markets is stronger at the front end of their yield curves and that long-term yields are more interconnected than short term ones, so that the global financial cycle is more relevant at the long end of the curve. U.S. unconventional monetary policies thus limit the monetary autonomy of emerging markets along the yield curve. These results are consistent with the mechanisms discussed by Obstfeld (2015), Kalemli-Özcan (2019) and Kolasa and Wesołowski (2020).

A growing literature analyzes the spillover effects of U.S. monetary policy on the local currency yields of emerging markets. For instance, Hausman and Wongswan (2011) find significant spillovers to local currency bond yields, while Bowman et al. (2015) compare the spillovers of conventional and unconventional monetary policies. The present paper is nonetheless more closely related to the work in Curcuru et al. (2018), Adrian et al. (2019) and Albagli et al. (2019), who decompose the yields to analyze the transmission channels of such spillovers, but it differs in a number of dimensions. Most importantly, this paper accounts for the credit risk embedded in the yields of emerging markets, and considers different types of monetary policy surprises identified with intraday data.[7]

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

[7] Rogers et al. (2014) and Rogers et al. (2018) analyze the spillovers on bond yields using surprises identified with intraday data but they focus on advanced economies. Gilchrist et al. (2019) study the effects for advanced and emerging countries but for debt denominated in foreign currency.

2 Local Currency Yield Curves

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

2.1 Construction of Synthetic Yield Curves

The main idea to construct the synthetic LC yield curves is to use the U.S. yield curve as the benchmark for all other countries and to swap it into LC by adding a foreign exchange forward premium at each maturity. The forward premium compensates investors for the expected depreciation of the currency; since in this paper the exchange rate is expressed in LC per U.S. dollar (USD), a currency depreciates when the exchange rate increases. This approach assumes frictionless financial markets; in particular, it assumes that (i) unconstrained arbitrageurs have access to U.S. and LC bonds, (ii) the derivatives contracts used to construct the forward premium have no counterparty risk, and (iii) U.S. yields are free of default risk. Du and Schreger (2016) show that this is a useful benchmark to quantify the credit risk in the LC debt of emerging markets.

The zero-coupon synthetic LC yield for an n-period bond at time t, $\widetilde{y}_{t,n}^{LC}$, is defined as

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

in which $y_{t,n}^{US}$ denotes the zero-coupon yield for an n-period U.S. Treasury security at time t, and $\rho_{t,n}$ is the n-period forward premium from USD to LC at time t. 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 because outright forwards are less liquid. Since fixed-for-fixed cross-currency swap rates are rarely observed in the market directly, they are 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), which are then swap into fixed-rate cash flows also in USD using interest rate swaps. Both types of swaps are liquid, marked to market and collateralized instruments, so the bilateral counterparty risk in cross-currency swaps is small.

By contrast, the nominal zero-coupon yield, $y_{t,n}^{LC}$, is constructed directly from quotes of LC bonds actually traded in the market. Notice that since the construction of the synthetic yields relies on the U.S. yield curve and cross-currency swap rates, it does not require information about the nominal yields.[8]

According to the CIP condition, the nominal (direct) and the synthetic (indirect) LC interest rates should be equal. CIP thus implies that an issuer should be able to borrow directly or indirectly (synthetically) in LC at the same yield. Du et al. (2018b) show, however, that there are persistent and systematic deviations from CIP. Indeed, the spread between the nominal and synthetic yields ($y_{t,n}^{LC} - \widetilde{y}_{t,n}^{LC}$) measures CIP deviations in sovereign yields. In the case of advanced economies, Du et al. (2018a) argue that CIP deviations reflect differences in convenience yields relative to the U.S. By contrast, Du and Schreger (2016) point out that CIP deviations have a different interpretation for emerging markets.

The nominal-synthetic spread captures a credit risk compensation in the LC yields of emerging markets. Whereas the nominal yields of advanced economies are usually considered free of credit risk, the nominal yields of emerging markets include a credit risk compensation given the potential for default (Reinhart and Rogoff, 2011). Since the credit risk in the components of the synthetic yields in equation (1) is small, a synthetic yield can be seen as the borrowing rate paid by a hypothetical issuer in LC with no credit risk. Du and Schreger (2016) show that the nominal-synthetic spread is highly correlated with the rates of credit default swaps (CDS)—financial derivatives aimed to

[8] Since there is no forward premium for the USD relative to the USD, $\widetilde{y}_{t,n}^{US} = y_{t,n}^{US}$.

protect investors against default by a bond issuer.

CDS spreads are not used in this paper to account for LC credit risk because they do not adequately characterize it since defaults on LC bonds governed under domestic law do not trigger CDS payouts.[9] Nonetheless, CDS are suitable for studying the sovereign risk in bonds denominated in foreign currency (Longstaff et al., 2011).

2.2 Construction of Nominal Yield Curves

The construction of the nominal yield curve $y_{t,n}^{LC}$ uses the Bloomberg Fair Value (BFV) curves. Since these curves report coupon-equivalent par yields, I convert them into continuously-compounded yields (see Gürkaynak et al., 2007) to obtain the implied zero-coupon curves.[10] This approach applies to all but two countries for which no BFV curves exist. For Brazil and Israel, Bloomberg provides zero-coupon yields with coupon-equivalent compounding, known as IYC curves, which I also convert into continuously-compounded yields.[11]

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

Nominal and synthetic yield curves are constructed for 15 emerging markets and, to compare the results, 10 advanced economies selected based on data availability.[12] All of the emerging markets in the sample, with the exception of Malaysia, have adopted

[9] See the Credit Derivatives Physical Settlement Matrix of the International Swaps and Derivatives Association.

[10] As a robustness check, I estimate the nominal yield curves from actual prices for some of the countries in the sample with the Nelson–Siegel model, these curves follow those reported by Bloomberg closely.

[11] 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 economies—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.

[12] The 15 emerging markets are: Brazil, Colombia, Hungary, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, South Africa, Thailand and Turkey. The 10 advanced economies are: Australia, Canada, Denmark, Germany (based on the euro), Japan, Norway, New Zealand, Sweden, Switzerland and the U.K.

an inflation targeting regime.[13] In fact, the central banks in Hungary, the Philippines, Indonesia, Russia and Turkey adopted inflation targeting during the sample period.[14]

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 economies start no later than September 2001. The sample 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. There are thus at least 10 years of data for most of the emerging markets in the sample.[15] 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. Surveys of professional forecasters help to address this small sample problem, as discussed in section 3.3.

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.[16] 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 economies.

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 comes from two sources. For maturities of 1 through 10 years, the yields come from the dataset constructed by Gürkaynak et al. (2007).[17] Their estimation only considers Treasury securities with coupons. In general, Treasury securities with less than one year to maturity behave differently, partly because they are less actively traded than longer-maturity ones. Thus, I follow Duffee (2010) and use the

[13]Malaysia does not explicitly follows an inflation targeting regime, although it has several characteristics that are aligned with it.

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

[15]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, here it starts in July 2009.

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

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

estimates from the Center for Research in Security Prices (CRSP), which are robust at the short end of the curve. 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.[18]

The data to compute the forward premium also comes from two sources. 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, the Philippines and Thailand the data comes from Datastream. To construct the cross-currency swap rates, I use data on cross-currency basis swaps and interest rate swaps for each available maturity from 1 through 10 years. The data for the swap curves comes from Bloomberg.[19]

Table 1 reports descriptive statistics for different tenors of the nominal and synthetic yield curves for the emerging and advanced economies in the sample. The yield curves exhibit standard properties such as an upward slope. At the same time, the table provides information on how the curves of emerging markets differ from those of advanced economies. For instance, the level and the volatility (measured by the standard deviation) of their curves are larger than those of advanced economies. Also, the short end of their curves is more volatile than the long end, particularly so for the synthetic curve. Lastly, the spread between the nominal and the synthetic yields suggests that the credit risk compensation is on average positive and that it increases with maturity.

2.3.1 Timing

The parameters of the affine term structure models are estimated using end-of-month data, as explained in section 3.3. Since the U.S. yield curve is the benchmark to construct 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 surprises. The analysis of monetary policy spillovers in

[18]The 3- and 6-month yields implied by the fitted model of Gürkaynak et al. (2007) 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.

[19]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.

section 5.3 uses daily changes in nominal and synthetic yields. Since the closing prices in non-Western Hemisphere countries happen before the Fed's monetary policy announcements, their nominal yields are shifted one day back so that their daily changes adequately capture surprises in the announcements. The credit risk compensation for those countries is calculated using the shifted nominal yields.

3 Methodology

This section describes the affine term structure model used to decompose the yield curve of each country in the sample, and discusses the difficulties in estimating the parameters of the model. It then explains how survey data helps in the estimation. The decomposition has many different applications. This paper exploits it to analyze the transmission channels of U.S. monetary policy to the yields of emerging markets.

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 that prices all nominal bonds. Let M_{t+1} be the nominal stochastic discount factor. Accordingly, the bond price today is recursively defined as follows

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

in which $\mathrm{E}_t^{\mathbb{P}}[\cdot]$ denotes the conditional expectation at time t taken using the actual or physical probability measure, $\mathbb{P}$, that generates the data. The existence of the stochastic discount factor 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

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

in which $\mathrm{E}_t^{\mathbb{Q}}[\cdot]$ also denotes conditional expectation but taken under 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 $\mathbb{Q}$

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

in which $\mu^{\mathbb{Q}}$ is a $\mathrm{K} \times 1$ vector and $\Phi^{\mathbb{Q}}$ is a $\mathrm{K} \times \mathrm{K}$ transition matrix, 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, that is $\nu_{t+1}^{\mathbb{Q}} | X_t \sim \mathcal{N}_{\mathrm{K}}(0, I)$.

The pricing factors drive the dynamics of the one-period interest rate as follows

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

in which δ_0 is a scalar and δ_1 is a $\mathrm{K} \times 1$ 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

$$y_{t,n}^{\mathbb{Q}} = A_n^{\mathbb{Q}} + B_n^{\mathbb{Q}} X_t, \tag{6}$$

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

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

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

The yields $y_{t,n}^{\mathbb{Q}}$ 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 average expected future short-term interest rates and a term premium, the model needs to specify the dynamics for the market prices of risk, which control the transformation between the $\mathbb{Q}$ and $\mathbb{P}$ measures. In this sense, the stochastic discount factor is assumed to be conditionally lognormal

$$M_{t+1} = \exp\left(-i_t - \frac{1}{2}\lambda_t'\lambda_t - \lambda_t'\nu_{t+1}^{\mathbb{P}}\right), \tag{9}$$

in which λ_t is a $\mathrm{K} \times 1$ vector of market prices of risk. And, following Duffee (2002), it is also assumed to be an affine function of the pricing factors

$$\lambda_t = \lambda_0 + \lambda_1 X_t, \tag{10}$$

in which λ_0 is a $\mathrm{K} \times 1$ vector and λ_1 is a $\mathrm{K} \times \mathrm{K}$ matrix of parameters.

A well-known implication of this structure for the market prices of risk is that the dynamics of the pricing factors under the physical measure $\mathbb{P}$ can also be described by a VAR(1) as follows[20]

$$X_{t+1} = \mu^{\mathbb{P}} + \Phi^{\mathbb{P}} X_t + \Sigma\nu_{t+1}^{\mathbb{P}}. \tag{11}$$

in which $\mu^{\mathbb{Q}} = \mu^{\mathbb{P}} - \Sigma\lambda_0$, $\Phi^{\mathbb{Q}} = \Phi^{\mathbb{P}} - \Sigma\lambda_1$, $\nu_{t+1}^{\mathbb{P}}|X_t \sim \mathcal{N}_{\mathrm{K}}(0, I)$. Note that the covariance matrix of the shocks is the same under both measures; that is, it is measure independent.

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

$$y_{t,n}^{\mathbb{P}} = A_n^{\mathbb{P}} + B_n^{\mathbb{P}} X_t,$$

in which $A_n^{\mathbb{P}} = -\frac{1}{n}A_n$, $B_n^{\mathbb{P}} = -\frac{1}{n}B_n$, 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.[21]

The term premium for maturity n at time t, $\tau_{t,n}$, is then estimated as the difference

[20]The stochastic discount factor in equation (9) and the law of motion of the vector of pricing factors in equation (11) can be formalized separately or jointly. For instance, in a utility maximization framework, the stochastic discount factor is usually interpreted as the intertemporal marginal rate of substitution.

[21]See the appendices in Lloyd (2020) for a derivation of the loadings under both measures. Essentially, the price coefficients are obtained recursively after combining the no-arbitrage condition and the functional form for bond prices.

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 compensation to hold their bonds (Du and Schreger, 2016). This implies that while the nominal yield curve $y^{LC}_{t,n}$ is the relevant one for advanced economies, 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 in the affine model.

Finally, to ensure that the decomposition adds up, the credit risk compensation is computed as

$$\phi_{t,n} = y^{LC}_{t,n} - y^{\mathbb{Q}}_{t,n}. \tag{13}$$

Notice that the credit risk compensation equals the spread between the nominal and the fitted, rather than the synthetic ($\widetilde{y}^{LC}_{t,n}$) yields.

3.1.1 Weak Identification

The estimation of the parameters in the affine term structure model only requires zero-coupon yields as an input. While this data provides sufficient information to identify the pricing coefficients under the $\mathbb{Q}$ measure, $\{\mu^{\mathbb{Q}}, \Phi^{\mathbb{Q}}\}$, it is not enough to accurately identify the parameters under the $\mathbb{P}$ measure, $\{\mu^{\mathbb{P}}, \Phi^{\mathbb{P}}\}$. This information imbalance is relevant for the estimation of the term premium (see equation (12)). More generally, poorly identified parameters under the $\mathbb{P}$ measure result in unstable yield decompositions. Different solutions have been proposed in the literature to address this instability.[23]

Survey data provides additional information on the $\mathbb{P}$ dynamics. Guimarães (2014) argues that surveys anchor the long run mean of interest rates and shows that incorporating survey data on interest rate forecasts in the estimation provides robust decompositions of

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

[23] The solutions include restrictions on parameters (Duffee, 2010), bias-corrected estimators (Bauer et al., 2012) and complementing bond yield data with survey forecasts of future interest rates (Kim and Wright, 2005; Kim and Orphanides, 2012).

the U.S. and U.K. yield curves.[24] Since bond yields are highly persistent, the additional information from surveys is particularly relevant when sample sizes are small, in which case there might be too few interest rate cycles in the data. This is precisely the case with emerging markets, so including survey data in the estimation of the term structure model is especially important to obtain robust decompositions of their yields. On top of that, surveys allow for model-free estimates of the term premium, which serve as a robustness check for the model-implied term premium.

