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

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Abstract

This paper documents the channels through which U.S. monetary policy affects the bond yields of emerging markets. I show that traditional decompositions of sovereign yields are not suitable for emerging markets since they rely on a default-free assumption. Instead, I decompose the yields of 15 emerging markets into an expected future short-term interest rate, a term premium and a compensation for credit risk. I use this decomposition to analyze the transmission channels of U.S. monetary policy surprises identified with intraday data. The response of yields and their components to target, forward guidance and asset purchase surprises is economically significant, yet delayed over days. In general, the surprises spill over to all yield components. U.S. monetary policy therefore leads to a reassessment of policy rate expectations and a repricing of interest and credit risks in emerging markets.

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1 Introduction

[Go2ToC]

U.S. monetary policy has effects beyond its borders, yet the channels through which it influences the sovereign yield curves 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. Traditional decompositions of sovereign yields (a potential solution) are not suitable for emerging markets because they assume that their yields are free of credit risk.

This paper answers the question: how does U.S. monetary policy transmit to sovereign yields with credit risk? Credit risk distinguishes between advanced and emerging countries. Over the last decades, the role of emerging markets in the global economy has increased as well as their reliance on local currency (LC) 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] Therefore, investors holding the LC bonds of emerging markets bear the risk of not receiving the promised payments. I use synthetic LC yield curves to account for credit risk; they essentially swap the U.S. yield curve into a LC 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. The spread between the nominal (or actual) and synthetic yields captures the compensation for credit risk in the LC debt of emerging markets (Du and Schreger, 2016).

The main contribution of this paper is to empirically quantify the transmission channels of U.S. monetary policy to the yields of emerging markets, accounting for the credit risk embedded in them. To achieve this, I decompose the yields of 15 emerging markets into an expected future short-term interest rate, a term premium and a compensation for

[1]Not so long ago, they used to issue bonds at short maturities and in foreign currency. Now, it is more common for them to issue bonds with longer maturities and in LC.

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

[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.

credit risk,[4] using a standard affine term structure model augmented with data on survey forecasts to obtain robust decompositions of the yields (Guimarães, 2014). The credit risk compensation component is characteristic of emerging markets and, to the best of my knowledge, has not been accounted for in the literature that decomposes their yields. The resulting term premium is thus genuine since it is not contaminated by credit risk. I show, for instance, that it is consistent with the view that the term premium compensates investors for bearing inflation uncertainty (Wright, 2011); in fact, the evidence for emerging markets is stronger, in line with the fact that their inflation is more volatile than in advanced countries (Ha et al., 2019). Of course, the three-part decomposition of emerging market yields proposed here can be applied more generally in different contexts (e.g. to analyze the transmission of monetary policy domestically). Here I use the decomposition to analyze the transmission channels of U.S. monetary policy.

The main finding in the paper is that surprises in Fed's policy decisions give rise to a reassessment of policy rate expectations and a repricing of risks in emerging markets. The surprises are identified using intraday data around the Fed's monetary policy announcements, which is by now a well-established strategy to overcome endogeneity concerns because it isolates the surprise component of monetary policy decisions. The responses to target, forward guidance and asset purchase surprises are economically significant, especially in the days following a surprise since the responses are sluggish and amplify over time. The surprises spill over to all yield components, not only the term premium, and including the compensation for credit risk. In particular, I show that investors generally expect central banks in emerging markets to follow the U.S. monetary stance in response to decisions by the Fed. Moreover, easing target surprises are primarily transmitted through lower expected short rates. Additionally, the effects of forward guidance and asset purchase surprises last longer in emerging market yields than in the U.S. Finally, the different responses over time of the yield curves in the U.S. and in emerging markets

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

to the surprises has an influence on the compensation for credit risk.

This paper also documents that, since the global financial crisis, U.S. monetary policy spillovers to emerging markets through a yield curve channel, according to which their monetary autonomy decreases along the yield curve. As argued by Obstfeld (2015), central banks in emerging markets retain their monetary autonomy under a global financial cycle; however, they are limited in what it can achieve.

This paper contributes to different branches of the literature. It pioneers the application of term structure models on synthetic yields, which have been widely used recently to study deviations from covered interest parity (CIP).[5] But instead of concentrating on the CIP deviations, this paper focuses on the synthetic yields themselves to decompose the nominal bond yields of emerging markets more finely. It also contributes to the literature studying sovereign credit risk,[6] but here I focus on bonds denominated in LC. Finally, this paper contributes to the growing literature analyzing the spillover effects of U.S. monetary policy on the LC yields of emerging markets.[7] Hausman and Wongswan (2011) find significant spillovers to LC bond yields, Bowman et al. (2015) meanwhile compare the spillovers of conventional and unconventional monetary policies. The present paper, however, is 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. Nonetheless, this paper is different in a number of dimensions. Most importantly, it accounts for the credit risk embedded in the yields of emerging markets, and considers different types of monetary policy surprises identified with intraday data.

The rest of the paper proceeds as follows. Section 2 explains how to construct the LC yield curves. Section 3 presents the affine term structure model used to decompose the

[5] 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 countries, whereas Du and Schreger (2016) show that they capture a credit risk compensation 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.

[6] To explain sovereign credit risk, Hilscher and Nosbusch (2010) report the relevance of domestic factors, 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.

[7] Rogers et al. (2016) and Rogers et al. (2018) analyze the spillovers on bond yields but focus on advanced countries. Gilchrist et al. (2019) study the effects for advanced and emerging countries but for debt denominated in foreign currency.

yields. Section 4 assesses the yield decompositions. Section 5 analyzes the U.S. monetary policy spillovers to the yields of emerging markets. The last section concludes.

2 Local Currency Yield Curves

[Go2ToC]

This section explains how to construct the nominal and synthetic LC yield curves of emerging markets, and explains that the 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 swap the U.S. yield curve into LC using the forward premium at each maturity (Du and Schreger, 2016) The forward premium compensates investors for the expected depreciation of a currency, an increase in the exchange rate when it is expressed in LC per U.S. dollar (USD), as is used throughout this paper. The key assumption behind this approach is that the U.S. yield curve is free of default risk; as such, it serves as the benchmark for all the other countries in the sample.

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

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

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

In contrast, the actual or nominal zero-coupon yield, $y^{LC}_{t,n}$, can be obtained directly from the quotes of the bonds traded in the market. Notice that the construction of the synthetic yield curve $\widetilde{y}^{LC}_{t,n}$ does not require information about the nominal yield curve $y^{LC}_{t,n}$,[8] as it relies on the U.S. yield curve and XCS rates.

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

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

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

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 are not triggers of CDS.[9] Longstaff et al. (2011) use them to study the sovereign risk in foreign currency denominated debt.

2.2 Construction of Nominal Yield Curves [Go2ToC]

I use the Bloomberg Fair Value (BFV) curves to estimate the nominal yield curve $y_{t,n}^{LC}$. Since these curves report coupon-equivalent par yields, I convert them into continuously-compounded yields (see Gürkaynak, Sack, and Wright, 2007) to obtain the implied zero-coupon curves.[10] This is done for all but two countries for which there are no BFV curves. For Brazil and Israel, Bloomberg provides zero-coupon yields with coupon-equivalent compounding. I also convert these yields, known as IYC curves, into continuously-compounded yields.[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 [Go2ToC]

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

[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 countries—the benchmark for some of the results reported later—and, compared to the BFV curves, the short end of the IYC curves seems disconnected from the rest of the curve for some countries and dates.

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

have adopted an inflation targeting regime.[13] In fact, the central banks in Hungary, 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 countries start no later than September 2001, but 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. Thus, there are 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. This small sample problem is addressed using surveys of professional forecasters 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 countries.

The construction of the LC synthetic yield curves involves data from the U.S. yield curve and the forward premium for different maturities, as explained in section 2.1. Data for the U.S. zero-coupon yield curve is obtained from two sources. For maturities of one through ten years, the yields come from the dataset constructed by Gürkaynak, Sack, and Wright (2007) (hence GSW).[17] Treasury securities with less than one year to maturity are less actively traded than longer-maturity ones. The estimates from the Center for

[13]Although Malaysia does not follow an inflation targeting regime, it has several characteristics that are aligned with such a regime.

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

[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, it starts in July 2009.

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

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

Research in Security Prices (CRSP) are thought to be more robust at the short end of the curve (Duffee, 2010). Specifically, the 3- and 6-month yields are the annualized 13- and 26-week rates (bid/ask average) in the CRSP Risk-Free Rates Series.[18]

As mentioned before, the calculation of the forward premium varies by maturity. For maturities of less than one year, I use data on the spot exchange rate along with 3- and 6-month forwards from Bloomberg for all but three countries; for Korea, Philippines and Thailand the data is obtained from Datastream. To construct the XCS rates, I use data on cross-currency basis swaps and interest rate swaps for each available maturity from one through ten years. The data for the swap curves comes from Bloomberg.[19]

Table 1 reports descriptive statistics for different tenors of the nominal and synthetic yield curves for the emerging and advanced countries in the sample. The yield curves exhibit standard properties; for instance, they are upward sloping. At the same time, the table provides information on how the curves of emerging markets differ from those of advanced countries. First, the level and the volatility (measured by the standard deviation) of their curves are larger than those of advanced countries. Second, 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 indicates that the credit risk compensation is on average positive and 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 for the synthetic yield curves, those dates are the last business days of each month according to the U.S. calendar.

Getting the timing right is key to adequately measure the responses of emerging market yields to U.S. monetary policy surprises. The analysis of monetary policy spillovers

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

[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.

in section 5.3 uses daily changes in nominal and synthetic yields, which need to correctly capture the surprises in Fed announcements. Since the nominal yields reported by Bloomberg are pulled at around 16 hours New York time, they are shifted one day forward for the non-Western Hemisphere countries so that their daily changes adequately capture surprises in Fed announcements. The credit risk compensation for those countries is calculated using the shifted nominal yields.

3 Methodology

[Go2ToC]

This section describes the affine term structure model used to decompose the yield curve of each country in the sample. It discusses the difficulties in estimating the parameters of the model and how survey data helps in the estimation. The robustness of the decomposition is assessed in the next section. This decomposition can be applied in many different contexts. One such application is to analyze the transmission channels of U.S. monetary policy to emerging market yields, which is addressed later in the paper.

3.1 Affine Term Structure Model

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

If there is no arbitrage, there exists a strictly positive stochastic discount factor (SDF) that prices all nominal bonds. Let M_{t+1} be the nominal SDF. 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 of a random variable taken using the actual or physical probability measure, $\mathbb{P}$, that generates the data. The existence of the SDF also implies that there exists a theoretical risk-neutral or risk-adjusted pricing measure, $\mathbb{Q}$—different from the $\mathbb{P}$ measure—that is defined as follows:[20]

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

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

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

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

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, which is written as $\nu_{t+1}^{\mathbb{Q}} | X_t \sim \mathcal{N}_{\mathrm{K}}\left(0, I\right)$.

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

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

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 $A_n = \mathcal{A}(\delta_0, \delta_1, \mu^{\mathbb{Q}}, \Phi^{\mathbb{Q}}, \Sigma, n)$

[20]Since the price at maturity of a zero-coupon bond is 1, recursive substitution of equations (2) and (3) implies that $P_{t,n} = \mathrm{E}_t^{\mathbb{P}} \left[\Pi_{j=1}^{n} M_{t+j} \right] = \mathrm{E}_t^{\mathbb{Q}} \left[\exp\left(-\Sigma_{j=0}^{n-1} i_{t+j} \right) \right]$.

and the $1 \times \mathrm{K}$ vector $B_n = \mathcal{B}(\delta_1, \Phi^{\mathbb{Q}}, n)$ are loadings that satisfy the recursive equations:[21]

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

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

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 a future expected short-term interest rate 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 SDF 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. 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:[22]

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

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:

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

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

[22] The SDF 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 SDF is usually interpreted as the intertemporal marginal rate of substitution.

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.[23]

The term premium for maturity n at time t, $\tau_{t,n}$, can then be estimated as the difference between the yields obtained under the $\mathbb{Q}$ and $\mathbb{P}$ measures:[24]

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

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 $y_{t,n}^{LC}$ is the relevant one for advanced countries, it is not so for emerging markets because it is not free of credit risk. In that case, the synthetic yield curve $\widetilde{y}_{t,n}^{LC}$ better aligns with the risk-free assumption and so with the affine model.

Finally, to ensure that the decomposition adds up, the credit risk compensation is obtained as the spread between the observed nominal yield $y_{t,n}^{LC}$ and the fitted (rather than $\widetilde{y}_{t,n}^{LC}$) yield $y_{t,n}^{\mathbb{Q}}$.

3.1.1 Informational Deficiency

[Go2ToC]

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

This informational deficiency problem owes to the high persistence of bond yields, which results in small sample bias (Kim and Orphanides, 2012). In fact, there might be too few interest rate cycles per country. In that case, the dynamics of the pricing factors will tend to mean-revert too quickly, overestimating the stability of the expected path of the short rate and attributing much of the variability in yields to fluctuations in the term

[23] See Lloyd (2020) for a derivation of the loadings under both measures.

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

premium. The instability in the decomposition of the yield curves of advanced countries is a well-known phenomenon.[25] Guimarães (2014) shows that incorporating survey data on interest rate forecasts in the estimation provides robust decompositions of the U.S. and U.K. yield curves.[26]

Survey data is particularly important to get reliable decompositions for emerging markets since the sample size for these countries is relatively shorter, compared with data from advanced countries. In addition, surveys are also used to obtain a model-free estimate of the term premium, which serves as a robustness check for the one obtained from the model.

3.2 Survey Data [Go2ToC]

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.[27] Figure 1 plots the long-horizon forecasts for inflation. With the exception of Brazil and Turkey, inflation expectations in emerging markets have been stable or even declining, and are generally within the upper and lower bounds for the domestic inflation target.

Although there is no source for long-term forecasts for the short rate of emerging markets, they can be inferred from existing data. For this purpose, I treat emerging markets as small open economies. Specifically, the implied forecasts for the short rate equal the expected average inflation as reported by Consensus Economics, plus the expected global

[25]Different solutions have been proposed in the literature, including 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).

[26]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.

[27]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.

real rate over the same horizon, inferred by a combination of survey forecasts of future short-term U.S. Treasury bill yields and of future U.S. inflation as follows:

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

in which 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.[28] The 5- and 10-year implied forecasts for the U.S. real rate obtained from surveys are closely aligned to the respective zero-coupon real yields derived using U.S. TIPS market data by Gürkaynak et al. (2010);[29] however, TIPS yields are not used as the benchmark due to the well-known liquidity problems of TIPS. 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.[30] The two approaches yield similar values for the implied forecasts for the domestic short-term rates, the correlation between them is 0.75 and 0.83 for the 5- and 10-year tenors, respectively.

I assume that 5-year ahead (implied) forecasts for the short rate of emerging markets

[28] 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.

[29] For the 10-year horizon, the correlation of the two series is 0.91, yet the TIPS series is twice as volatile as the survey series.

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

equal 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)).[31]

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

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

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

3.3 Estimation

[Go2ToC]

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

The JSZ normalization allows for the near separation of the model's likelihood function into the product of the $\mathbb{P}$ and $\mathbb{Q}$ likelihood functions, and reduces the dimension of the parameter space from $(\delta_0, \delta_1, \mu^{\mathbb{Q}}, \Phi^{\mathbb{Q}}, \Sigma)$ to $(i^{\mathbb{Q}}_\infty, \lambda^{\mathbb{Q}}, \Sigma)$, where $i^{\mathbb{Q}}_\infty$ is the short rate under $\mathbb{Q}$ in the long-run and $\lambda^{\mathbb{Q}}$ is a $\mathrm{K} \times 1$ 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 JSZ, I consider that the first three principal components of the yield curve in each country are the linear combinations of yields measured without error, they are

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

usually referred to as the level, slope and curvature of the yield curve.[32]

The affine model is estimated using the JSZ normalization following a two-step procedure. First, the $\mathbb{P}$ parameters are estimated by OLS of the VAR in equation (11) using the K principal components of the yield curve. This provides initial values for the maximum likelihood estimation of the matrix Σ. Then, taking $\widehat{\mu}^{\mathbb{P}}$ and $\widehat{\Phi}^{\mathbb{P}}$ as given, the $\mathbb{Q}$ parameters can be estimated by maximum likelihood.

The estimation uses end-of-month data. The relevant (risk-free) yield curve for advanced countries is the nominal one $y_{t,n}^{LC}$, whereas for emerging markets it is the synthetic one $\widetilde{y}_{t,n}^{LC}$. For advanced countries, only yield data was available. For emerging markets, however, the model is augmented with survey data on the last day of the month for which the data was published.[33] Since yield data is monthly and survey data is available twice a year, the latter 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:

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

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.

[32] 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 countries.

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

On months when survey data is available, the observation equation increases by the number of survey forecasts S as follows:

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

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, $\mathbf{B}^S$ is a $\mathrm{S} \times \mathrm{K}$ matrix with rows equal to B_n^e for $n = 1, \ldots, \mathrm{S}$, $\mathbf{u}_t^S \sim \mathcal{N}_{\mathrm{S}}(0, I)$ and $\mathbf{\Sigma}_S$ is a lower triangular $\mathrm{S} \times \mathrm{S}$ 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 JSZ normalization as initial values for the Kalman filter. Second, I assume homoskedasticity in yields and survey errors, so that $\mathbf{\Sigma}_Y = \sigma_y I_{\mathrm{N}}$ and $\mathbf{\Sigma}_S = \sigma_s I_{\mathrm{S}}$, where I_{N} and I_{S} are $\mathrm{N} \times \mathrm{N}$ 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 helps to discipline the model, they are not a panacea. For instance, surveys might not be representative of market expectations nor of the expectations of the marginal investor, they are also subject to measurement error[34] 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. As such, I follow Kim and Orphanides (2012) and fix σ_s at a conservative level of 75 basis points; as a reference, when σ_s is allowed to be estimated, its average value among all emerging markets is 31 basis points.

3.3.2 Estimating Daily Pricing Factors [Go2ToC]

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

[34] In particular, recall that Consensus Economics does not report long-term forecasts for the short rate of emerging markets, so they were inferred from available data.

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, which is then applied to the daily yields to estimate the daily pricing factors. 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 [Go2ToC]

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

4.1 Model Fit [Go2ToC]

Figure 3 illustrates the fit of the model for the 10-year synthetic yields.[35] 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 countries 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.[36]

[35] I focus on the 10-year maturity to report the results for the sake of brevity.

[36] 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.

4.2 Robustness

Once the model is estimated, it can be used to decompose the yields. However, the relevance of any subsequent application of the decomposition and its ability to provide valuable insights hinges on how reliable it is. To assess the robustness of the decomposition, I compute the standard errors for each component using the delta method. Specifically, since each yield component Ψ is a function of the parameters of the model θ, $\Psi = h(\theta)$, 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 $\widehat{\Omega} = \widehat{\mathcal{H}_\theta}^{-1}$, where $\widehat{\mathcal{H}_\theta}$ is the the second derivative matrix of the log-likelihood function evaluated at the optimum and is also calculated numerically.

In practice, after the estimation, there is uncertainty in both the parameters and the pricing factors; however, the effect of uncertainty associated with the pricing factors on each component is relatively small. To assess 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. The average standard error over time and across emerging markets is less than 9 basis points for the fitted yields and their components; for advanced countries, the average standard error is less than 3 basis points. Therefore, I assume that the pricing factors are known with certainty and proceed to apply the delta method as explained in the previous paragraph.

Figures 4 and 5 illustrate the benefits of using survey data for emerging markets. They display the term premium and the credit risk compensation along with their confidence bands of ±2 standard errors.[37] In general, surveys help to obtain robust decompositions, consistent with the findings of Guimarães (2014) for the U.S. and the U.K.

[37] The confidence bands for the expected future short term interest rate are shown in the appendix. Equivalent information, however, is reported in figure 7.

4.3 Decomposition Assessment

[Go2ToC]

Figure 6 shows the decomposition of the 10-year yields of emerging markets.[38] Two patterns immediately emerge from the figure. First, the main component of the nominal yields of most countries is the expectation of the future short rate, for which a downward trend over the sample period can be seen for most of the countries, consistent with evidence for advanced economies (Adrian et al., 2019). Second, the credit risk compensation and the term premium are time-varying and both play an important role in the dynamics of emerging market yields. In general, the term premium plays a relatively bigger role than the credit risk compensation in explaining yield variation for most countries, but the relative importance of the two components varies by country and can even change over time, as can be seen for Hungary and the Philippines.

4.3.1 Expected Future Short Rate

[Go2ToC]

Figure 7 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 to assess the monetary stance in a country and the suitability of the central bank's monetary policy decisions. Since the implied long-term forecasts for the short rate are based on the long-term U.S. real interest rate (see section 3.2), the expected future *real* interest rate—the difference between the future expected short rate implied by the model and the domestic long-term inflation forecast—should be similar across countries. Figure 8 verifies this. It shows that, once correcting for credit risk and inflation, the real interest rates of emerging markets fluctuate near zero. This is consistent with estimates of the real rate for advanced countries. Holston

[38] The decomposition for advanced countries is not displayed for two reasons. First, it has already been studied previously, see for instance Wright (2011) and Adrian et al. (2019). Second, the dataset does not include survey data for advanced countries and so their decompositions may not be robust. They are, however, used as a benchmark to assess some results (e.g. fitting errors).

et al. (2017) show that real interest rates in those countries have converged toward zero over the last decades, making their central banks more likely to be constrained by the zero lower bound.

4.3.2 Term Premium [Go2ToC]

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

The survey-based term premium is commonly used as a model-free measure to assess the term premium obtained from the model, which here is calculated as 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 7), the two measures of term premia comove positively, the correlation between the two across countries is 0.52.

Wright (2011) documents a downward trend in the term premia of advanced countries and argues that it owes in part to a reduction in inflation uncertainty. Figure 4 shows that, after correcting for credit risk, the term premia in some emerging markets decreased over the sample period. Since inflation in emerging markets tends to be higher and more volatile than in advanced countries (Ha et al., 2019), it is reasonable to assume that the relationship between the term premia and inflation uncertainty is even more relevant in emerging markets than in advanced countries. To test this hypothesis, I run panel regressions of the model-implied term premium on a measure of inflation uncertainty, namely the standard deviation of the permanent component of inflation based on the unobserved components stochastic volatility (UCSV) model proposed by Stock and Watson (2007). The UCSV model assumes that inflation has permanent and transitory components subject to uncorrelated shocks that vary over time. Following Wright (2011), I fit the UCSV model to quarterly data for each country. To test for significance, I use the Driscoll–Kraay estimator that allows the errors to be correlated across countries and over time.[39]

Table 3 reports the coefficient estimates for different tenors. The standard deviation of the permanent component is significant for medium- to long-term maturities, and its effect increases with maturity. Further, the result becomes stronger after controlling for the business cycle (proxied by the real GDP growth in each country). However, it is important to acknowledge that the specification might be subject to econometric problems since it involves persistent variables and ignores the fact that the regressor of interest is estimated. The result is nonetheless at least aligned with the view that the term premium in emerging markets compensates 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 different advanced countries before and, especially, after the global financial crisis. Figure 4 shows that negative term premia are not restricted to advanced countries. In particular, some emerging Asian countries seem to have experienced episodes of negative term premia in the long end of their yield curves after the global financial crisis. When compared across maturities, two patterns stand out (see figure D.1 in the appendix). First, term premia tend to increase with maturity, indicating that longer-term bonds are seen as riskier than short-term bonds. Second, different countries experienced negative term premia but at the short end of their yield curves, suggesting that international and domestic investors in LC bond markets seem to have had a particular preference for short-term LC bonds after the global financial crisis.