3.2 Survey Data

Long-term forecasts are particularly helpful to pin down the parameters of the model under the $\mathbb{P}$ measure, $\{\mu^{\mathbb{P}}, \Phi^{\mathbb{P}}\}$. 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; the data is available from March 2001 to October 2017.[25] Figure 1 plots the inflation forecasts. 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 their inflation target.

Although there is no source for long-term forecasts for the short rate of emerging markets, they can be inferred from existing data using the Fisher equation. For this purpose, I treat emerging markets as small open economies. Specifically, the implied forecast for the short rate ($i_{t,n}^{survey}$) equals the expected average inflation as reported by Consensus Economics ($\pi_{t,n}^{CEsurvey}$), plus the expected global real rate over the same horizon ($r_{t,n}^{*}$), inferred by a combination of survey forecasts of future short-term U.S. Treasury bill yields ($i_{t,n}^{SPFsurvey}$) and of future U.S. inflation ($\pi_{t,n}^{SPFsurvey}$) as follows

$$i_{t,n}^{survey} = \pi_{t,n}^{CEsurvey} + r_{t,n}^{*} = \pi_{t,n}^{CEsurvey} + \left(i_{t,n}^{SPFsurvey} - \pi_{t,n}^{SPFsurvey} \right).$$

[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. Although there is no survey data on long-term inflation forecasts for Israel and South Africa, appendix A shows that trend inflation is a good proxy.

The required data for the U.S. is available quarterly from the Survey of Professional Forecasters. 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.[26] The 5- and 10-year zero-coupon real yields of Gürkaynak et al. (2010) constructed with data from the U.S. TIPS market serve as a reference for the respective implied forecasts for the U.S. real rate obtained from surveys. The levels of the two series are comparable. TIPS yields are not the benchmark, however, because they are more volatile (their term premium is time varying) and suffer from liquidity problems.

Figure 2 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.[27] The two approaches yield similar values for the implied forecasts for the domestic short-term rates, the correlation between the two is 0.75 and 0.83 for the 5- and 10-year tenors, respectively.

I assume that the 5-year ahead (implied) forecast for the short rate of emerging markets equals the expected average short rate under $\mathbb{P}$ given by

$$y^e_{t,n} = \frac{1}{n}\mathrm{E}^{\mathbb{P}}_t\left[\sum_{j=0}^{n-1} i_{t+j}\right] = A^e_n + B^e_n X_t,$$

in which $A^e_n = -\frac{1}{n}A_n$, $B^e_n = -\frac{1}{n}B_n$, 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)).[28]

[26]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.

[27]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 one 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 for the dependent variable comes from the policy rate statistics of the Bank for International Settlements.

[28]The difference between $y^{\mathbb{P}}_{t,n}$ and $y^e_{t,n}$ is a convexity term due to Jensen's inequality, which increases

Long-term (implied) forecasts are in turn matched to the 5-year forward rate starting 5 years hence. In the model, the forward rate from n to m periods hence given by $f_{t,n|m} = (my_{t,m} - ny_{t,n}) / (m-n)$ becomes

$$f^{e}_{t,n|m} = \frac{1}{m-n} \mathrm{E}^{\mathbb{P}}_{t} \left[\sum_{j=n}^{m-1} i_{t+j} \right] = A^{e}_{n|m} + B^{e}_{n|m} X_t.$$

in which $A^{e}_{n|m} = (mA^{e}_{m} - nA^{e}_{n}) / (m-n)$ and $A^{e}_{n|m} = (mB^{e}_{m} - nB^{e}_{n}) / (m-n)$.

3.3 Estimation

The convergence to the global optimum in affine term structure models estimated by maximum likelihood has been traditionally subject to computational challenges and multiple local optima. Joslin et al. (2011) propose a normalization of the affine model that improves the convergence to the global optimum of the likelihood function.

The Joslin et al. (2011) 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 $\mathrm{K} \times 1$ vector of ordered eigenvalues of $\Phi^{\mathbb{Q}}$. It is common to assume that K linear combinations of the N observed bond yields are measured without error, $\mathrm{K} < \mathrm{N}$, whereas $\mathrm{N} - \mathrm{K}$ linear combinations of yields are measured with error. Following Joslin et al. (2011), I consider that the first three principal components of the yield curve in each country are the linear combinations of yields measured without error. Those principal components are usually referred to as the level, slope and curvature of the yield curve.[29]

The estimation of the affine model uses the Joslin et al. (2011) normalization and follows a two-step procedure. First, the $\mathbb{P}$ parameters are estimated by OLS of the VAR in equation (11) using the K principal components as pricing factors. This step provides initial values for the maximum likelihood estimation of the matrix Σ. Then, taking $\widehat{\mu}^{\mathbb{P}}$

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.

[29] On average, they explain more than 99.5% of the variation in the synthetic yields of emerging markets and 99.9% in the nominal yields of advanced economies.

and $\widehat{\Phi}^{\mathbb{P}}$ as given, the $\mathbb{Q}$ parameters are estimated by maximum likelihood.

The estimation uses end-of-month data on synthetic yields ($\widetilde{y}_{t,n}^{LC}$) for emerging markets and on nominal yields ($y_{t,n}^{LC}$) for advanced economies, according to their relevant *risk-free* yield curves. Only yield data is available for advanced economies, whereas for emerging markets the model is augmented with survey data on the last day of the month for which the data was published.[30] Since survey data is available twice a year (and yield data for the estimation is monthly), it is regarded as missing in non-release dates.

3.3.1 Survey-Augmented Model

The Kalman filter 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 (11). 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

$$\mathbf{y}_t = \mathbf{A} + \mathbf{B}X_t + \mathbf{\Sigma}_Y \mathbf{u}_t, \tag{14}$$

in which $\mathbf{y}_t$ 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 number of survey forecasts S as follows

$$\begin{bmatrix} \mathbf{y}_t \\ \mathbf{y}_t^S \end{bmatrix} = \begin{bmatrix} \mathbf{A} \\ \mathbf{A}^S \end{bmatrix} + \begin{bmatrix} \mathbf{B} \\ \mathbf{B}^S \end{bmatrix} X_t + \begin{bmatrix} \mathbf{\Sigma}_Y \mathbf{u}_t & \mathbf{0} \\ \mathbf{0} & \mathbf{\Sigma}_S \mathbf{u}_t^S \end{bmatrix} \tag{15}$$

in which $\mathbf{y}_t^S$ is a $\mathrm{S} \times 1$ vector of survey forecasts with elements $i_{t,n}^{survey}$, $\mathbf{A}^S$ is a $\mathrm{S} \times 1$ vector with elements A_n^e or $A_{n|m}^e$, $\mathbf{B}^S$ is a $\mathrm{S} \times \mathrm{K}$ matrix with rows equal to B_n^e or $B_{n|m}^e$

[30]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 economies 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 economies.

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 $\mathrm{S} \times \mathrm{S}$ matrix with positive elements on the diagonal.

To estimate the survey-augmented model, I follow Guimarães (2014) and Lloyd (2020) in two aspects. First, I use the estimated parameters from the Joslin et al. (2011) 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 $\mathrm{N} \times \mathrm{N}$ and $\mathrm{S} \times \mathrm{S}$ identity matrices, respectively. This reduces the number of parameters to be estimated.

It is important to acknowledge that although surveys have good forecasting properties and help to anchor the model to the reality in each country, they are not a panacea. For instance, surveys might not represent market expectations nor the expectations of the marginal investor,[31] they might also be subject to measurement error, and relying too much on them can be counterproductive as it may lead to overfitting. Thus, although surveys certainly contain useful information, I consider them as imperfect or 'noisy' measures of expectations. Accordingly, I follow Kim and Orphanides (2012) by fixing σ_s at a conservative level of 75 basis points, even though when σ_s is allowed to be estimated, its average value across all emerging markets is 31 basis points.

3.3.2 Estimating Daily Pricing Factors

The estimation of the parameters in the model uses end-of-month data because at the daily frequency there is noise that can undermine the estimation. Nonetheless, the parameters estimated with monthly data can be used to estimate the pricing factors at the daily frequency (Adrian et al., 2013).

The maximum likelihood estimation procedure explained above gives estimates for both the parameters and the pricing factors. I regress the estimated monthly pricing factors on the end-of-month observed yields to obtain the matrix of loadings implied by those pricing factors. That matrix is then multiplied by the daily yields to estimate the

[31] Notwithstanding, when comparing the 5-year ahead CPI inflation median forecast from the Survey of Professional Forecasters against the Survey of Primary Dealers and the Survey of Market Participants, the absolute difference over 2015:I and 2020:II is on average 5 and 13 basis points, respectively.

daily pricing factors—accounting for the intercept. Finally, the estimated parameters (with monthly data) along with the estimated daily pricing factors are used to fit—and decompose—the yields at the daily frequency.

4 Decomposing the Yields of Emerging Markets

This section argues that the yield decompositions obtained with the survey-augmented model are sensible. It highlights the benefits of using synthetic curves and survey data when analyzing the yields of emerging markets. Among the many potential applications of the decompositions, the next section applies them to characterize the response of emerging market yields to U.S. monetary policy.

4.1 Model Fit

The results focus on the 10-year maturity for the sake of brevity. Figure 3 illustrates the fit of the model for the synthetic yields. In general, the model fits the data reasonably well. 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 economies in the sample, those fitting errors are small, at around 5 basis points in line with previous 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, which it is still a reasonable fit.[32]

4.2 Robustness

The estimated model is used to decompose the yields, but the extent to which any application provides valuable insights hinges on the reliability of the decomposition. To assess its robustness, I compute the standard errors for each component using the delta method. Specifically, since each yield component Ψ is a function of the parameters θ in

[32]Nevertheless, it is important to keep in mind that for some countries, large fitting errors might be an indication of less liquid and deep markets.

the model, $\Psi = g(\theta)$, its distribution is calculated based on the following

$$\sqrt{\mathrm{N}}\left(\widehat{\Psi} - \Psi\right) \xrightarrow{d} \mathcal{N}\left(0,\, \Gamma\,\Omega\,\Gamma'\right),$$

in which Ω is the asymptotic covariance matrix of the estimator $\widehat{\theta}$ and Γ is the Jacobian matrix of partial derivatives calculated numerically. Ω is estimated using the sample Hessian estimator $\widehat{\Omega} = \widehat{\mathcal{H}_\theta}^{-1}$, for which the second derivative matrix of the log-likelihood function evaluated at the optimum, $\widehat{\mathcal{H}_\theta}$, is also calculated numerically.

Although there is uncertainty in both the parameters and the pricing factors after the estimation, the effect of uncertainty associated with the pricing factors on each component is usually small.[33] Therefore, when applying the delta method, I assume that the pricing factors are known with certainty. Figures D.1 and D.2 in the appendix display the term premium and the credit risk compensation along with their confidence bands. They illustrate the benefits of using survey data for emerging markets. Specifically, surveys help in obtaining robust yield decompositions for emerging markets, consistent with the findings of Guimarães (2014) for the U.S. and the U.K.

4.3 Decomposition Assessment

Table 2 summarizes the decomposition across emerging markets.[34] On average, the expected short rate explains most of the variability in yields at the short end of the curve and slowly decreases with maturity. By contrast, the relevance of the term premium and the credit risk compensation increases with maturity. The three parts respectively represent around 61, 28 and 11% of the 10-year nominal yields of emerging markets.

Figure 4 shows the decomposition of the 10-year yield for each country, from which two patterns emerge. First, the term premium and the credit risk compensation are

[33] To verify this, at each period, I compute the standard errors by pre- and post-multiplying the variance of the pricing factors (generated by the Kalman filter) by the respective factor loadings for the fitted yields, the expected future short term rate and the term premium. In all cases, the average standard error (over time and across countries) is less than 9 basis points for emerging markets, and less than 3 basis points for advanced economies.

[34] The decompositions for advanced economies are not displayed for two reasons. First, they have already been studied before, see for instance Wright (2011) and Adrian et al. (2019). Second, the dataset does not include survey data for advanced economies and so their decompositions may not be robust. They are nonetheless a useful benchmark to assess some results like with the fitting errors.

time-varying and both play an important role in the dynamics of yields; their relative importance varies by country but the term premium plays a relatively bigger role, in general. Second, there is a downward trend in the expected future short rate and the term premium of several countries, consistent with the evidence for advanced economies (Wright, 2011; Adrian et al., 2019).

The results for individual countries are consistent with their particular circumstances. For instance, the expected short rate in Mexico increased during the tightening cycle that started following the 2016 U.S. presidential election.[35] The credit risk compensation for Hungary increased after 2010, when the current populist government came into power. Also, Hungary and Poland have seen a decline in their term premia after the global financial crisis, in line with other European countries in response to the unconventional monetary policies of the European Central Bank.

4.3.1 Expected Future Short Rate

Figure 5 shows that the 10-year expected future short rate tracks the (implied) long-term interest rate forecasts reasonably well, even though the model does not rely too much on them given the conservative value used for σ_s.

The expected future short rate implied by the model can also be assessed in terms of the long-term real interest rate, a key variable in assessing the monetary stance in a country and the suitability of the central bank's monetary policy decisions. Since the implied long-term forecast for the short rates is based on the long-term U.S. real interest rate (see section 3.2), the expected future *real* interest rate—the difference between the model-implied future expected short rate and the domestic long-term inflation forecast—should be similar across countries. Figure 6 verifies this. It shows that, once correcting for credit risk and inflation, the real interest rates of emerging markets fluctuate near zero, consistent with real rate estimates for advanced economies; for instance, Holston et al. (2017) show that their real rates have trended toward zero over the last decades, which makes more likely for their central banks to be constrained by the zero lower bound.