4.3.3 Credit Risk Compensation [Go2ToC]

The dynamics of the credit risk compensation 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. Unlike the term premium, no clear trend is visible for the credit risk compensation, nor a pattern is detected when looking across maturities.

The role of the credit risk compensation in explaining yield variation is non-negligible,

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

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. Nevertheless, although far from perfect, it is a valid measure of credit risk, and 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 decompose the 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.[40] In the data, the term premium and the credit risk compensation are negatively correlated as is the case between the future expected short rate and the credit risk compensation. This evidence 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 or default, which can be referred to as implicit and explicit defaults, respectively. They could be seen as substitutes if inflating away the debt reduces the need to default. Indeed, a trade-off between explicit and implicit defaults in emerging markets is not discarded by the data.

5 U.S. Monetary Policy Spillovers

[40] On 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 future expected short rate and the *expected* component of the credit risk compensation are likely to move in opposite directions.

[Go2ToC]

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

5.1 The Yield Curve Channel

[Go2ToC]

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 a financially-open country to insulate its economy from shocks abroad. Rey (2013) argues that even a flexible exchange rate does not fully offset financial shocks from abroad and that, in fact, 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 countries oriented to have an effect on long-term yields, like forward guidance and quantitative easing, spillover abroad via, for instance, the term premium.[41] Due to the high comovement of long-term yields, unconventional monetary policies reduce the monetary autonomy of emerging markets along the yield curve. That

[41] 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 spillover into the term premia of emerging markets.

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.

To formally assess whether whether some nodes of the yield curve comove more than others, I use the connectedness index developed by Diebold and Yilmaz (2014), which 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.[42] Figure 9 plots the connectedness index for different maturities. It reveals that the long end is indeed more connected than the short end in advanced countries and more recently in emerging markets—since the taper tantrum episode of 2013. Although the connectedness of the short end is similar between the two groups of countries, the degree of comovement of the long end in emerging markets is half (around 35%) the level of advanced countries (around 70%). The difference in connectedness is therefore driven by the medium and long end of their yield curves. Kolasa and Wesołowski (2020) report that the share of foreign investors in the sovereign bond markets of emerging economies increased from 10% in 2008 to 25% in 2019. Nevertheless, figure 9 suggests that the medium- and longer-term bonds of emerging markets are mostly held by local investors, which means that local factors would still play a role in explaining the long end of their curves.

The yield curve channel requires 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. future expected short rate) in explaining the yields of emerging markets at different maturities. Further, I use the three-part decomposition of those yields to see whether it passes through to the term premia in emerging markets exclusively and/or through the other components. In fact, the assessment of the

[42]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.

yield curve channel would be limited without the decomposition. For this purpose, I run the following panel regressions

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

in which α_i are country fixed effects, $z_{i,t}$ is a vector of global and domestic variables that likely drive the yields, including the components of the U.S. yield curve, 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.[43] To test for significance, I use the Driscoll–Kraay estimator that allows the errors to be correlated across countries and over time.[44]

For the explanatory variables of interest, I use 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.[45] Baker et al. (2016) construct a news-based economic policy uncertainty (EPU) index,[46] I use the global and U.S. versions of the EPU index as alternative, and arguably exogenous, measures of global uncertainty. The index of economic activity based on world industrial production proposed by Hamilton (2019) is included to capture global real economic activity. 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.

[43] 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.

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

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

[46] 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.

The evidence in tables 4 and 5 is in line with the yield curve channel.[47] First, the response of the future expected short rate 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 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 test directly the thesis in Kalemli-Özcan (2019) explained above thanks to the yield decompositions. There are indeed risk spillovers to the future expected short rate of emerging markets, they 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 because if it had been ignored, it would have actually altered the conclusions on direct and cross effects between the components of the yields. 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 premia and the credit risk compensation, but not with the expected future

[47] 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.

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.[48] Lastly, there is evidence on the risk-taking channel of exchange rates, according to which a currency appreciation is associated with easier financial conditions (and compressed sovereign bond spreads) due to balance sheet effects.[49] 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 (15) may suffer from econometric problems such as persistent variables, reverse causality and omitted variables. These issues are addressed next.

5.2 Identification of Monetary Policy Surprises [Go2ToC]

The surprises in monetary policy decisions are identified using high-frequency 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.[50] In days with no FOMC meeting, the surprises are set to zero. The dataset does not include releases of minutes and speeches by Fed officials, only monetary policy announcements.

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

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

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

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

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 a regression of the yield change of the 8-quarters ahead Eurodollar futures contract on the target surprise.[51] 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, asset purchase surprises are considered from October 2008 onwards. Forward guidance surprises have nevertheless been relevant before and after the global financial crisis.[52] Table C.3 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, thus easing surprises are larger on average and more common than tightening surprises.

5.3 The Effects on Emerging Market Yields [Go2ToC]

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.[53] Event studies would report the response of the variables on the day of the surprise. Local projections are preferred in this context because they additionally provide the responses over subsequent

[51] 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.

[52] 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).

[53] 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.

periods. In fact, given the pervasive post-announcement drift in the bond markets of advanced economies documented by Brooks et al. (2019), it is reasonable to assume that a similar phenomenon of slow-moving capital is present in emerging markets. Finally, to understand the transmission of the Fed's decisions to the yields of emerging markets, I leverage on the yield decompositions at the daily frequency.

I run the following panel local projections:

$$y_{i,t+h} - y_{i,t-1} = \alpha_{h,i} + \sum_{j=1}^{3} \beta_h^j \epsilon_t^j + \gamma_h \Delta y_{i,t-1} + \phi_h s_{i,t-1} + u_{i,t+h}, \tag{16}$$

in which h indicates the horizon (in days) with $h = 0, 1, \ldots, 45$, $\alpha_{h,i}$ are country fixed effects, each ϵ_t^j represents one of the three types of monetary policy surprises,[54] $s_{i,t-1}$ is a one-day lag in the exchange rate (LC per USD) and $u_{i,t+h}$ is the error term. 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 one of its components) to monetary policy surprise j at horizon h.[55] 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 are used as a benchmark to assess the responses of the yields of emerging markets,[56] they are reported in appendix D. The responses are consistent with results reported in the existing literature. For instance, target easing surprises reduce yields, mainly driven by a decline in the future expected short rate. Meanwhile, forward guidance and asset purchase easing surprises decrease yields, in part due to reduction in the term premium.

5.3.1 Target Surprises

[54] By definition, the surprises are unanticipated by the market, so there is no need to control for past or future surprises. At the same time, although there is no need to control for the other types of surprises (since they are uncorrelated by construction), the estimation is more efficient when all the surprises are included simultaneously.

[55] The contemporaneous effects of the surprises is what would be reported under an event study methodology, and would be obtained here by setting $h = 0$ in equation (16).

[56] 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).

Figure 10 shows the response of the yield curve in emerging markets to a target surprise. First of all, the magnitude of the initial response in emerging markets is lower than the response of U.S. yields. However, the response increases over time. This delayed response has been documented by Brooks et al. (2019) for the U.S. and by Adrian et al. (2019) for a sample comprised mostly by advanced countries. Brooks et al. (2019) attribute the delayed response to a portfolio rebalancing channel. This delayed reaction is also seen for forward guidance and asset purchase surprises, as explained later.

Following a target surprise, the yield curve of emerging markets steepens because the surprise reduces the short end of the yield curve but not the long end, like in the U.S. One implication of the yield curve channel is that central banks in emerging markets are limited to influence the long end of their yield curves following a monetary policy surprise in the U.S. The results show that investors expect central banks in emerging markets to follow the Fed's decision. Indeed, the response to a target easing surprise is essentially driven by the expected short rate. However, there is no material difference in the response of that component across maturities. In fact, what transpires is a parallel reduction in the expected short rate across maturities.

The three-part decomposition of the yields makes clear that the credit risk compensation is a factor that needs to be taken into account when assessing the transmission of U.S. monetary policy to emerging markets. Figure 10 also reflects that the long end of the U.S. and the synthetic yield curves decline relatively more than that of the nominal one. Intuitively, these effects reduce the cost of borrowing in LC at the risk-free rate relatively more, emerging markets are thus comparatively more risky. The credit risk compensation at the long end increases by about 100 basis points one month after the surprise.

In sum, economically significant spillovers from easing target surprises build over time reducing the expected future short rate and increasing the long term credit risk compensation of emerging markets. Fed policies can therefore have fiscal implications, which have not been previously discussed in the literature. Target surprises have no significant effects on the term premia. Thus, term premia are not the only channel through which spillovers limiting the monetary autonomy of emerging markets at the long end can happen.

5.3.2 Forward Guidance Surprises

[Go2ToC]

Given that the U.S. monetary policy spillovers to long-term yields have increased substantially after the global financial crisis (Albagli et al., 2019), figures 11 and 12 display the responses of the emerging market yields to a forward guidance surprise before and after October 2008, respectively.

Before the global financial crisis, a forward guidance easing surprise led throughout the month to a parallel shift downward in the yield curves of emerging markets. In general, investors did not expect central banks to follow the Fed's decision. The response was mainly driven by a lower term premium, also parallel across maturities, and lasted longer in emerging market yields than in the U.S.

After the global financial crisis, the transmission of forward guidance surprises has changed but it does not seem that spillovers to nominal yields increased (in term of magnitudes). The decline in the long end of the yield curves of emerging markets is shorter than that at the short end. The downward shift is thus not longer a parallel one, so the yield curve steepens over the month. Similarly, the decline relative to the long end of the U.S. yield curve is also shorter; as a result, emerging markets become relatively more risky, which is reflected in an increase in the credit risk compensation at the long end.

Finally, a forward guidance easing surprise reduces the term premia at the long end and the expected short rate at the short end—investors expect the central banks to follow the Fed's decision. This is consistent with the risk spillover mechanism of the yield curve channel (Kalemli-Özcan, 2019), . Also in line with that channel, the response of the term premia at the long end is larger than at the short end.

In sum, figures 10 and 11 show that before the global financial crisis the yield curve channel was not at play, or at least not working through the expected future short rate or the term premia, but through the credit risk compensation. Meanwhile, figure 12 is consistent with the yield curve channel. Figure D.8 in appendix D shows that the conclusions here are not driven by the response of the forward premium.[57]

5.3.3 Asset Purchase Surprises [Go2ToC]

Figure 13 display the response of the yield curve of emerging markets to an asset purchase surprise. According to the response of the expected future short rate, investors expect the central banks in emerging markets to follow the Fed's move in terms of direction but in a much smaller magnitude.

Although the on-impact effect is larger in the U.S. yields, it lasts longer in emerging market yields. In both cases, the effect on the long end of the curve is notably larger than at the short end. Thus, an asset purchase easing surprise flattens both yield curves, but due to the delayed response in emerging markets, the credit risk compensation increases following the surprise. The response of the credit risk compensation to an asset purchase surprise is not only due to the delayed effect in emerging countries. It also reflects the reaction of investors in the U.S. Treasuries market since the long-term U.S. yield declines more than one-to-one following the surprise. More broadly, the responses of the credit risk compensation to the three types of monetary policy surprises indicate that the direction of the response depends on the type of surprise. Further, it can revert over time, which would explain the negative correlation reported in section 4.3.3.

Similar to the response to a forward guidance surprise 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 short end. Also, the response of the term premia at the long end is larger than at the short end.

In general, although figures 12 and 13 are consistent with the yield curve channel, figure 11 is not.[58] That is, the yield curve channel is a relatively recent phenomenon.

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

[58] Target surprises are not included in this comparison since the yield curve channel involves the response of the long-term yields, yet the long end of the yield curve does not significantly respond to a

6 Concluding Remarks

[Go2ToC]

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. This decomposition is robust.