[35] After the election, market participants expected a deterioration in the bilateral relation.

4.3.2 Term Premium

While the (bond) risk premium is usually associated with the term premium in advanced economies, the two concepts are different in emerging markets. The purpose of leveraging on synthetic yields (and surveys) is to estimate a genuine term premium, clean of credit risk. This subsection assesses its sensibility.

The survey-based term premium serves as a robustness check for the model-implied term premium. It is a model-free measure that equals the difference between the *synthetic* yield and the short rate forecast over the same horizon. Since the model-implied expectations track the interest rate forecasts closely (see figure 5), the two measures of term premia comove positively, with a correlation of 0.52 across countries.

Wright (2011) documents a downward trend in the term premia of advanced economies and argues that it owes in part to a reduction in inflation uncertainty. Since inflation in emerging markets tends to be higher and more volatile than in advanced economies (Ha et al., 2019), it is reasonable to assume that the relationship between the term premia and inflation uncertainty is particularly relevant in emerging markets. To test this hypothesis, I run the following panel regressions

$$\tau_{i,t} = \alpha_i + \beta_1' \sigma_{i,t}^{\pi} + \beta_2' g_{i,t} + u_{i,t}, \tag{16}$$

in which α_i are country fixed effects, $\sigma_{i,t}^{\pi}$ is a measure of inflation uncertainty, $g_{i,t}$ is the domestic real GDP growth to control for the business cycle, and $u_{i,t}$ is the error term. The dependent variable $\tau_{i,t}$ is the model implied term premium at different maturities. Following Wright (2011), the inflation uncertainty measure is the standard deviation of the permanent component of inflation based on the Stock–Watson unobserved components stochastic volatility (UCSV) model, estimated using quarterly data for each country.[36] To test for significance, I use the Driscoll–Kraay estimator that allows the errors to be correlated across countries and over time.[37]

Table 3 reports the results. The response to the standard deviation of the permanent

[36]The UCSV model assumes that inflation has permanent and transitory components subject to uncorrelated shocks that vary over time.

[37]The Pesaran test of cross-sectional independence is rejected in all cases at the 1% significance level.

component is significant and increases with maturity. The result becomes stronger after controlling for the business cycle. It is important to acknowledge, however, that the specification might be subject to econometric problems since it involves persistent variables and ignores measurement error. The result is nonetheless aligned with the view that term premia in emerging markets compensate investors for bearing inflation uncertainty.

Finally, a term premium becomes negative when investors see bonds as hedges and are therefore willing to give up some investment return. This phenomenon has been reported for advanced economies before and, especially, after the global financial crisis. Figure D.1 indeed shows that negative term premia is not an advanced country phenomenon. IMF-WB (2020) report a particularly strong demand for LC bonds in Asia since 2011, which partly explains the negative term premia seen for Korea, Malaysia, the Philippines and Thailand. Moreover, figure D.4 in the appendix not only shows that term premia increase with maturity—indicating that long-term bonds are seen as riskier than short-term bonds—but that other countries also experienced negative term premia, yet at the short end of their yield curves, suggesting that investors in LC bonds had a particular preference for short-term LC bonds after the global financial crisis.

4.3.3 Credit Risk Compensation

Unlike the term premium, no clear trend is visible for the credit risk compensation, nor a pattern is detected when looking across maturities. The dynamics are in line with the results reported by Du and Schreger (2016) who, in particular, show that it is highly correlated with the CDS of the respective country.

The role of the credit risk compensation in explaining yield variation is non-negligible (see table 2), and thus it matters which curve is used (nominal or synthetic) for decomposing the yields of emerging markets. Although its unconditional mean is positive, there have been brief episodes in which the credit risk compensation has been negative. These situations are unrealistic and can reflect financial market frictions (Du and Schreger, 2016), including market segmentation between foreign and local investors and short selling constraints. The nominal-synthetic spread is thus a valid measure of credit risk that is far from perfect, but definitely better than ignoring it. Otherwise, estimates of the term premium would be contaminated with credit risk.

Given that both the term premium and the credit risk compensation help explain yield variation in emerging markets, a natural question is whether and how they are related. However, while the term premium compensates investors for bearing the uncertainty that interest rates might suddenly increase, the credit risk compensation actually rewards them for two things. One is a compensation for the *expected* loss owing to default, whereas the other compensates them for bearing the *uncertainty* that defaults might be larger than expected. Attempting to isolate those two parts is beyond the scope of this paper. Therefore, interpreting any potential correlation between the term premium and the credit risk compensation is not straightforward.[38] In the data, the term premium and the credit risk compensation are negatively correlated as is the case between the average expected future short rates and the credit risk compensation, which suggests that the expected component of the credit risk compensation is relatively more relevant. Intuitively, a country facing difficulties servicing its debt can either inflate it away and/or default, which can be referred to as implicit and explicit defaults, respectively. The negative correlation in the data suggests a trade-off between the two, in which case inflation and default would be substitutes. If so, inflating away the debt would reduce the need to default. Galli (2020) shows that in models of debt dilution inflation and default are indeed substitutes.[39]

5 U.S. Monetary Policy Spillovers

This section applies the decomposition described in previous sections to analyze the transmission channels of U.S. monetary policy to emerging market yields. It provides

[38]One the one hand, the term premium and the *uncertainty* component of the credit risk compensation are likely to move in the same direction. On the other hand, the average expected future short rates and the *expected* component of the credit risk compensation are likely to move in opposite directions.

[39]Galli (2020), however, argues for a positive correlation between inflation and default. An alternative explanation for the negative correlation involves market segmentation between foreign and local investors. For instance, if only foreign investors require to be compensated for bearing certain risks, synthetic yields will increase but not nominal yields, reducing the spread between the two and, at the same time, increasing either the expected short rate or the term premium.

evidence of a yield curve channel for the U.S. monetary policy. It also documents a strong and persistent response of emerging market yields to U.S. monetary policy surprises.

5.1 The Yield Curve Channel

Under the traditional Mundell-Fleming trilemma—the impossibility to combine free capital flows, a fixed exchange rate and an independent monetary policy—a flexible exchange rate helps to insulate a financially-open economy from shocks abroad. Rey (2013) argues that a flexible exchange rate does not fully offset those shocks because there is a global financial cycle—mainly driven by U.S. monetary policy—operating through channels other than the exchange rate, like the comovement of global asset prices and cross-border bank lending; such a cycle drives portfolio flows in and out of emerging markets, influencing their domestic financial conditions.

Obstfeld (2015) and Kolasa and Wesołowski (2020) describe what can be referred to as the yield curve channel of the global financial cycle. Central banks in emerging markets can independently exert control on the short end of their yield curves, but are less powerful swaying the long end because long-term yields are highly correlated and, thus, influenced by global forces, like the U.S. monetary policy. Accordingly, monetary policy decisions in advanced economies oriented to have an effect on long-term yields, like forward guidance and quantitative easing, spill over abroad via, for instance, the term premium.[40] Due to the high comovement of long-term yields, unconventional monetary policies reduce the monetary autonomy of emerging markets along the yield curve. That is, the global financial cycle has larger effects at the long end than at the short end of the yield curve, limiting the effectiveness of domestic monetary policy to steer the economy since the entire yield curve is relevant for the spending decisions of households and firms. In addition, Kalemli-Özcan (2019) argues that monetary autonomy is also limited at the short end of the yield curve because there are risk spillovers influencing short-term yields.

[40] Adrian et al. (2019) find that the correlation of the term premia in long-term yields has actually increased over the last years. Turner (2014) argues that changes in the U.S. term premium spill over into the term premia of emerging markets.

5.1.1 Comovement of Yields

To formally assess whether some nodes of the yield curves of emerging markets comove more than others, I use the connectedness index developed by Diebold and Yilmaz (2014). The index assesses shares of forecast error variation in a country's bond market due to shocks arising elsewhere. The connectedness index fluctuates between 0 and 100 percent, with higher numbers indicating a higher degree of comovement.[41] The index is computed for different maturities.

Figure 7a shows that the long end in emerging markets is indeed more connected than the short end, especially since the taper tantrum episode of 2013. Nevertheless, figure 7b shows that the long end in advanced economies is even more connected. The degree of comovement of the long end in emerging markets is half (around 35%) the level in advanced economies (around 70%). This suggests that the medium- and long-term bonds of emerging markets are mostly held by local investors.[42] If so, local factors still play a role in explaining the long end of their curves.[43]

5.1.2 Drivers of Yields

The yield curve channel requires one to distinguish between interest rates at different maturities and calls attention to the role of the U.S. term premium. Here I assess the role of the U.S. term premium (and of the U.S. average expected future short rates) in explaining the yields of emerging markets at different maturities. Moreover, I use the three-part decomposition of those yields to see, for example, whether the U.S. term premium exclusively passes through to the term premia in emerging markets. In fact, the assessment of the yield curve channel would be limited without the decomposition. For this purpose, I run the following panel regressions

$$y_{i,t} = \alpha_i + \gamma_1' z_{i,t}^1 + \gamma_2' z_{i,t}^2 + u_{i,t}, \tag{17}$$

[41] Following Adrian et al. (2019) and Bostanci and Yilmaz (2020), I compute 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 daily changes of yields.

[42] According to Kolasa and Wesołowski (2020), the share of foreign investors in the LC bonds of emerging markets increased from 10% in 2008 to 25% in 2019.

[43] Figure D.5 in the appendix reports essentially the same patterns but using one-year rolling correlations of daily yield changes at different maturities.

in which α_i are country fixed effects, $z_{i,t}^1$ is a vector containing the components of the U.S. yield curve, $z_{i,t}^2$ is a vector of global and domestic variables that likely drive the yields, and $u_{i,t}$ is the error term. The dependent variables $y_{i,t}$ are the nominal yields and their three components for the 10- and 2-year maturities.[44] As before, I use the Driscoll–Kraay standard errors to test for significance.[45]

The explanatory variables of interest come from the decomposition of the U.S. yield curve based on the Kim and Wright (2005) model, which addresses the small sample problem using survey forecasts of future interest rates. I control for the monetary stance and local macroeconomic conditions using the policy rate reported by each country to the Bank for International Settlements, as well as domestic inflation and unemployment rates. Rey (2013) highlights the role of the Cboe's volatility index (Vix) as an important driver of the global financial cycle, it reflects the implied volatility in stock option prices and is usually seen as a measure of risk aversion and economic uncertainty.[46] Baker et al. (2016) construct a news-based economic policy uncertainty (EPU) index that serves as the basis for the global and U.S. versions,[47] which are used as alternative, and arguably exogenous, measures of global uncertainty. The index of global economic activity proposed by Hamilton (2019) captures real variables. Finally, the exchange rate (LC per USD) is included to rule out explanations of changes in yields based on currency movements; the exchange rate is standardized for each country over the sample period.

Tables 4 and 5 report the results. The evidence is in line with the yield curve channel.[48] First, the response of the average expected future short rates of emerging markets to the domestic policy rate decreases with maturity and is positively associated with its U.S. counterpart only at the long end, both results are in line with the argument that monetary

[44]Kalemli-Özcan (2019) focuses on yields with maturities of 1 year or less. Here I focus on the 2-year yield because is a benchmark commonly used by market participants. The conclusions based on the 10- and 2-year maturities carry on if the 5- and 1-year maturities are used instead. Appendix C reports the results for the 5- and 1-year maturities. The 1-year maturity is the shortest one for which the decomposition of the U.S. yield curve used here is available.

[45]The Pesaran test of cross-sectional independence is rejected in all cases at the 1% significance level.

[46]Given the sudden spikes in the index, it is common to use it in logs. For consistency, the other uncertainty indexes are also used in logs.

[47]Although the EPU index has been replicated for different countries, it is only available for five of the emerging markets in the sample: Brazil, Colombia, Mexico, Russia and South Korea.

[48]The tables report the estimates for the full specification of the model. The results are robust to specifications of the model that progressively include the regressors for each dependent variable.

autonomy is stronger at the short end than at the long end of the curve. Second, the response of the term premia of emerging markets to the U.S. term premium increases with maturity and is positively associated with the Vix only at the long end, both results consistent with the claim that the U.S. term premium, and the global financial cycle in general, is more relevant for the long end than for the short end of the curve. Third, the U.S. term premium not only influences the yields in emerging markets through its effect on their term premia but through the other components too. In particular, I can directly test the thesis in Kalemli-Özcan (2019) regarding risk spillovers to the short rate thanks to the yield decompositions. Indeed, these risk spillovers to the average expected future short rates of emerging markets decrease with maturity and operate through the U.S. term premium rather than the Vix. Lastly, here is where accounting for credit risk pays off; when it is ignored, the conclusions on direct and cross effects between the components of the yields change. Why? Because the resulting 'term premium' mixes together a pure term premium and a credit risk compensation.

A glimpse on the drivers of the yields of emerging markets is a byproduct of the analysis on the yield curve channel. For instance, inflation and unemployment are key domestic variables. In particular, the term premium and the credit risk compensation seem to be countercyclical, investors demand higher compensations 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 forward, demanding a higher term premium. As expected for measures of risk and uncertainty, shifts in the Vix are positively associated with the term premium and the credit risk compensation, but not with the expected future short rate. Also, higher economic uncertainty in the U.S. seems to induce a flight to quality in the short end of the yield curve and a reduction in the perceived credit quality.[49] Lastly, there is evidence supporting the risk-taking channel of exchange rates,[50]

[49]The coefficient for the U.S. EPU index in the term premium column is negative and positive in the credit risk compensation column.

[50]According to the standard trade-channel effect, an appreciation is contractionary because it discourages exports and stimulates imports, reducing the trade balance.

according to which a currency appreciation is associated with easier financial conditions (and compressed sovereign bond spreads) due to balance sheet effects. However, here it works through the expected future short rate and the term premium rather than through the credit risk compensation as reported by Hofmann et al. (2019).

So far, the yield decompositions have been valuable to assess the validity of the yield curve channel and understand the driving forces behind the sovereign yields of emerging markets. Notwithstanding, the model in equation (17) may suffer from econometric problems such as persistent variables, reverse causality and omitted variables. Moreover, the measures of comovement are not limited to episodes driven by monetary policy surprises. In addition, the sample period includes few U.S. policy rate surprises. These issues are addressed next.

5.2 Identification of Monetary Policy Surprises

The surprises in monetary policy decisions are identified using intraday data on asset prices around the Fed's monetary policy announcements in order to capture changes in the information set of market participants. Asset price changes are calculated from 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.[51] In days with no FOMC meeting, the surprises are set to zero. The dataset does not include minute releases nor speeches by Fed officials.

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. Following Rogers et al. (2018), I consider three separate types of U.S. monetary policy surprises, which are referred to hereinafter as target, forward guidance and asset purchase surprises. The target surprise is the change in the yield on the current- or next-month federal funds futures contracts, as proposed by Kuttner (2001). The forward guidance surprise is the residual from regressing the yield change of the 8-quarters ahead

[51] Following Gürkaynak et al. (2005), I exclude from the analysis the meeting of September 2001 that followed the terrorist attacks in New York.

Eurodollar futures contract on the target surprise.[52] Finally, the asset purchase surprise is the residual from a regression of the yield change in the 10-year Treasury futures contract on the target and forward guidance surprises. By construction, the surprises are uncorrelated. A positive value in any of the surprises represents a tightening of the monetary policy stance, and vice versa.

The relevance of the surprises has varied over time. After 2008, there were no changes in the current policy rate until the first rate hike in December 2015, so target surprises were essentially zero during that period. By contrast, the meaning of asset purchase surprises is unclear before October 2008; therefore, they are considered from October 2008 onwards. Forward guidance surprises have nevertheless been relevant before and after the global financial crisis.[53] Table C.3 in the appendix reports descriptive statistics for the three types of surprises on monetary policy announcement days. In general, the Fed has been more aggressive in stimulating than in contracting the U.S. economy, since easing surprises are larger on average and more common than tightening surprises.

5.3 The Effects on Emerging Market Yields

The transmission of U.S. monetary policy to the yields of emerging markets is assessed using panel local projections for the daily changes in the yields.[54] While event studies report the response of the variables on the day of a surprise, local projections additionally provide the responses over subsequent periods. It is important to be able to capture the persistence in the response of emerging market yields given the pervasive post-announcement drift in the bond markets of advanced economies documented by Brooks et al. (2019). To better understand the transmission of the Fed's decisions to the yields, I leverage on the yield decompositions at the daily frequency.

[52] The yield change of the 4-quarters ahead Eurodollar futures contract could also be used to capture the forward guidance surprise. However, intraday changes in that contract became essentially zero after 2011 since market participants expected the policy rate to remain at zero for at least a year. Eurodollar futures contracts are bets on the future level of 3-month interest rates.

[53] In general, the surprise is set to zero in non-announcement days or in periods outside of the considered range (e.g. before October 2008 for asset purchase surprises).

[54] Jordà (2005) advocates the use of local projections as an alternative to VAR models in order to generate impulse responses that are robust to misspecification. See Hofmann et al. (2019) and Adrian et al. (2019) for recent applications of panel local projections.

Specifically, I run the following panel local projections:

$$y_{i,t+h} - y_{i,t-1} = \alpha_{h,i} + \sum_{j=1}^{3} \beta_h^j \epsilon_t^j + \gamma_h \Delta y_{i,t-1} + \eta_h s_{i,t-1} + u_{i,t+h}, \tag{18}$$

in which h indicates the horizon (in days) with $h = 0, 1, \ldots, 45$ and each ϵ_t^j represents one of the three types of monetary policy surprises.[55] The regressions include country fixed effects $\alpha_{h,i}$, a lag of the dependent variable,[56] and a lag of the exchange rate $s_{i,t-1}$. The regressions are ran for the 10- and 2-year nominal yields and each of their components. The confidence bands are constructed using Driscoll–Kraay standard errors, which allow for time and cross-sectional dependence.

The parameters of interest, β_h^j, measure the average response of the nominal yield (or its components) to monetary policy surprise j at horizon h.[57] All responses are assessed relative to a one basis point reduction (an easing) in any of the surprises, since the Fed has been more aggressive in that direction during the sample period.

The response of the U.S. yields and its components to the three surprises serves as a benchmark to assess the responses of the yields of emerging markets. As before, the U.S. yields come from the dataset of Gürkaynak et al. (2007), and the components from the decomposition proposed by Kim and Wright (2005). The responses are reported in appendix D. They are consistent with the findings in the existing literature. For instance, target easing surprises reduce yields, mainly driven by a decline in the average expected future short rates; while forward guidance and asset purchase easing surprises decrease yields, in part due to a reduction in the term premium. Moreover, the responses build over time in all cases.

[55] There is no need to control for past or future surprises since, by definition, they are unanticipated by the market. On the other hand, even though the types of surprises are uncorrelated by construction, the estimation is more efficient when all the surprises are included simultaneously.

[56] As argued by Hofmann et al. (2019), the large number of daily observations reduces the potential for Nickell bias that arises by including a lagged dependent variable in panel regressions with fixed effects and small time dimensions. Indeed, the impulse responses reported here are essentially the same when the lag of the dependent variable is excluded.

[57] The contemporaneous effects of the surprises, which would be reported under an event study methodology, can be obtained by setting $h = 0$ in equation (18).

5.3.1 Target Surprises

Figure 8 shows the response of the yields of emerging markets to a target easing surprise. The magnitude of the initial yield response is lower than in the U.S., but it builds over time. This delayed response is documented by Brooks et al. (2019) for the U.S. and by Adrian et al. (2019) for a sample comprised mostly of advanced economies. Moreover, the reaction to forward guidance and asset purchase surprises is also sluggish, as discussed later. Therefore, slow-moving capital is also present in emerging markets.[58] Brooks et al. (2019) attribute the delayed response to a portfolio rebalancing channel.

Following a target surprise, both the U.S. and emerging market yield curves steepen. The surprise reduces the short but not the long end of the yield curves in such a way that the long end of the synthetic yield curve declines by more than the nominal one. That is, borrowing long-term in LC synthetically becomes cheaper; equivalently, the opportunity cost of lending long-term directly in LC increases. As a result, the credit risk compensation at the long end rises by almost one-to-one in the month following the surprise. The surprise therefore seems to trigger capital flows towards emerging markets that slowly concentrate on short term LC bonds. This would explain the effect on the long-term credit risk compensation, which declines on impact but increases over the month following the surprise. The credit risk compensation is thus an important factor to understand the transmission of U.S. monetary policy to emerging markets. Nevertheless, the response of their yields to a target surprise is mainly driven by the expected short rate; in particular, investors expect for central banks in emerging markets to follow the U.S. monetary stance.

In sum, economically significant spillovers from target easing surprises build over time reducing the expected future short rate and increasing the long term credit risk compensation of emerging markets. These results show that U.S. monetary policy spillovers are not limited to the term premium. They also highlight a channel that has not been discussed in the literature, the potential fiscal implications for emerging markets of the Fed's monetary policies.

[58] Figure D.12 in the appendix shows that the delayed responses are not driven by the response of the forward premium, the term added to the U.S. yield curve to construct the synthetic yields.

5.3.2 Forward Guidance Surprises

Since U.S. monetary policy spillovers to long-term yields increased after the global financial crisis (Albagli et al., 2019), figures 9 and 10 display the responses of emerging market yields to a forward guidance easing surprise before and after October 2008, respectively. Before the global financial crisis, a forward guidance easing surprise led to a downward parallel shift in the yield curves of emerging markets in the month following the surprise. In general, investors did not expect central banks in those countries to follow the Fed's decision, since the effect on the expected short rate was generally not significant. The yield response was instead mainly driven by a parallel decline in the term premium, which in fact lasted longer than the response of U.S. yields.

After the global financial crisis, the transmission of forward guidance surprises changed, but the magnitudes remain similar. The decline in the nominal yields at the long end has a shorter duration relative to both the front end of the curve in emerging markets and the long end of the U.S. yield curve. As a result, in the month following the surprise, the nominal yield curve in emerging markets steepens while the U.S. yield curve flattens. Again, these effects increase the opportunity cost of lending long-term to emerging markets in LC, leading to an increase in the credit risk compensation at the long end, even though the expected short rate and the term premium decline. In fact, the effect on the term premium would be hard to detect should the credit risk be ignored.

In addition, the transmission of a forward guidance easing surprise after the global financial crisis is consistent with the yield curve channel. First, the surprise reduces the U.S. term premium at the long end almost one-to-one over the month (see figure D.8a). Similarly, the decline in the term premia of emerging markets at the long end is larger than at the short end. In addition, investors expect central banks in emerging markets to mirror Fed's decisions, in line with a risk spillover mechanism (Kalemli-Özcan, 2019).

5.3.3 Asset Purchase Surprises

Figure 11 displays the response of the yields of emerging markets to an asset purchase easing surprise. The surprise flattens the yield curves in the U.S. and in emerging markets.

In both cases, the effect at the long end of the curves is larger than at the short end. The on-impact response of U.S. yields is larger, whereas the response of the nominal yields of emerging markets lasts longer. These two effects in turn explain the response of the credit risk compensation, which initially increases followed by a sluggish and considerable decline, especially at the long end of the curve. The counterintuitive initial increase reflects characteristics of both bond markets. On one side, an asset purchase surprise triggers a strong investor reaction in the market for U.S. Treasuries, leading to a more than one-to-one on-impact decline in the long-term U.S. yield (see figure D.8a). On the other, the yields of emerging markets decline sluggishly. Nonetheless, the eventual decline in the credit risk compensation is consistent with a relaxation of global financial conditions, increasing the willingness (and the capital flows) to invest in the long-term debt of emerging markets.

In terms of the yield curve channel, an asset purchase easing surprise reduces the term premia at the long end and the expected short rate at the front end of the curve, similar to the effect of a forward guidance easing surprise. Also, the response of the term premia at the long end is larger than at the short end. More generally, the yield curve channel is not at play in figures 8 and 9, whereas figures 10 and 11 align with it. The yield curve channel is thus a relatively recent phenomenon that coincides with the implementation of unconventional monetary policies in advanced economies.

6 Concluding Remarks

This paper decomposes the yields of 15 emerging markets accounting for the credit risk embedded in them, and empirically quantifies the transmission channels of U.S. monetary policy to the yields of emerging markets. The nominal yields of emerging markets are decomposed into an expected future short-term interest rate, a term premium and a compensation for credit risk.

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.

That is, the surprises spill over to all yield components, not only the term premium, and including the compensation for credit risk. The fiscal implications for emerging markets of the Fed's monetary policies is an unexplored but prospective area for future research. The responses to target, forward guidance and asset purchase surprises are sluggish but amplify over time with economically significant effects. In addition, since the global financial crisis, U.S. monetary policy has spilled over to emerging markets through a yield curve channel, which limits their monetary autonomy along the yield curve.

More work is needed to have a better understanding of the spillovers. U.S. monetary policy influences investors' risk tolerance and preferences for the LC bonds of emerging markets, which in turn give rise to (slow-moving) capital flows in or out of those bonds. The relative importance of short-term and long-term bonds following a surprise determines the response of the yield curves of emerging markets. Understanding the effects on investors' risk tolerance and preferences will further improve the ability of emerging markets to mitigate any undesired domestic effect of monetary policy decisions abroad.

The results presented here can be extended in several directions. Two of the many applications of the decomposition of emerging market yields are to analyze the transmission of monetary policy domestically and to further decompose each part (e.g. split the average expected future short rates into an inflation expectation and an expected real interest rate). The results might also inform theoretical models for pricing sovereign defaultable bonds. Finally, surprises from other central banks (e.g. European Central Bank) can be included in the analysis to broaden our understanding of monetary policy spillovers.

Table 1. Descriptive Statistics of Yield Curves

		3M	6M	1Y	2Y	5Y	10Y
		Emerging Markets					
Nominal Yields	Average	5.1	5.3	5.4	5.7	6.3	6.8
	S. Dev.	3.2	3.3	3.2	3.2	3.0	2.9
		Advanced Countries					
	Average	2.0	2.1	2.1	2.3	2.7	3.2
	S. Dev.	2.1	2.1	2.1	2.1	2.0	1.8
		Emerging Markets					
Synthetic Yields	Average	5.1	5.2	5.3	5.3	5.8	6.3
	S. Dev.	4.3	4.1	4.0	3.7	3.4	3.2
		Advanced Countries					
	Average	1.6	1.7	1.8	2.0	2.5	3.2
	S. Dev.	2.1	2.1	2.2	2.1	2.0	2.0

Notes: This table reports the average, the standard deviation, the minimum and the maximum values using end-of-month data for different tenors of the nominal and synthetic yields of the emerging markets and advanced countries in the sample. All figures are expressed in annualized percentage points.

Table 2. Descriptive Statistics for the Decomposition of Emerging Market Yields

	3M	6M	1Y	2Y	5Y	10Y
	Expected Short Rate					
Average	5.1	5.2	5.2	5.1	4.8	4.3
S. Dev.	3.7	3.4	3.1	2.7	2.2	1.8
	Term Premium					
Average	0.0	0.0	0.1	0.3	1.0	2.0
S. Dev.	1.3	1.4	1.4	1.5	1.5	1.7
	Credit Risk Premium					
Average	0.3	0.5	0.6	0.7	0.9	0.8
S. Dev.	2.0	1.5	1.2	1.1	1.0	0.9

Notes: This table reports the average, the standard deviation, the minimum and the maximum values using end-of-month data for different tenors of the components of the emerging market nominal yields. All figures are expressed in annualized percentage points.