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. The responses to target, forward guidance and asset purchase surprises are economically significant, especially in the days following a surprise since the response is sluggish and amplifies over time. The surprises spill over to all yield components, not only the term premium, and including the compensation for credit risk.

This paper also documents that since the global financial crisis, the U.S. monetary policy has spillovers to emerging markets through a yield curve channel, according to which their monetary autonomy decreases along the yield curve.

The work presented here can be extended in several directions. Among the many applications of the decomposition of emerging market yields is to analyze the transmission of monetary policy domestically, to inform theoretical models for pricing sovereign defaultable bonds and to further decompose each part (e.g. the future expected rate into an inflation expectation and an expected real interest rate). Regarding spillovers, monetary policy surprises from other central banks (e.g. European Central Bank) can be included in the analysis.

target surprise (see figure 10).

Table 1. Descriptive Statistics of Yield Curves

		3M	6M	1Y	2Y	5Y	10Y
Nominal Yields				Emerging Markets			
	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
Synthetic Yields				Emerging Markets			
	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. All cases include country fixed effects. 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 Rirsk
U.S. Term Premium	1.01***	0.57***	0.88***	-0.44***
	(0.14)	(0.08)	(0.08)	(0.11)
U.S. E. Short Rate	0.23*	0.31***	0.12*	-0.20***
	(0.09)	(0.05)	(0.06)	(0.06)
UCSV-Perm	-63.81***	-52.88***	-41.07***	30.14*
	(17.42)	(14.37)	(10.33)	(13.49)
Policy Rate	0.25***	0.30***	0.01	-0.07***
	(0.03)	(0.02)	(0.02)	(0.02)
Inflation	16.20***	2.67	7.78***	5.75***
	(2.63)	(1.72)	(1.44)	(1.68)
Unemployment	25.78***	2.77	12.02***	10.98***
	(3.43)	(2.07)	(1.61)	(2.03)
LC per USD (Std.)	40.02***	31.69***	20.92***	-12.59***
	(5.26)	(3.22)	(2.92)	(3.61)
Log(Vix)	59.49***	-12.44	36.16***	35.77***
	(13.10)	(10.47)	(10.71)	(9.68)
Log(EPU U.S.)	7.87	-3.10	0.05	10.92**
	(5.61)	(2.64)	(2.73)	(3.93)
Log(EPU Global)	-63.04**	-40.30***	-20.82	-1.92
	(20.09)	(6.46)	(11.26)	(10.77)
Global Ind. Prod.	0.96	0.56	-0.29	0.69
	(1.03)	(0.86)	(0.41)	(0.93)
Fixed Effects	Yes	Yes	Yes	Yes
Lags	4	4	4	4
No. Countries	15	15	15	15
Observations	2192	2192	2192	2192
R^2	0.69	0.72	0.49	0.24

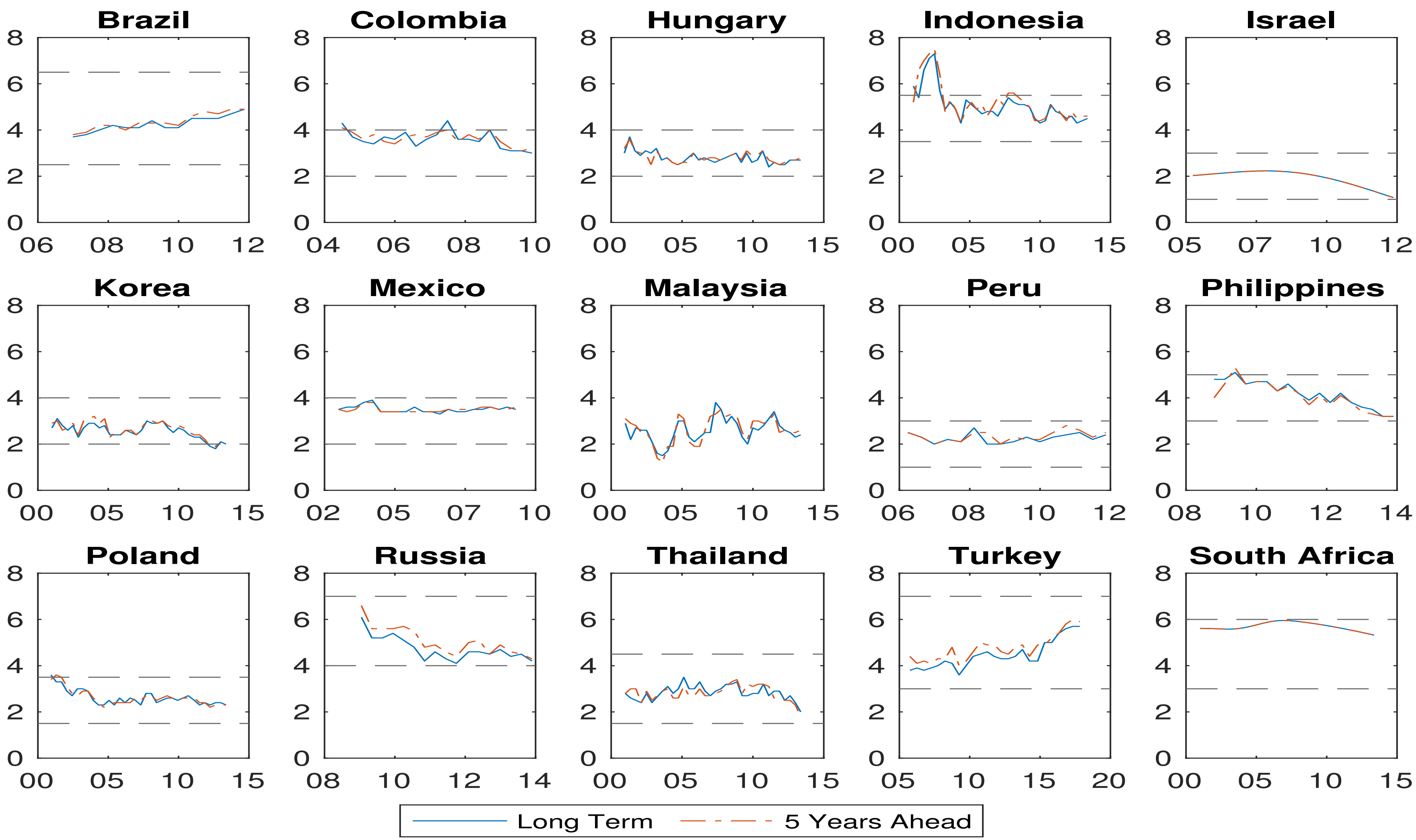
Notes: This table reports the estimated slope coefficients of panel data regressions of the 10-year nominal yields and their components on selected explanatory variables. The sample includes monthly data for 15 emerging markets starting in 2000:1 and ending in 2019:1. The dependent variables are the nominal, the expected short rate, the term premium and the credit risk compensation. All 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 activity index based in industrial production from 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 Rirsk
U.S. Term Premium	1.74***	1.85***	0.63***	-0.74***
	(0.24)	(0.17)	(0.17)	(0.21)
U.S. E. Short Rate	-0.01	0.00	0.05	-0.07*
	(0.04)	(0.03)	(0.03)	(0.03)
UCSV-Perm	-62.91**	-71.73***	-22.55*	31.37*
	(20.81)	(18.47)	(11.35)	(15.39)
Policy Rate	0.64***	0.56***	0.13***	-0.05
	(0.03)	(0.03)	(0.02)	(0.03)
Inflation	10.26***	1.25	7.82***	1.19
	(2.45)	(2.44)	(2.27)	(2.30)
Unemployment	11.60***	1.82	0.80	8.97***
	(2.81)	(1.88)	(1.57)	(1.93)
LC per USD (Std.)	24.40***	22.73***	16.94***	-15.27***
	(4.85)	(4.89)	(3.89)	(4.43)
Log(Vix)	57.50***	-7.64	-5.02	70.15***
	(9.96)	(14.34)	(8.19)	(12.44)
Log(EPU U.S.)	9.85*	1.08	-6.64*	15.41***
	(3.81)	(3.74)	(2.70)	(4.17)
Log(EPU Global)	-64.80***	-49.19***	-12.44	-3.17
	(13.26)	(8.93)	(8.95)	(12.71)
Global Ind. Prod.	2.27***	0.04	-1.26*	3.49***
	(0.66)	(0.92)	(0.57)	(0.78)
Fixed Effects	Yes	Yes	Yes	Yes
Lags	4	4	4	4
No. Countries	15	15	15	15
Observations	2192	2192	2192	2192
R^2	0.80	0.76	0.35	0.30

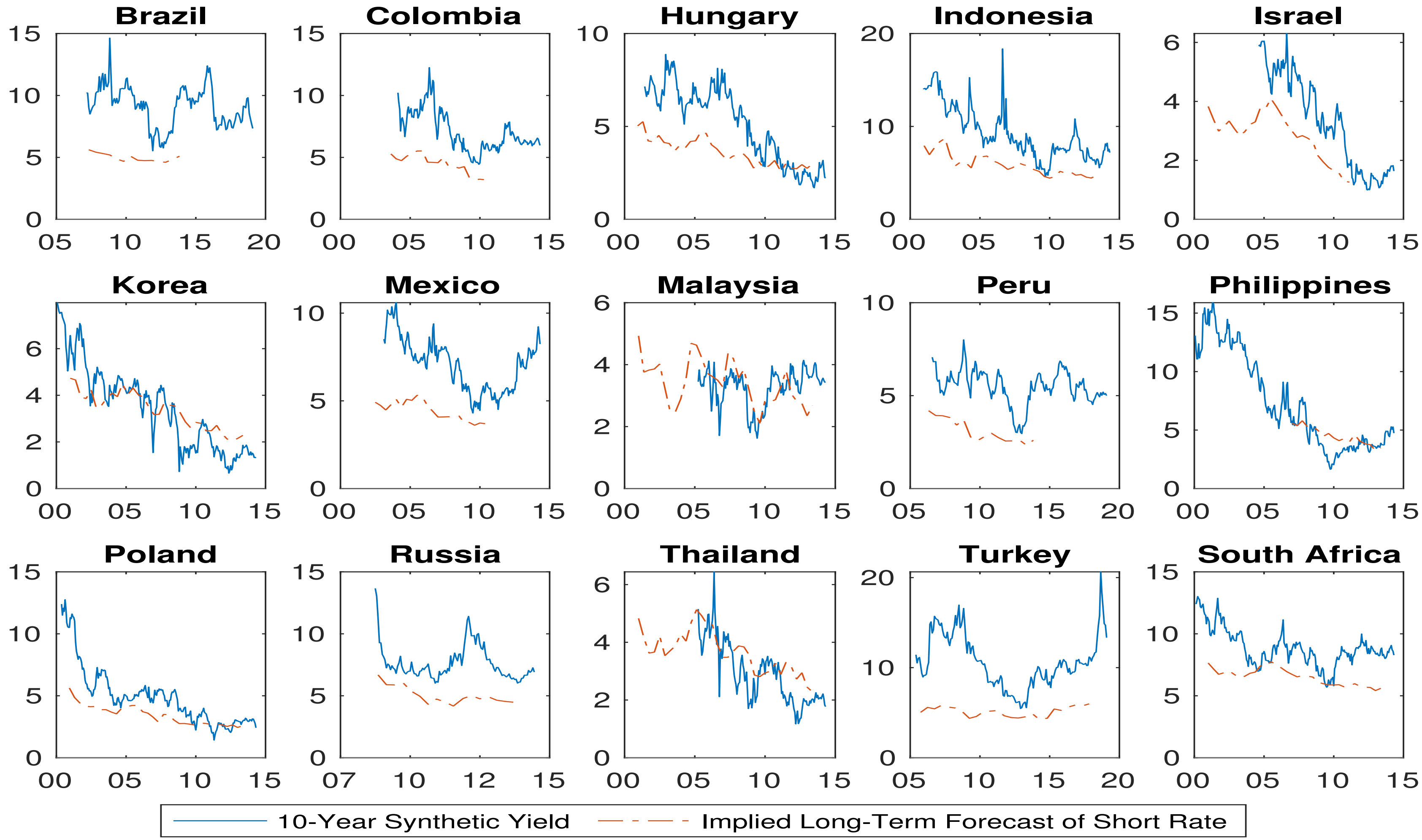
Notes: This table reports the estimated slope coefficients of panel data regressions of the 2-year nominal yields and their components on selected explanatory variables. The sample includes monthly data for 15 emerging markets starting in 2000:1 and ending in 2019:1. The dependent variables are the nominal, the expected short rate, the term premium and the credit risk compensation. All 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 activity index based in industrial production from 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