Table 3. Term Premia and Inflation Volatility

	6 Months		1 Year		2 Years		5 Years		10 Years	
UCSV-Perm	93.0	75.3	85.7*	83.2	88.7***	97.8**	103.1***	124.2***	121.9***	151.3***
	(52.2)	(49.5)	(37.1)	(43.7)	(24.7)	(31.6)	(15.3)	(18.7)	(16.1)	(18.3)
GDP Growth		-2.56		-2.62		-1.91		-2.14		-3.97*
		(3.37)		(4.00)		(3.53)		(1.67)		(1.55)
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lags	3	3	3	3	3	3	3	3	3	3
No. Countries	15	14	15	14	15	14	15	14	15	14
Observations	870	796	870	796	870	796	870	796	870	796
R^2	0.04	0.03	0.04	0.03	0.05	0.05	0.10	0.11	0.11	0.15

Notes: This table reports the slope coefficients of panel data regressions of the model-implied term premia for different maturities on the standard deviation of the permanent component of inflation according to the UCSV model (UCSV-Perm) and GDP growth. The sample includes quarterly data for 15 countries starting in 2000:I and ending in 2018:IV. The term premia is expressed in basis points. GDP growth is expressed in percent. Driscoll–Kraay standard errors are in parenthesis. *, **, *** asterisks respectively indicate significance at the 10%, 5% and 1% level.

Table 4. Drivers of the Emerging Market 10-Year Nominal Yield and Its Components

	Nominal	E. Short Rate	Term Premium	Credit Risk
U.S. Term Premium	0.97***	0.54***	0.85***	-0.42***
	(0.14)	(0.08)	(0.09)	(0.11)
U.S. E. Short Rate	0.17	0.25***	0.08	-0.17**
	(0.09)	(0.05)	(0.06)	(0.06)
Policy Rate	0.24***	0.30***	0.01	-0.06***
	(0.03)	(0.02)	(0.02)	(0.02)
Inflation	15.26***	1.77	7.06***	6.43***
	(2.27)	(1.56)	(1.36)	(1.73)
Unemployment	23.88***	1.14	10.74***	12.00***
	(3.43)	(2.09)	(1.65)	(2.23)
LC per USD (Std.)	41.58***	33.11***	22.07***	-13.61***
	(5.74)	(3.52)	(3.18)	(3.85)
Log(Vix)	49.95***	-20.18	30.13**	40.01***
	(12.63)	(10.45)	(10.49)	(9.59)
Log(EPU U.S.)	7.08	-3.81	-0.44	11.32**
	(5.58)	(2.69)	(2.72)	(3.93)
Log(EPU Global)	-61.04**	-38.72***	-19.64	-2.68
	(20.51)	(6.98)	(11.75)	(10.72)
Global Ind. Prod.	1.16	0.79	-0.10	0.46
	(1.13)	(0.86)	(0.46)	(0.93)
Fixed Effects	Yes	Yes	Yes	Yes
Lags	4	4	4	4
No. Countries	15	15	15	15
Observations	2194	2194	2194	2194
R^2	0.68	0.71	0.49	0.23

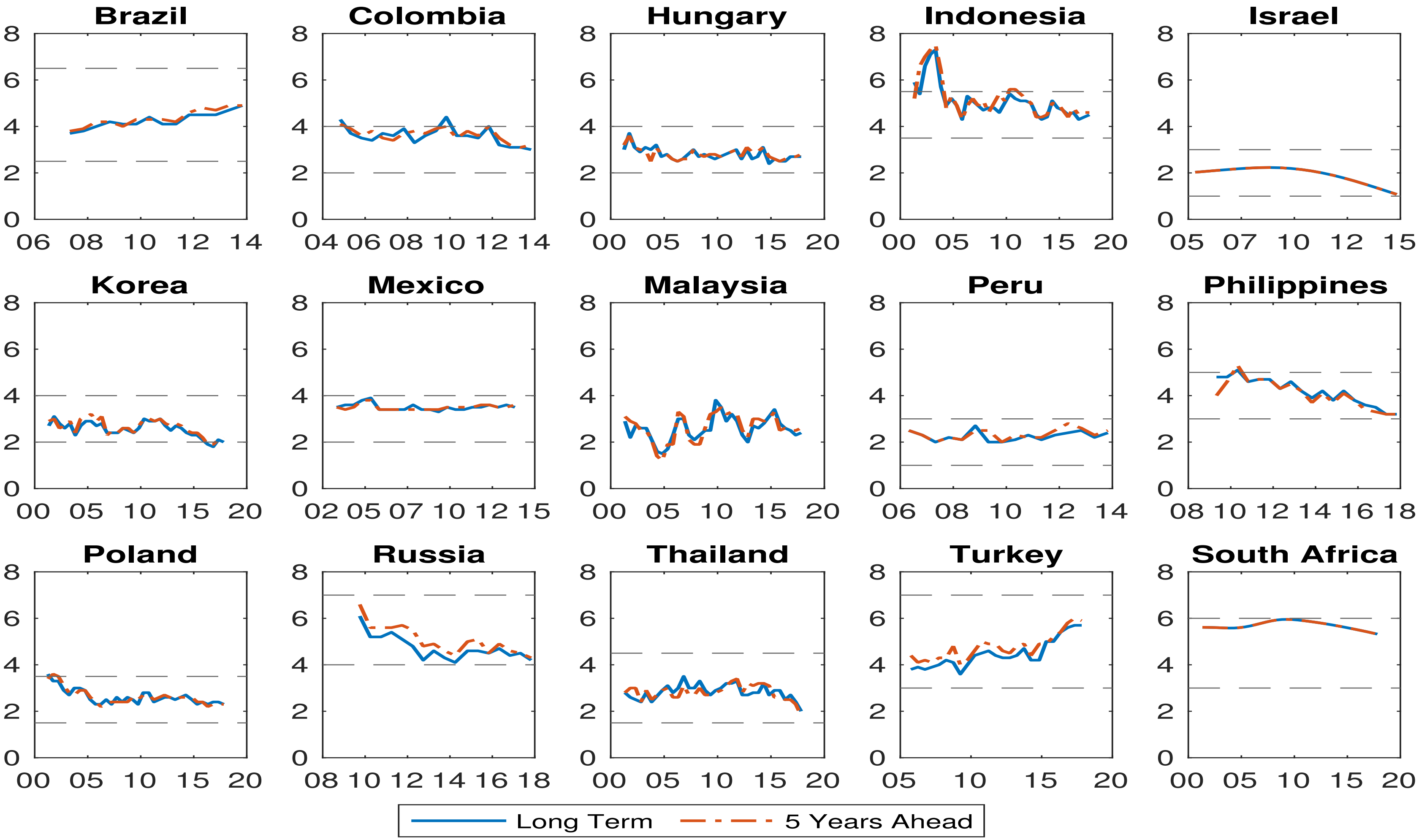
Notes: This table reports the estimated slope coefficients of panel data regressions of the 10-year nominal yield and its components (the expected short rate, the term premium and the credit risk compensation) on selected explanatory variables. The sample includes monthly data for 15 emerging markets starting in 2000:1 and ending in 2019:1. The dependent variables are expressed in basis points. The explanatory variables are the U.S. term premium and the U.S. expected short rate according to Kim and Wright (2005) with the same maturity as the dependent variables, the policy rate, domestic inflation and unemployment, the standardized exchange rate (local currency per USD), the log of the Vix, the log of the U.S. and global economic policy uncertainty indexes based on Baker et al. (2016), the global economic activity index of Hamilton (2019). Driscoll–Kraay standard errors in parenthesis. Lag length up to which the residuals may be autocorrelated is indicated. *, **, *** asterisks respectively indicate significance at the 10%, 5% and 1% level.

Table 5. Drivers of the Emerging Market 2-Year Nominal Yield and Its Components

	Nominal	E. Short Rate	Term Premium	Credit Risk
U.S. Term Premium	1.59***	1.68***	0.58***	-0.68**
	(0.22)	(0.17)	(0.17)	(0.21)
U.S. E. Short Rate	-0.03	-0.02	0.05	-0.06
	(0.04)	(0.03)	(0.03)	(0.04)
Policy Rate	0.64***	0.56***	0.13***	-0.05
	(0.03)	(0.03)	(0.02)	(0.03)
Inflation	8.91***	-0.15	7.40**	1.67
	(2.25)	(2.58)	(2.25)	(2.50)
Unemployment	9.39**	-0.62	0.04	9.97***
	(2.91)	(2.14)	(1.61)	(2.14)
LC per USD (Std.)	27.18***	25.67***	17.86***	-16.36**
	(4.84)	(4.86)	(4.04)	(4.91)
Log(Vix)	46.41***	-20.29	-9.10	75.79***
	(8.16)	(13.92)	(7.68)	(11.92)
Log(EPU U.S.)	8.42*	-0.66	-7.01*	16.10***
	(3.82)	(3.91)	(2.79)	(4.15)
Log(EPU Global)	-60.39***	-44.01***	-10.88	-5.50
	(13.69)	(9.62)	(9.32)	(12.88)
Global Ind. Prod.	2.61***	0.36	-1.16*	3.41***
	(0.68)	(0.93)	(0.57)	(0.76)
Fixed Effects	Yes	Yes	Yes	Yes
Lags	4	4	4	4
No. Countries	15	15	15	15
Observations	2194	2194	2194	2194
R^2	0.80	0.75	0.35	0.29

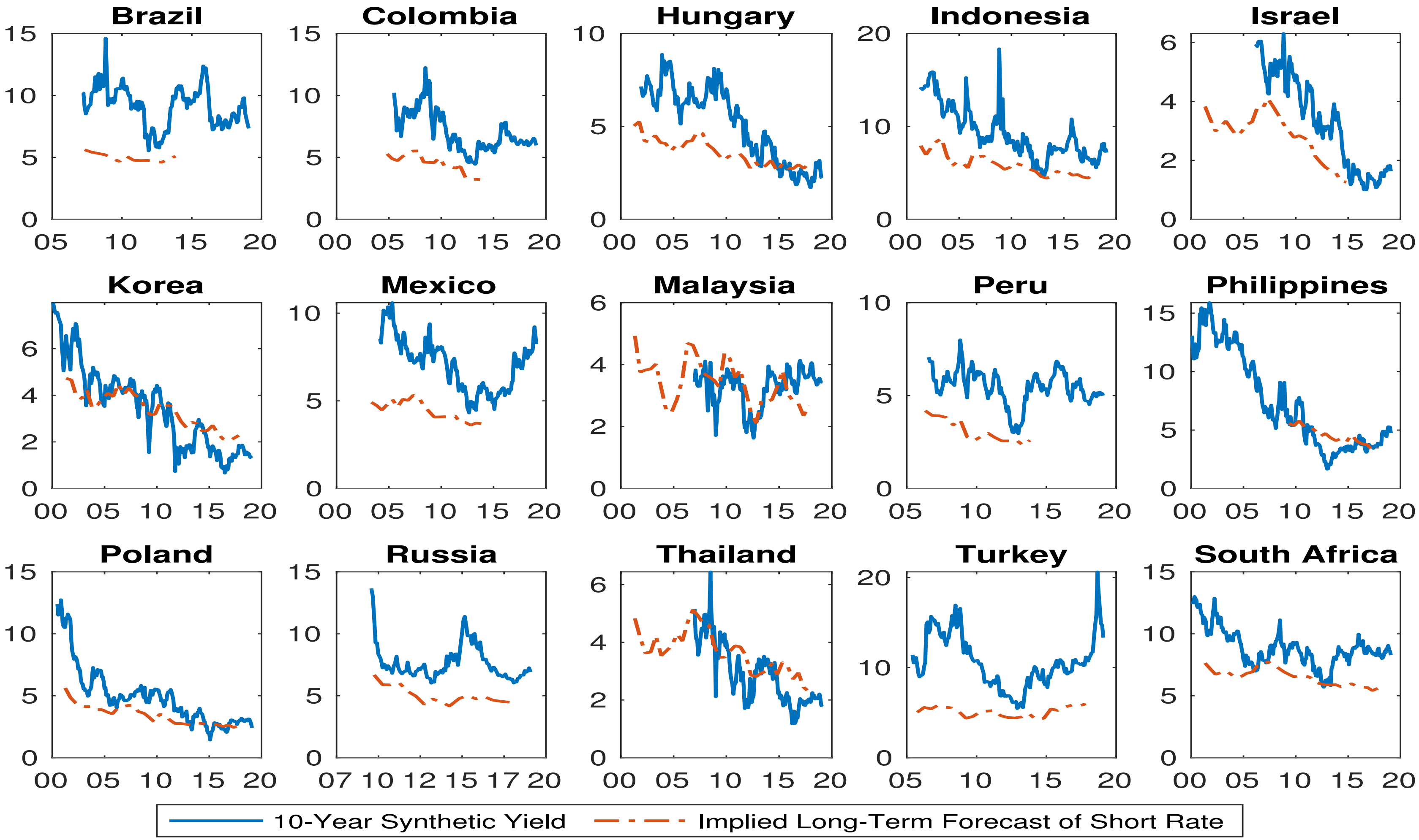
Notes: This table reports the estimated slope coefficients of panel data regressions of the 2-year nominal yield and its components (the expected short rate, the term premium and the credit risk compensation) on selected explanatory variables. The sample includes monthly data for 15 emerging markets starting in 2000:1 and ending in 2019:1. The dependent variables are expressed in basis points. The explanatory variables are the U.S. term premium and the U.S. expected short rate according to Kim and Wright (2005) with the same maturity as the dependent variables, the policy rate, domestic inflation and unemployment, the standardized exchange rate (local currency per USD), the log of the Vix, the log of the U.S. and global economic policy uncertainty indexes based on Baker et al. (2016), the global economic activity index of Hamilton (2019). Driscoll–Kraay standard errors in parenthesis. Lag length up to which the residuals may be autocorrelated is indicated. *, **, *** asterisks respectively indicate significance at the 10%, 5% and 1% level.

Figure 1. Long-Horizon Forecasts of Inflation



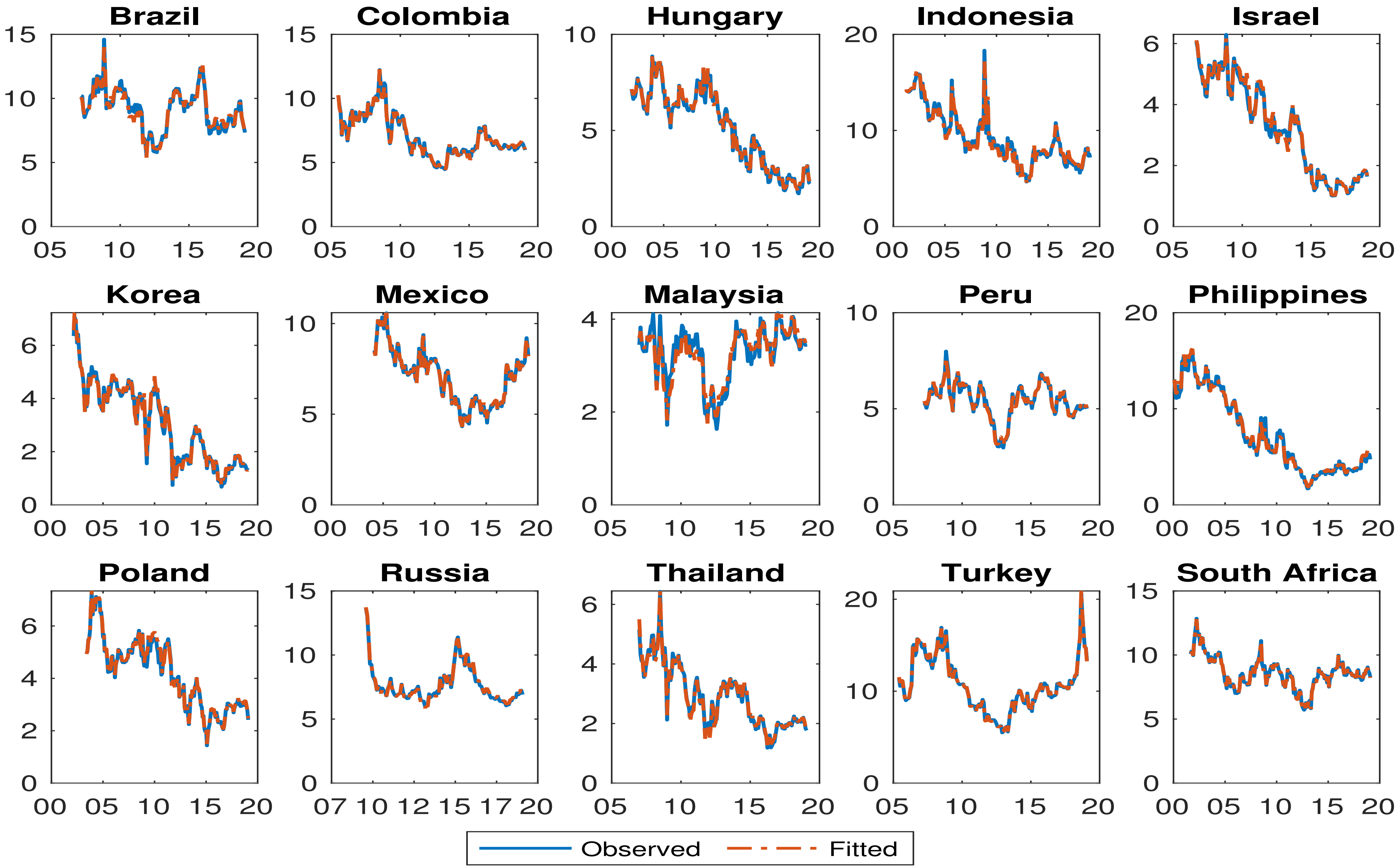
Notes: This figure plots the 5-years ahead (dashed line) and long-term (solid line) average consumer price inflation forecasts against the survey date. For Israel and South Africa, the figure shows the inflation trend, see appendix A. The figure also includes the upper and lower bounds for the domestic inflation target, where applicable. The upper and lower bounds are the most recent ones for each country. For Russia, the plotted band shows the highest and lowest bounds since 2009 since the country has updated its target range almost every year since early 2000s.

Figure 2. 10-Year Synthetic Yields and Long-Horizon Implied Forecasts of the Short Rate



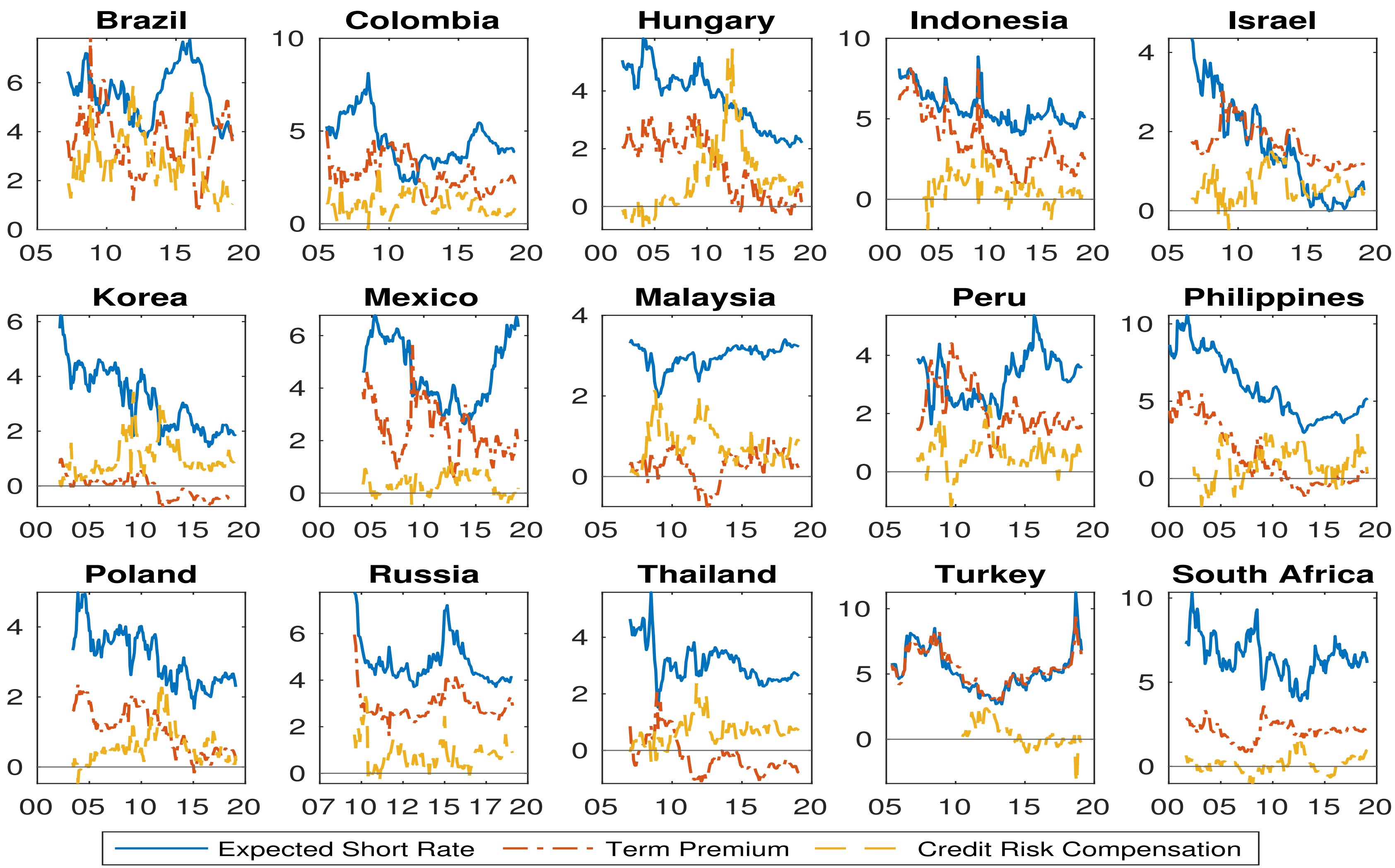
Notes: This figure plots the long-horizon implied forecast of the domestic nominal short-term interest rate (dashed line) and the 10-year synthetic yield (solid line). The implied forecast of the short rate is equal to the forecast of the U.S. real short-term rate plus the domestic consumer price inflation forecast for the same maturity. The forecast of the U.S. real short-term rate is equal to the difference between the forecast of the three-month U.S. Treasury bill rate and the forecast of the U.S. consumer price inflation for the same maturity.

Figure 3. Model Fit for Emerging Markets: 10-Year Synthetic Yields



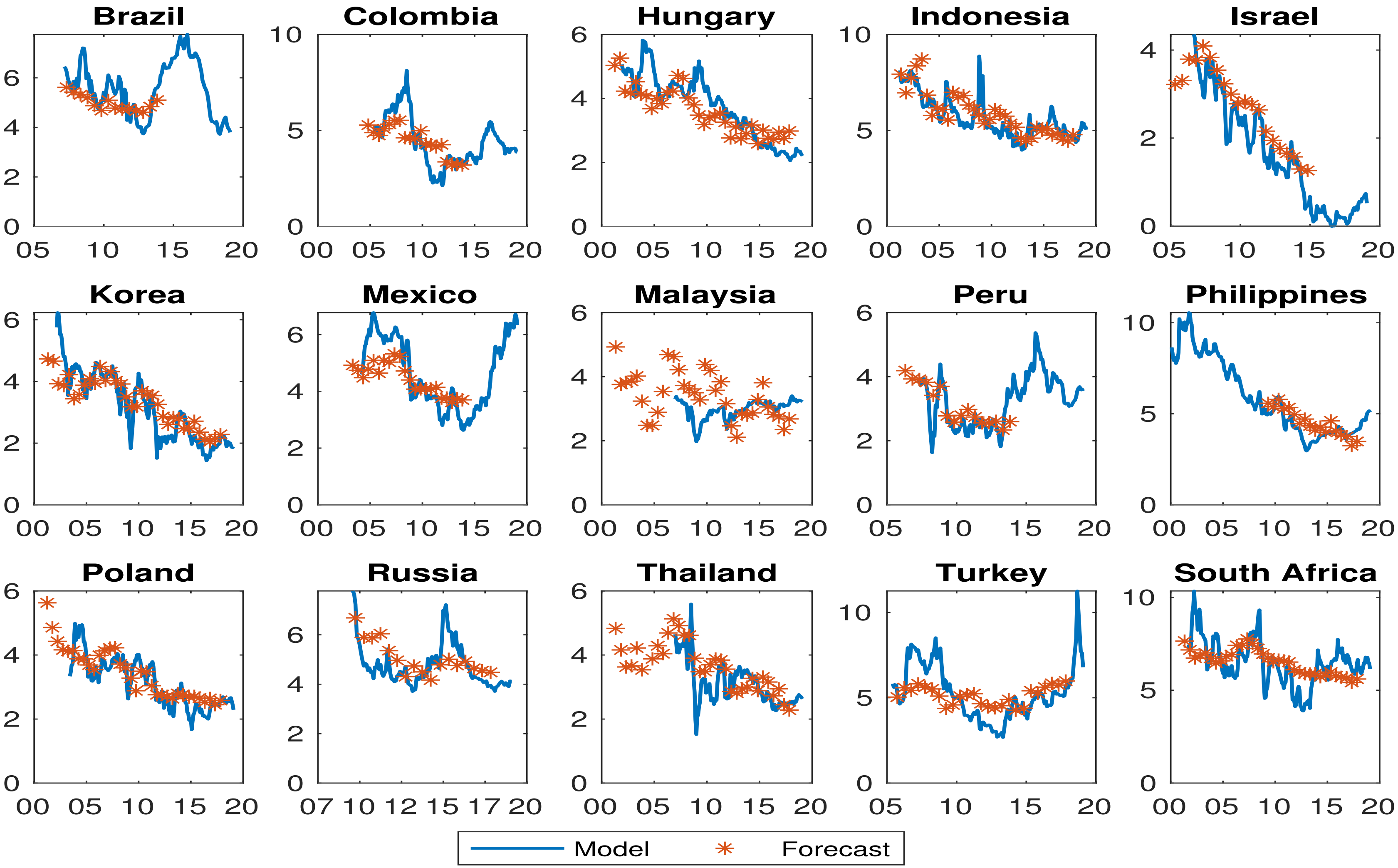
Notes: This figure plots the fitted (dashed line) and the actual (solid line) 10-year synthetic yields. The fitted yield is obtained after estimating the survey-augmented affine term structure model.