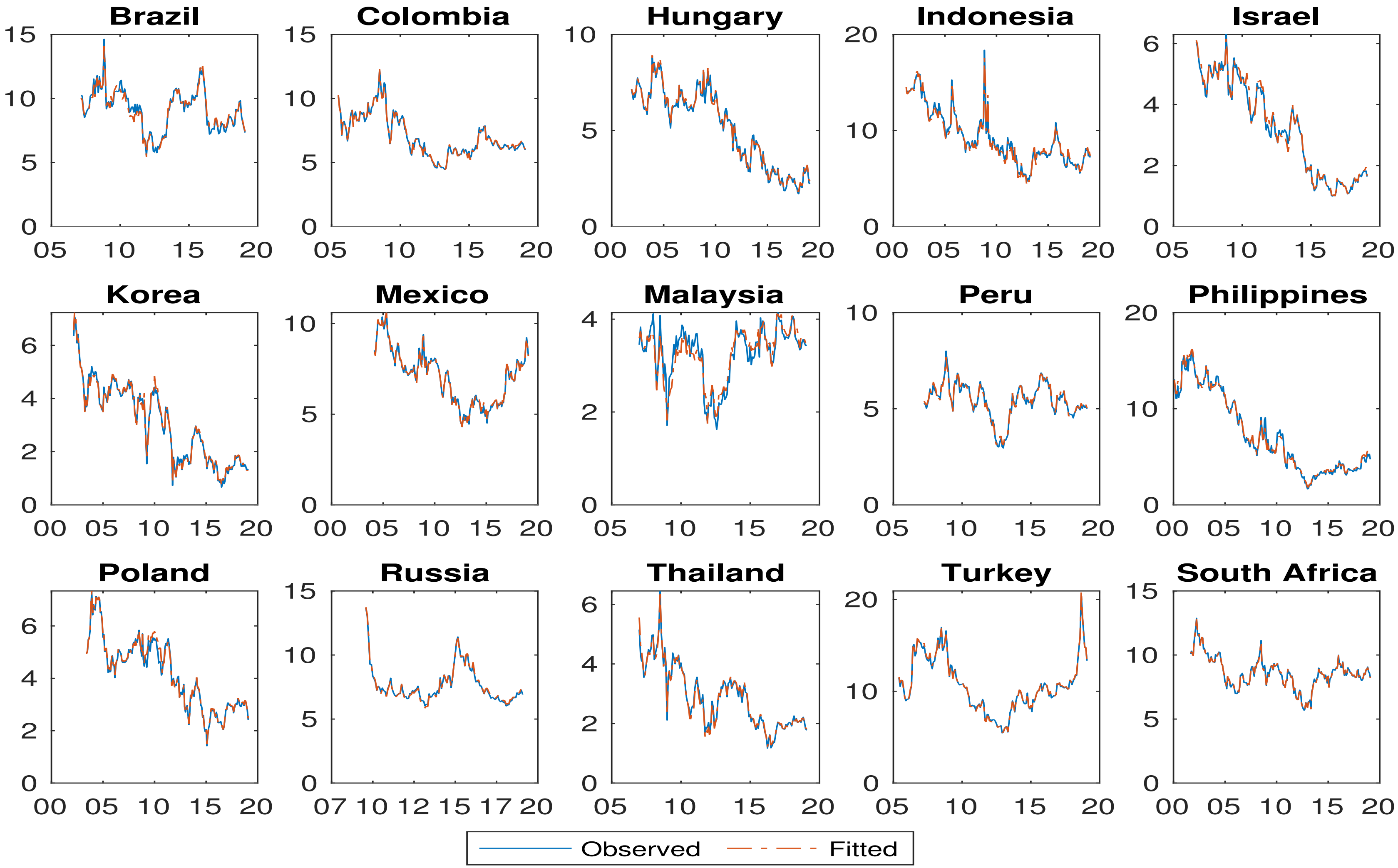
Notes: This figure plots the 5-years ahead (dashed line) and long-term (solid line) average consumer price inflation forecasts against the survey date. For Israel and South Africa, the figure shows the inflation trend, see appendix A. The figure also includes the upper and lower bounds for the domestic 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



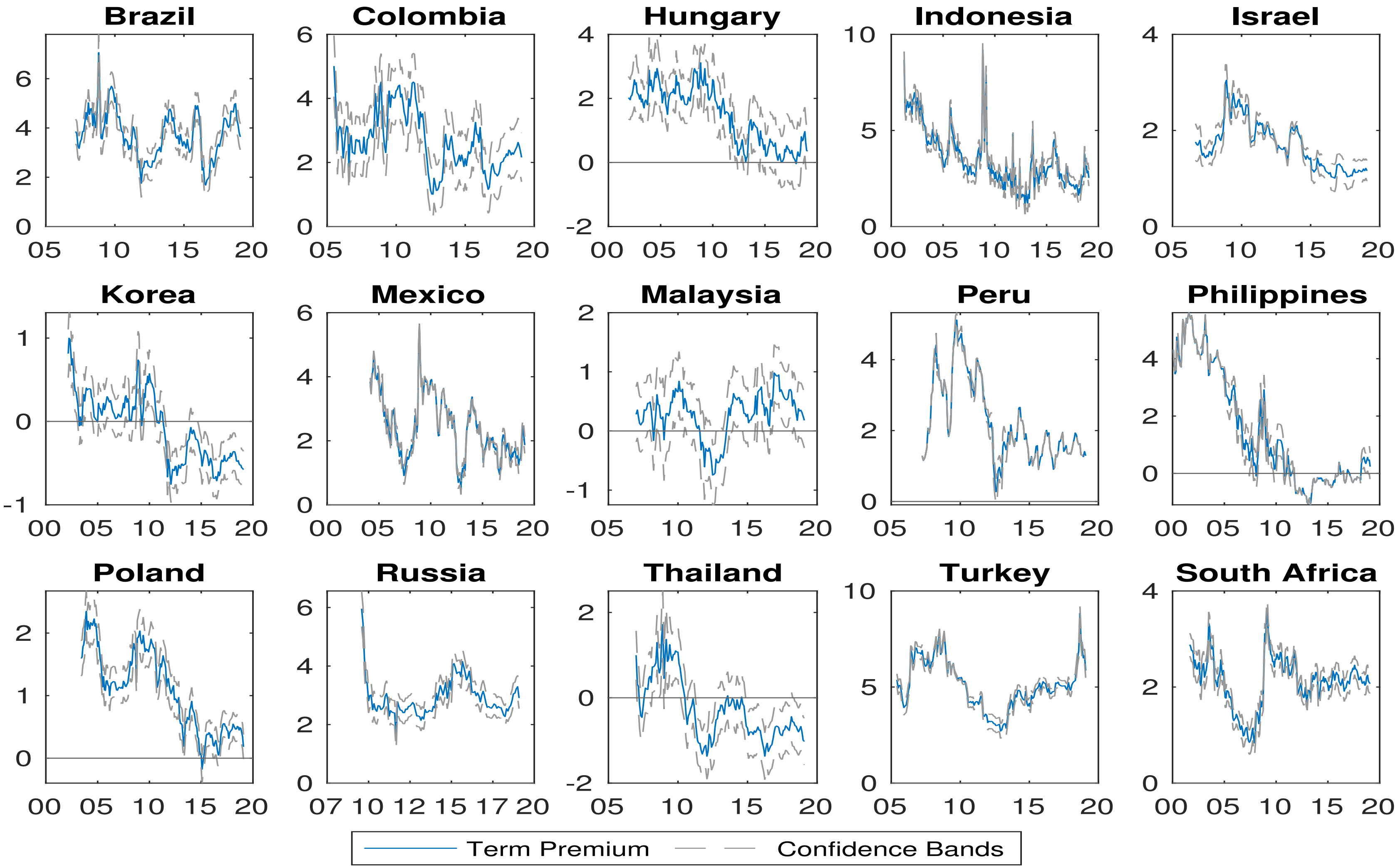
Notes: This figure plots the long-horizon implied forecast of the domestic nominal short-term interest rate (dashed line) and the 10-year synthetic yield (solid line). The implied forecast of the short rate is equal to the forecast of the U.S. real short-term rate plus the domestic consumer price inflation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



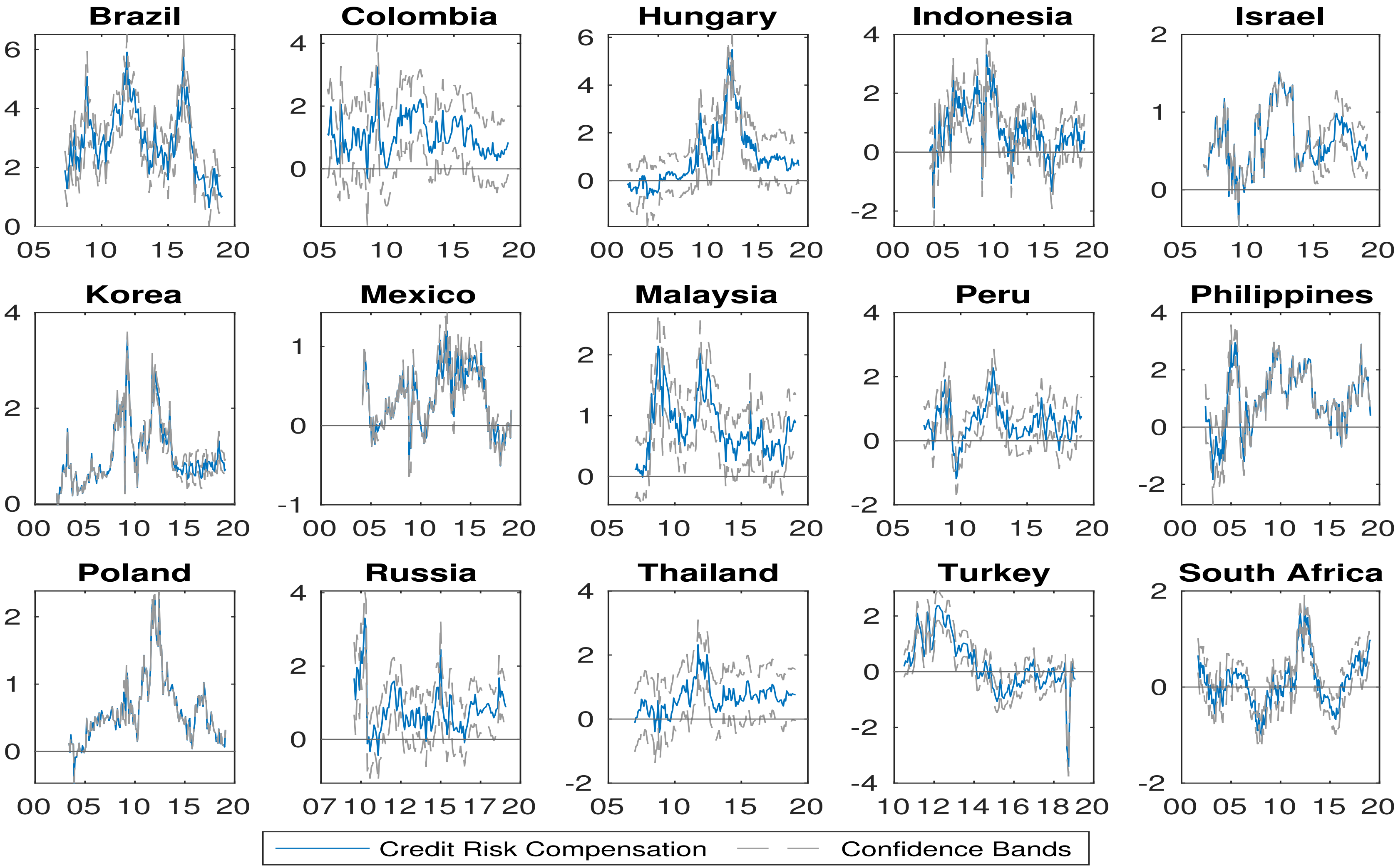
Notes: This figure plots the fitted (dashed line) and the actual (solid line) 10-year synthetic yields. The fitted yield is obtained after estimating the survey-augmented affine term structure model.