Figure 4. Decomposition of the 10-Year Nominal Yields of Emerging Markets



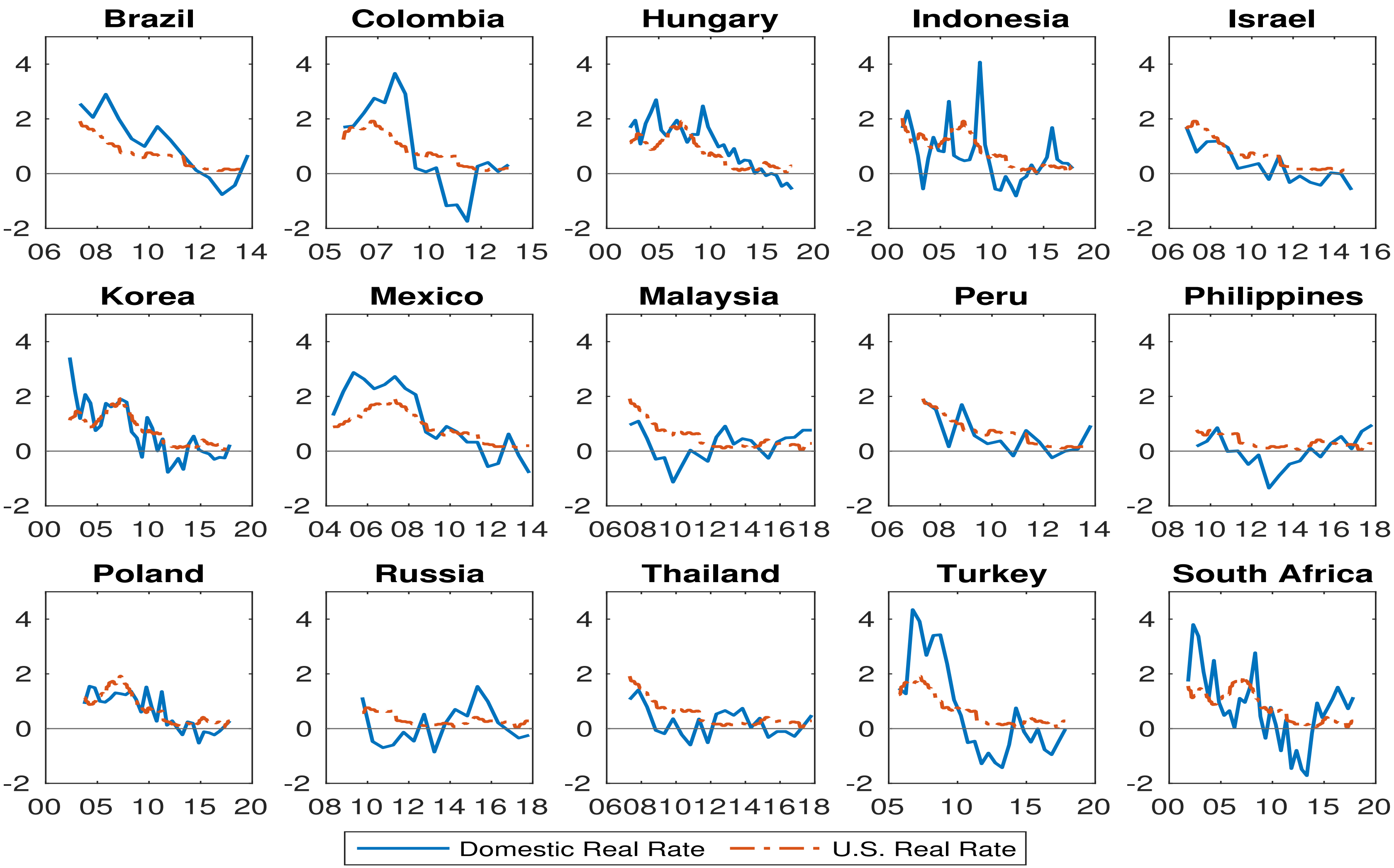
Notes: This figure plots the components of the 10-year nominal yields of emerging markets. The yields are decomposed into an expected future short-term interest rate (solid line), a term premium (dashed line) and a credit risk premium (dashed line).

Figure 5. Long Horizon Forecasts vs Model-Implied 10-Year Expectation of the Short Rate



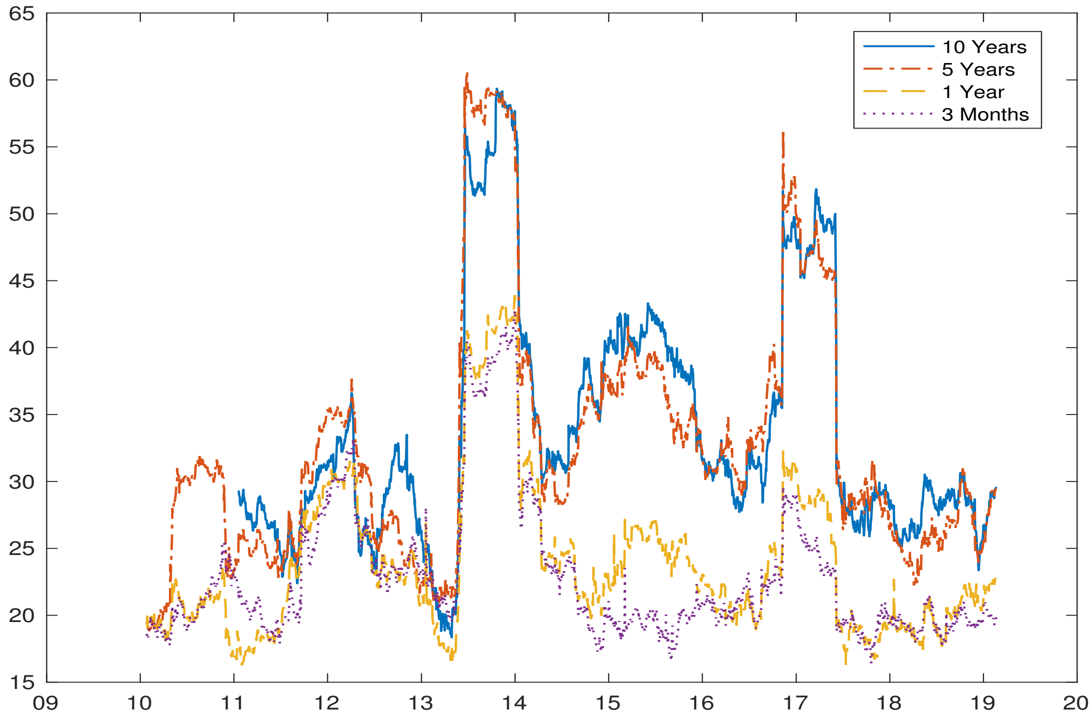
Notes: This figure plots the long-horizon forecast of the domestic short-term interest rate (asterisk) and the model-implied 10-year expectation of the short-term interest rate (solid line).

Figure 6. Model-Implied 10-Year Expectation of the Real Interest Rate

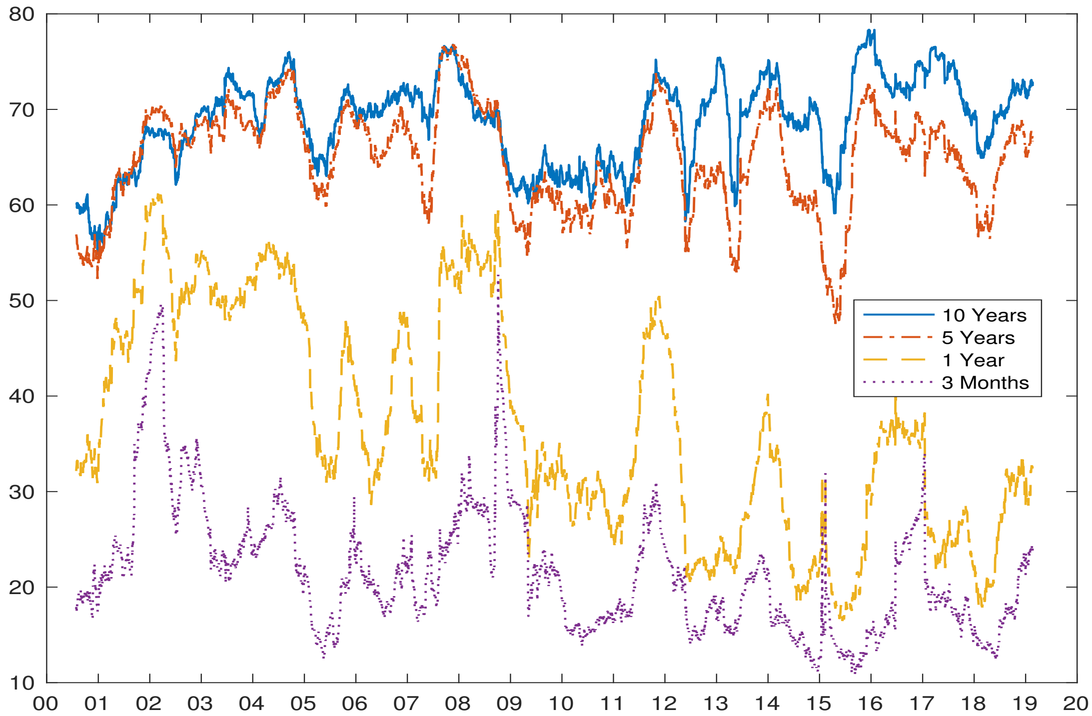


Notes: This figure plots the model-implied 10-year expectation of the domestic real interest rate. The real rate is equal to the difference between the model-implied 10-year expectation of the nominal interest rate and the long-term consensus forecast of consumer price inflation.

Figure 7. Comovement of Yield Curves



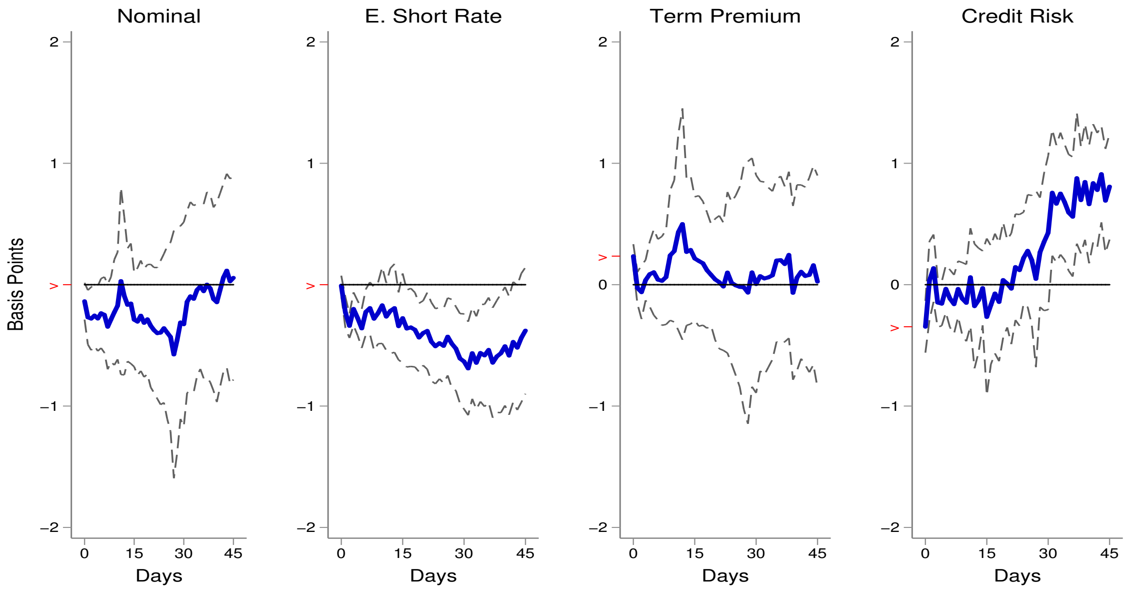
(a) Emerging Markets



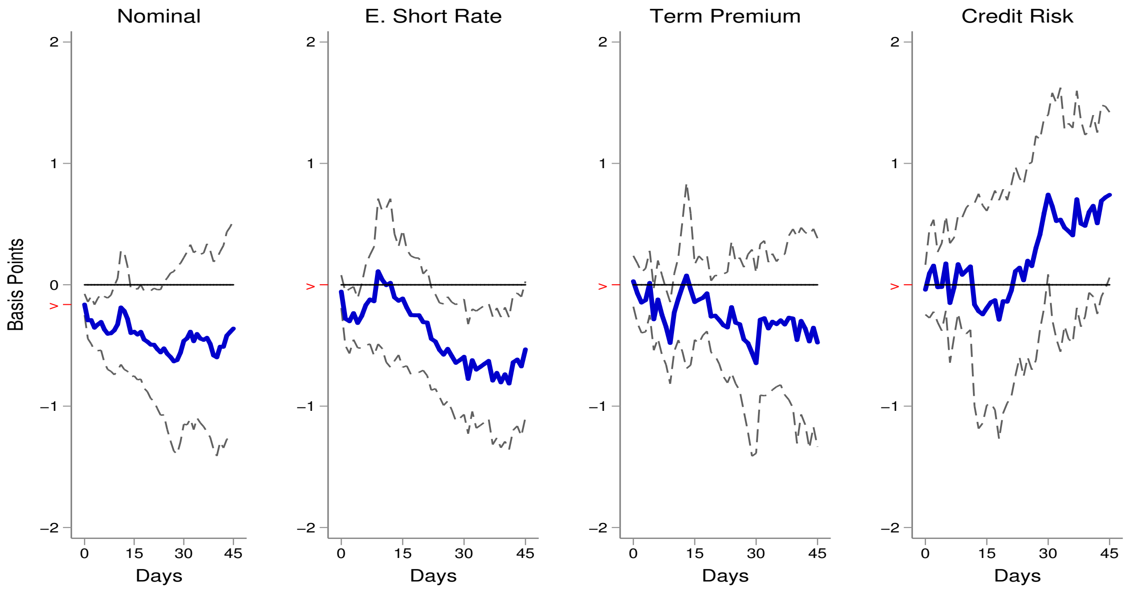
(b) Advanced Countries

Notes: This figure plots the connectedness index of Diebold and Yilmaz (2014) for the nominal yields of emerging markets and advanced countries for different maturities: 10 years (solid line), 5 years (dashed-dotted line), 1 year (dashed line), and 3 months (dotted line). The index is obtained using a vector autoregression of order 1, with a forecast horizon of 10 days and a rolling window of 150 days for the daily changes of the nominal yields each maturity.

Figure 8. Response of the Yield Curve to a Target Surprise



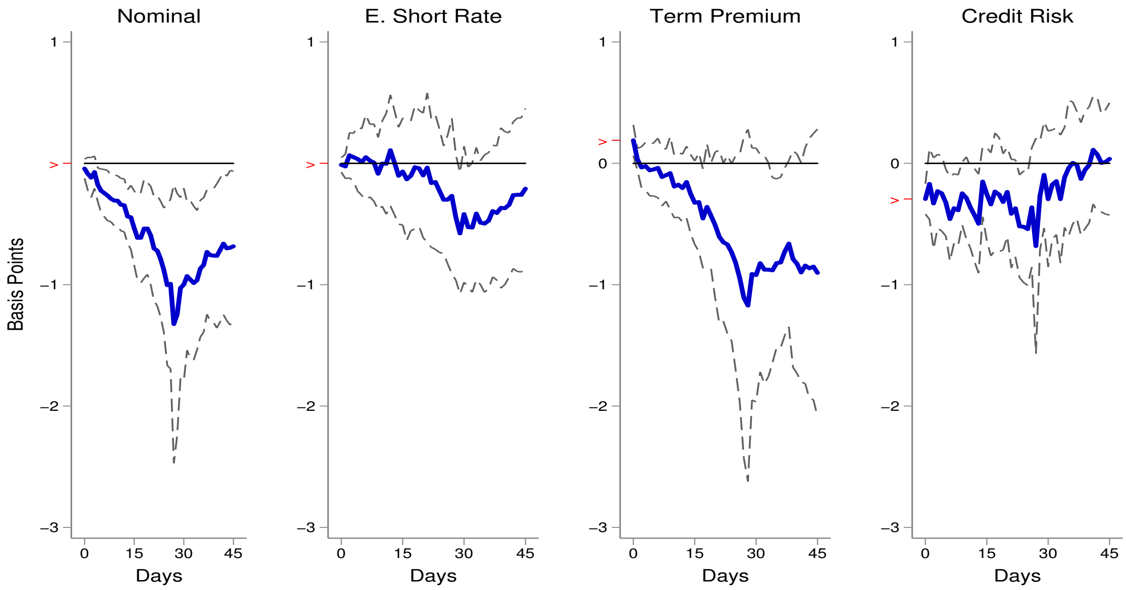
(a) 10-Year Yield



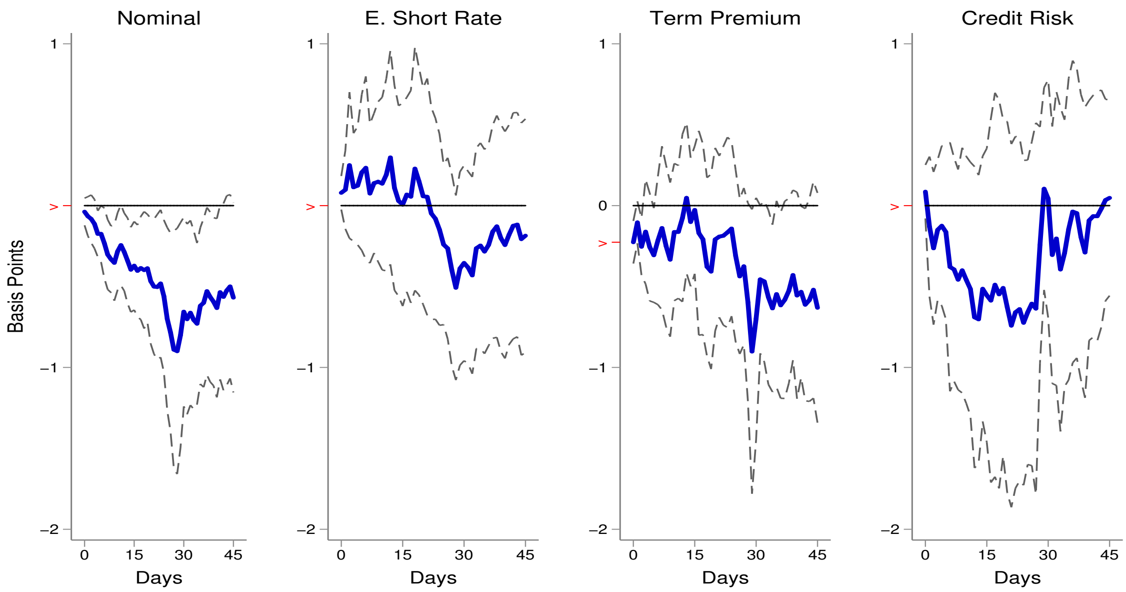
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year emerging market nominal yields and their components to a target surprise. Nominal yields are decomposed into an expected future short-term interest rate, a term premium and a credit risk compensation, see section 4 for details. Target surprises are identified using intraday data around Fed's monetary policy announcements, see section 5.2 for details. The 90% confidence bands are based on Driscoll–Kraay standard errors.

Figure 9. Response of the Yield Curve to a Forward Guidance Surprise: 2000-2008



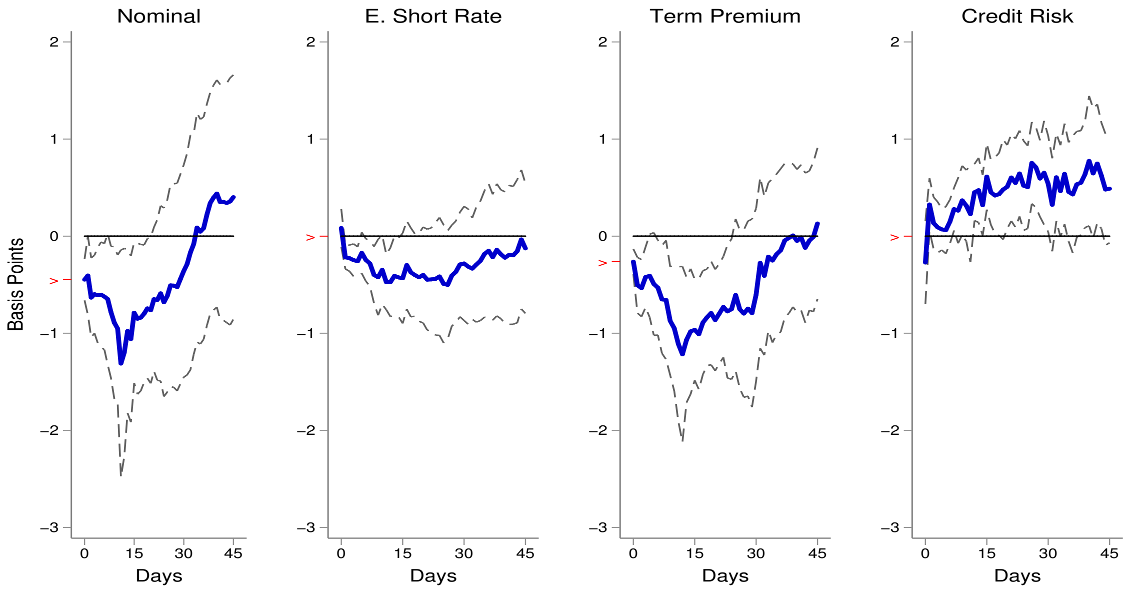
(a) 10-Year Yield



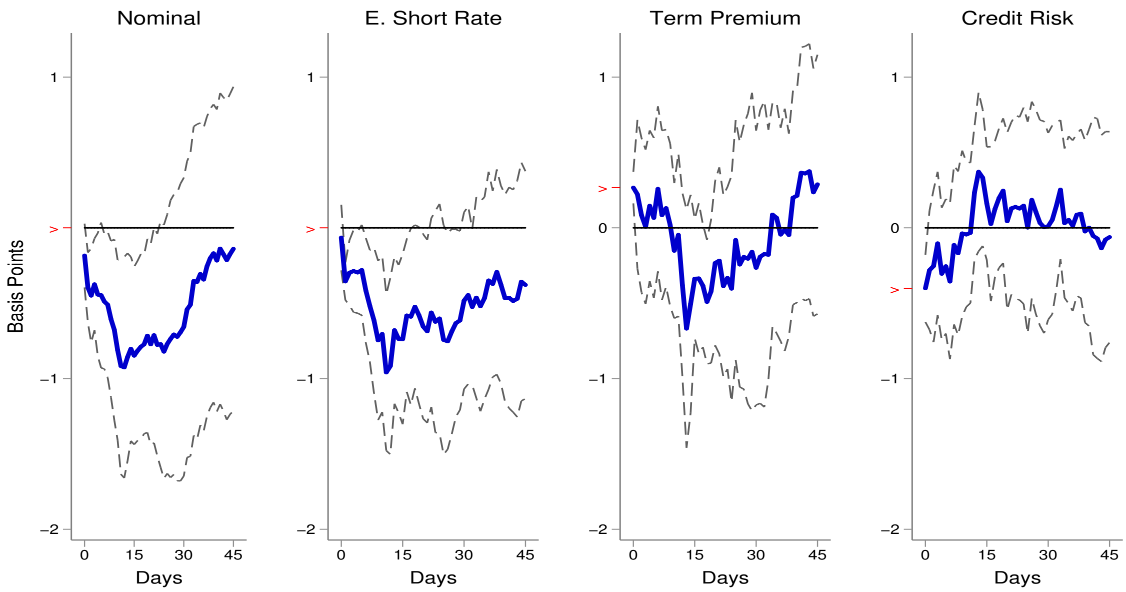
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year emerging market nominal yields and their components to a forward guidance surprise. Nominal yields are decomposed into an expected future short-term interest rate, a term premium and a credit risk compensation, see section 4 for details. Forward guidance surprises are identified using intraday data around Fed's monetary policy announcements, see section 5.2 for details. The 90% confidence bands are based on Driscoll–Kraay standard errors.

Figure 10. Response of the Yield Curve to a Forward Guidance Surprise: 2008-2019



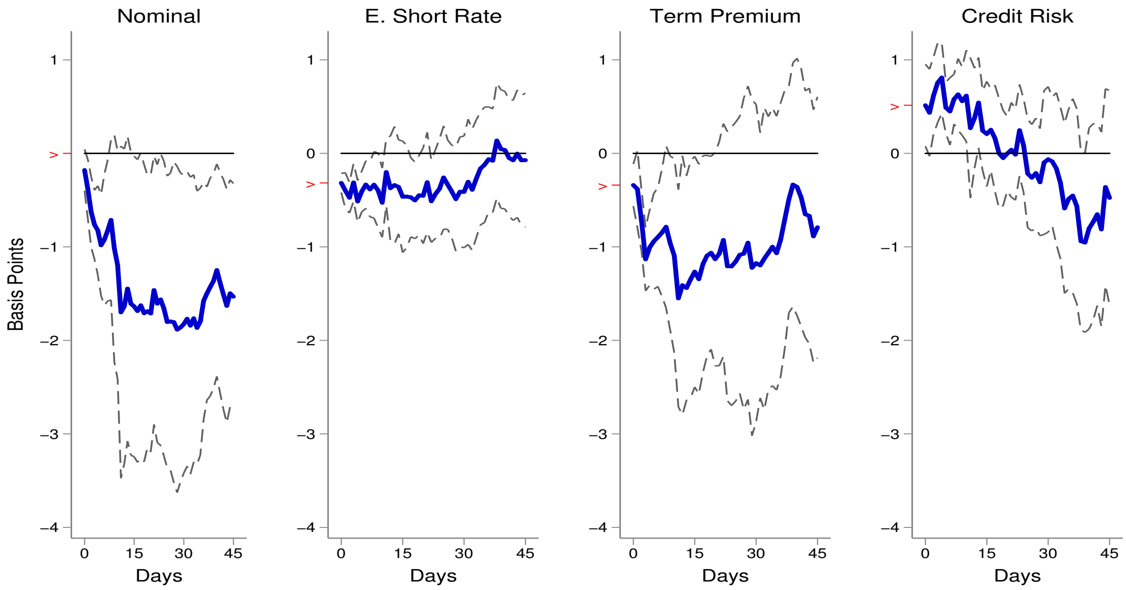
(a) 10-Year Yield



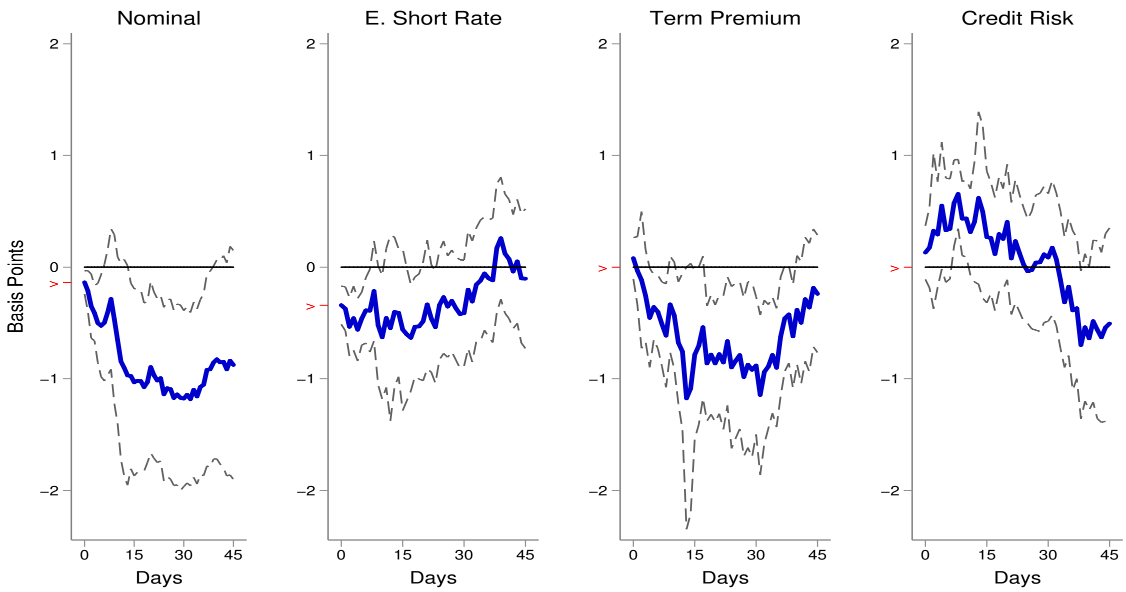
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year emerging market nominal yields and their components to a forward guidance surprise. Nominal yields are decomposed into an expected future short-term interest rate, a term premium and a credit risk compensation, see section 4 for details. Forward guidance surprises are identified using intraday data around Fed's monetary policy announcements, see section 5.2 for details. The 90% confidence bands are based on Driscoll–Kraay standard errors.

Figure 11. Response of the Yield Curve to an Asset Purchase Surprise



(a) 10-Year Yield



(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year emerging market nominal yields and their components to an asset purchase. Nominal yields are decomposed into an expected future short-term interest rate, a term premium and a credit risk compensation, see section 4 for details. Asset purchase surprises are identified using intraday data around Fed's monetary policy announcements, see section 5.2 for details. The 90% confidence bands are based on Driscoll–Kraay standard errors.

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