Figure 4. The 10-Year Term Premium of Emerging Markets



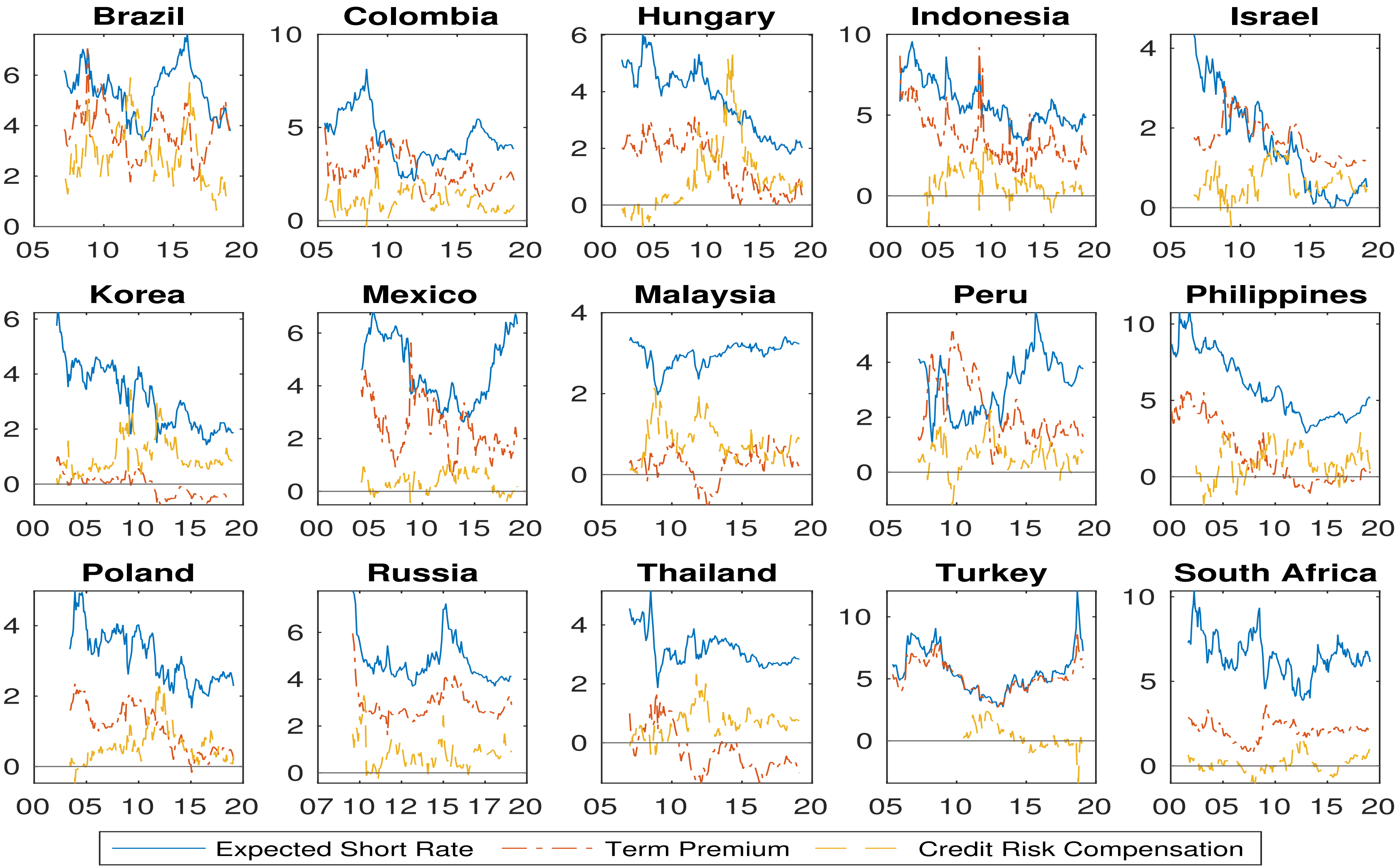
Notes: This figure plots the model-implied term premium of the emerging markets in the sample for the 10-year maturity (solid line) along with their confidence intervals equal to ±2 standard errors (dashed lines). The standard errors are estimated using the delta method. The covariance matrix is estimated using the sample Hessian estimator calculated numerically from the joint log density.

Figure 5. The 10-Year Credit Risk Compensation of Emerging Markets



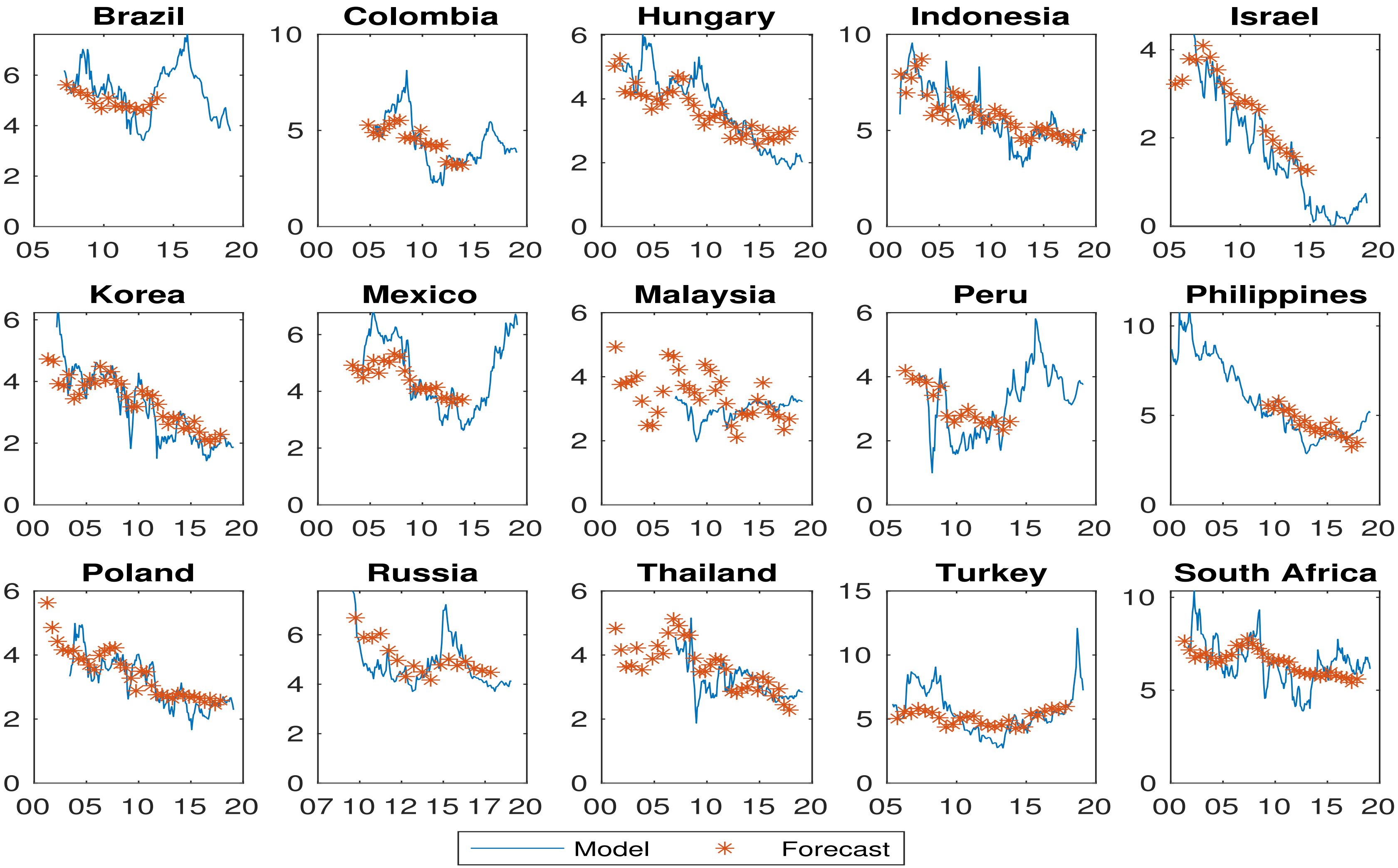
Notes: This figure plots the model-implied credit risk compensation of the emerging markets in the sample for the 10-year maturity (solid line) along with their confidence intervals equal to ± 2 standard errors (dashed lines). The standard errors are estimated using the delta method. The covariance matrix is estimated using the sample Hessian estimator calculated numerically from the joint log density.

Figure 6. Decomposition of the 10-Year Nominal Yields of Emerging Markets



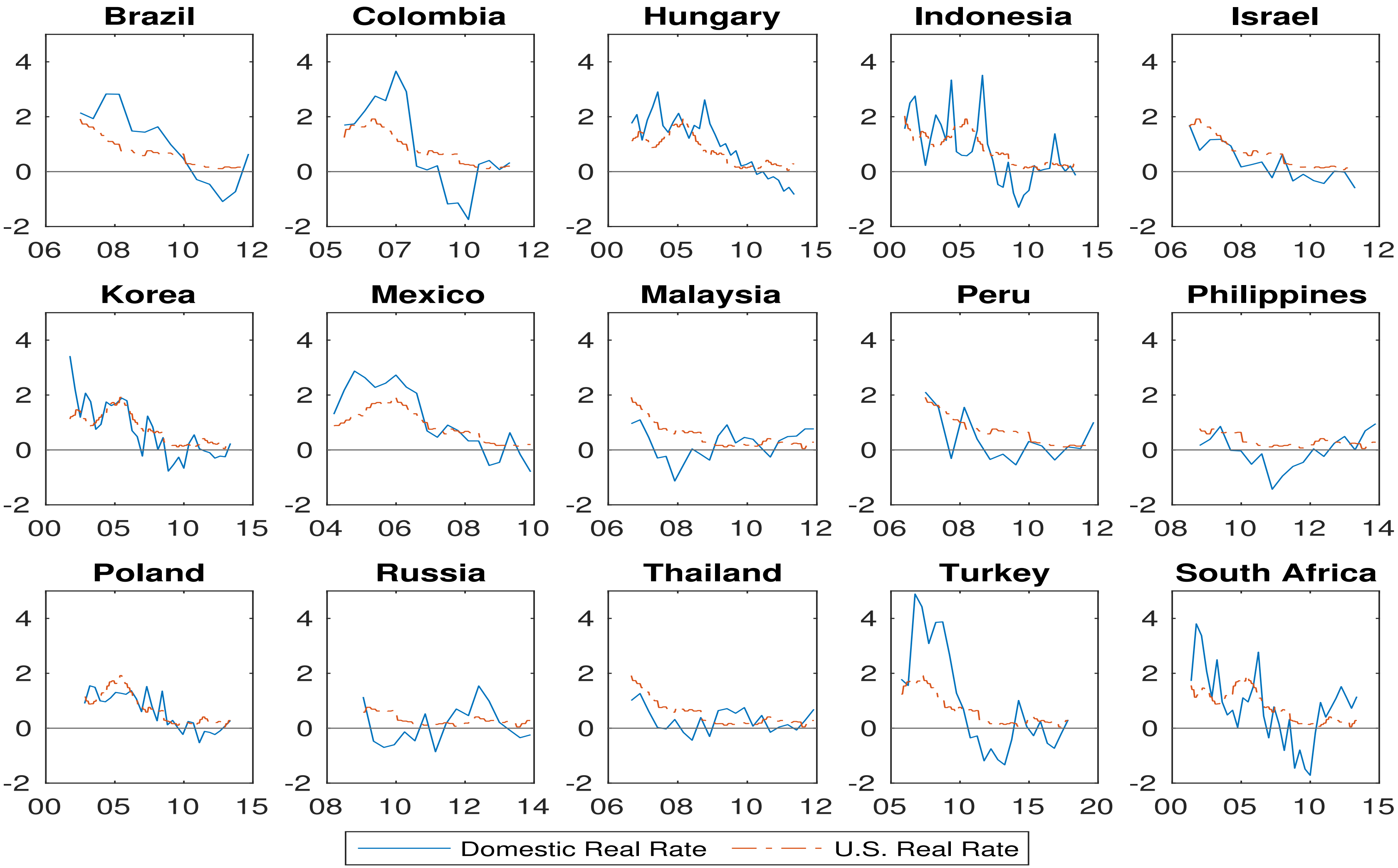
Notes: This figure plots the components of the 10-year nominal yields of emerging markets. The yields are decomposed into an expected future short-term interest rate (solid line), a term premium (dashed line) and a credit risk premium (dashed line).

Figure 7. Long Horizon Forecasts vs Model-Implied 10-Year Expectation of the Short Rate



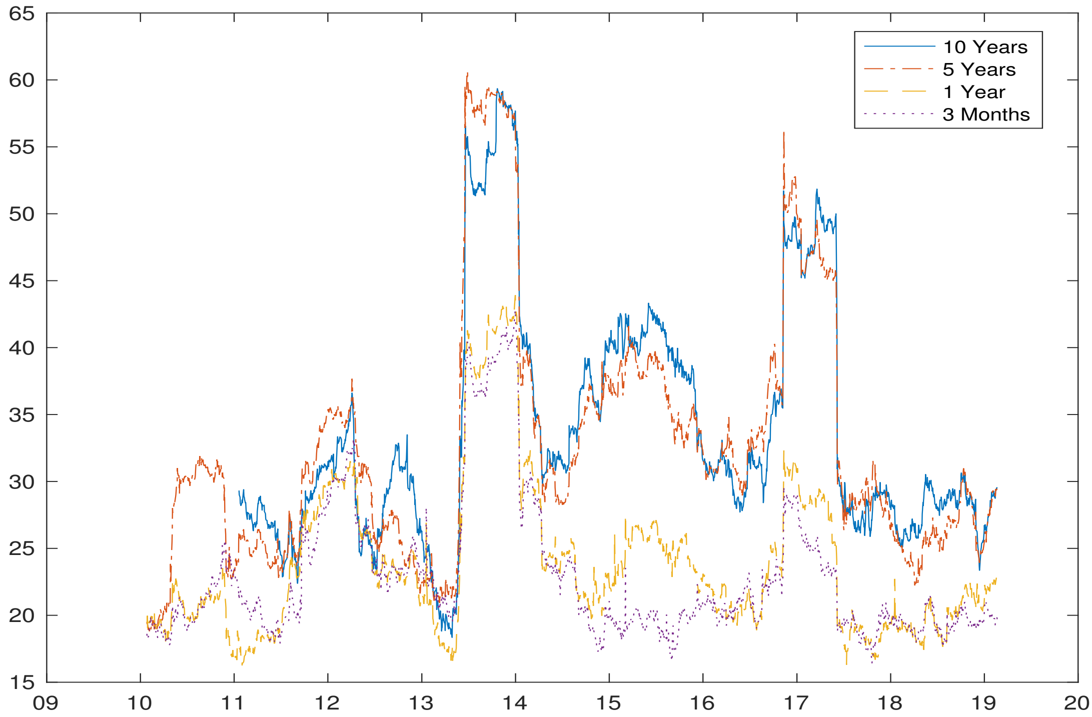
Notes: This figure plots the long-horizon forecast of the domestic short-term interest rate (asterisk) and the model-implied 10-year expectation of the short-term interest rate (solid line).

Figure 8. Model-Implied 10-Year Expectation of the Real Interest Rate

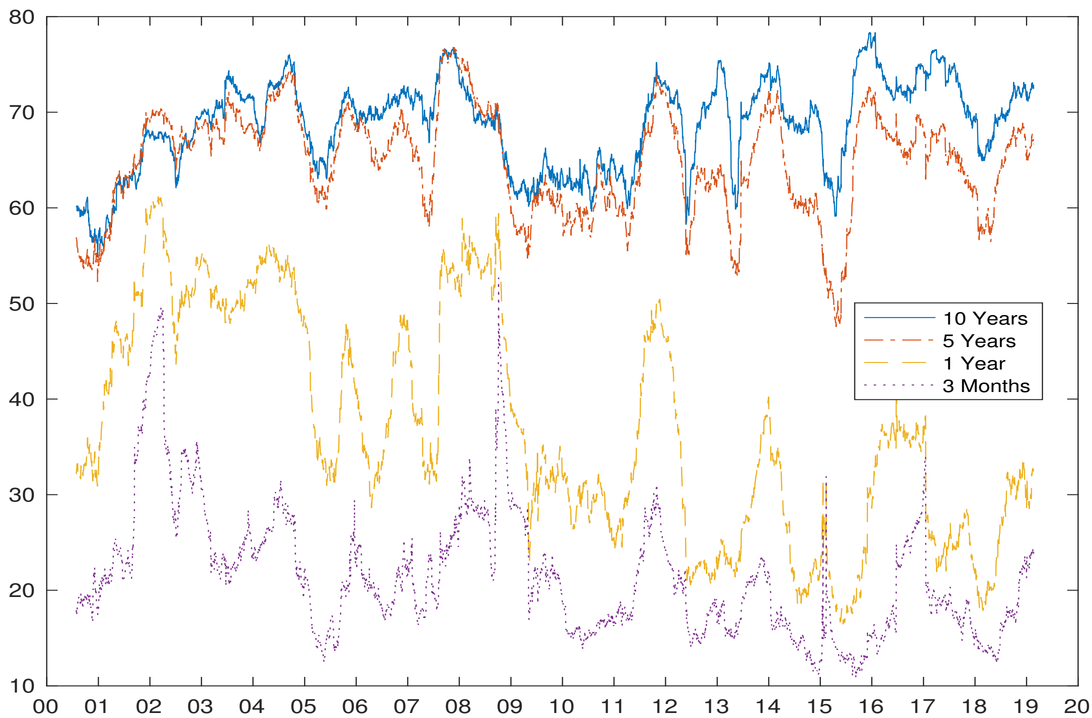


Notes: This figure plots the model-implied 10-year expectation of the domestic real interest rate. The real rate is equal to the difference between the model-implied 10-year expectation of the nominal interest rate and the long-term consensus forecast of consumer price inflation.

Figure 9. Connectedness of the Term Structure



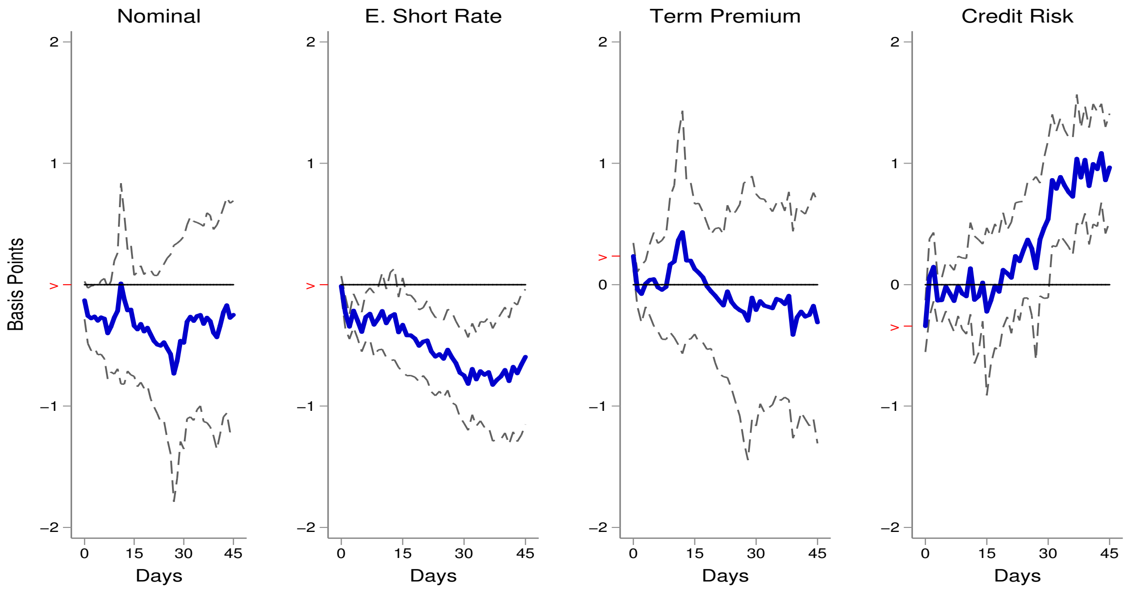
(a) Emerging Markets



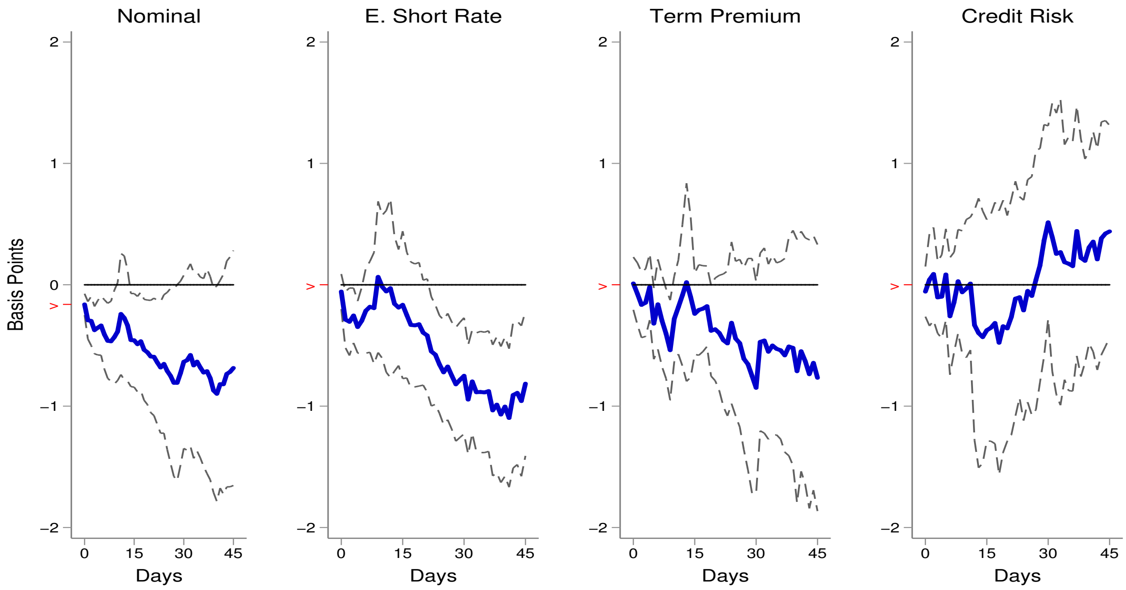
(b) Advanced Countries

Notes: This figure plots the connected index of Diebold and Yilmaz (2014) for nominal yields of emerging markets and advanced countries for 3 months (solid line), 1 year (line), 5 years (line) and 10 years (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 10. Response of the EM Yield Curve to a Target Surprise: 2000-2008



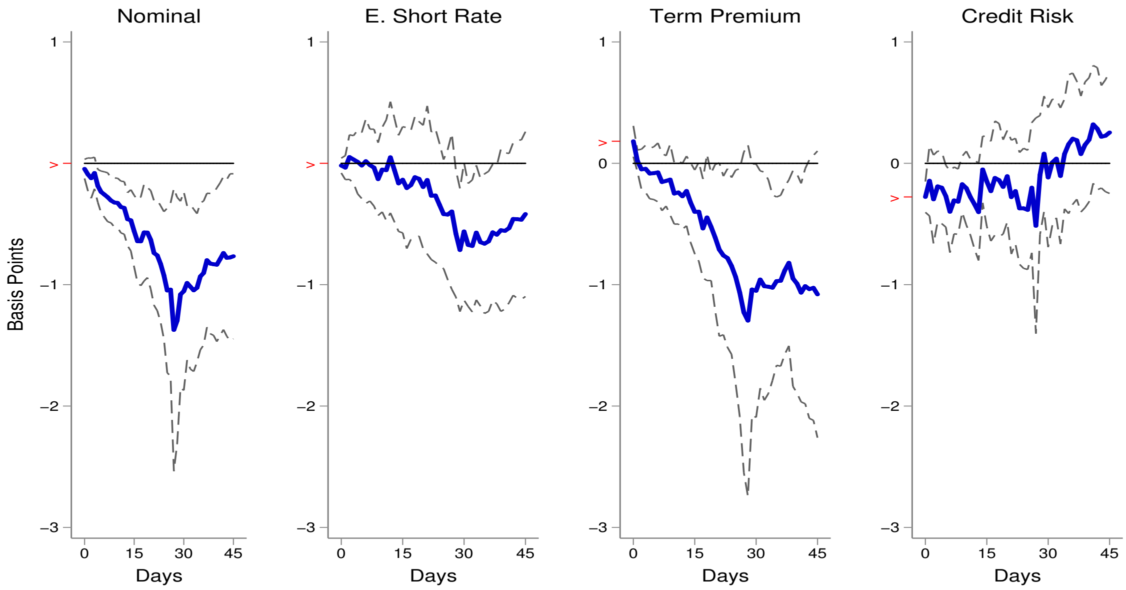
(a) 10-Year Yield



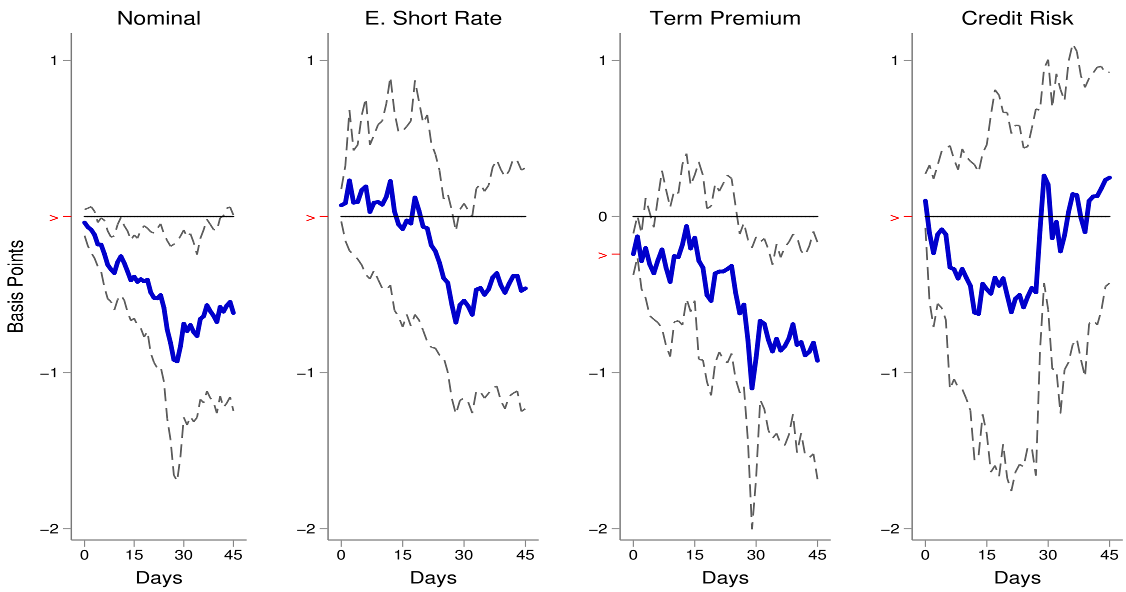
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year emerging market (EM) 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 high-frequency 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 EM Yield Curve to a Forward Guidance Surprise: 2000-2008



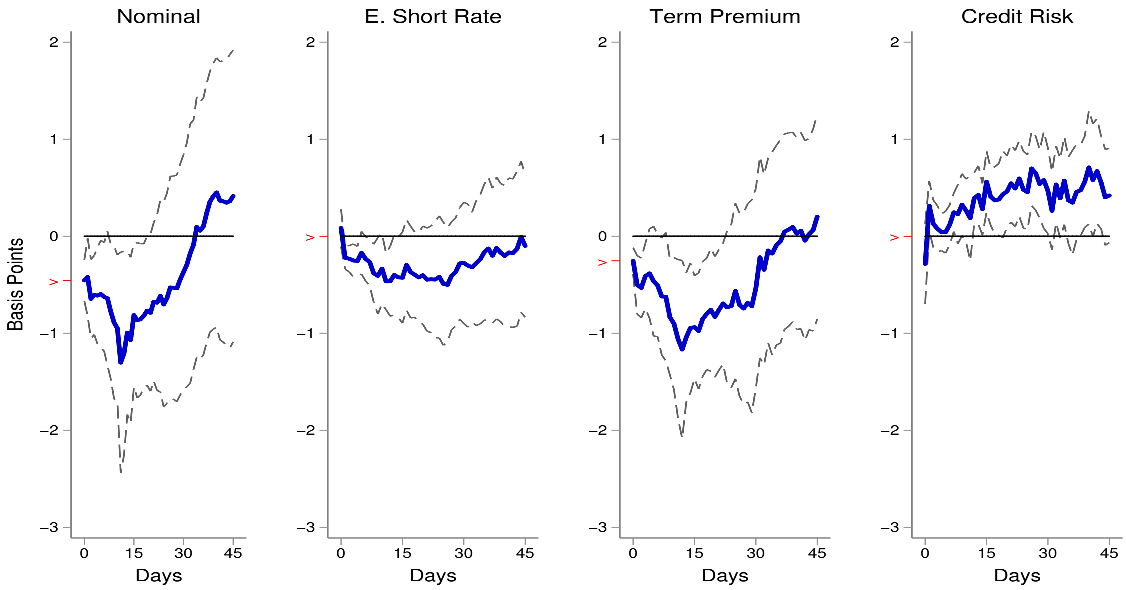
(a) 10-Year Yield



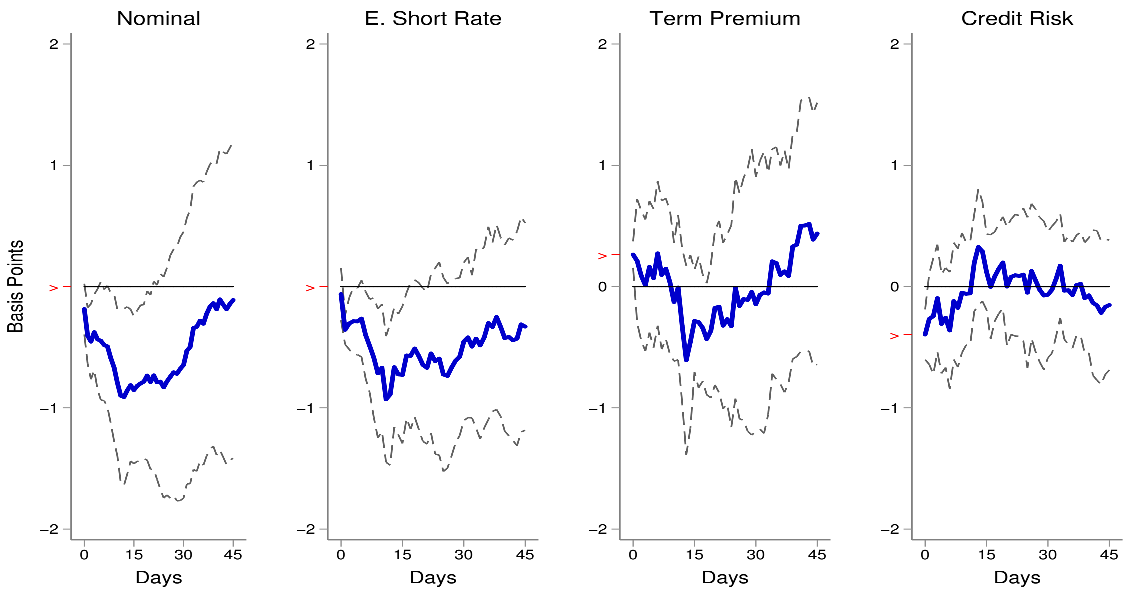
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year emerging market (EM) 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 high-frequency 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 12. Response of the EM Yield Curve to a Forward Guidance Surprise: 2009-2019



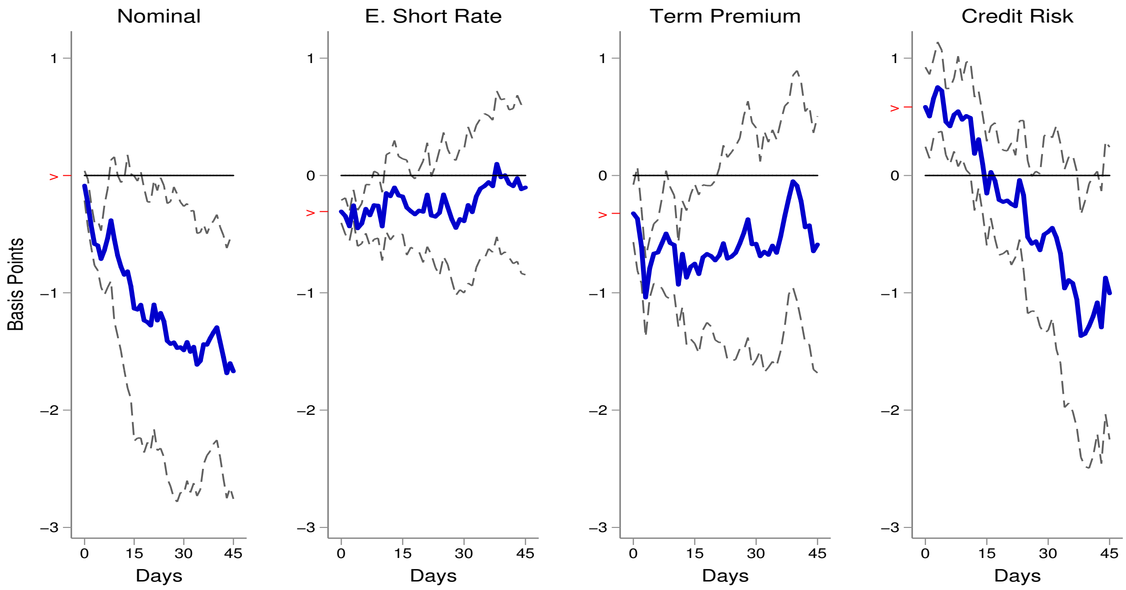
(a) 10-Year Yield



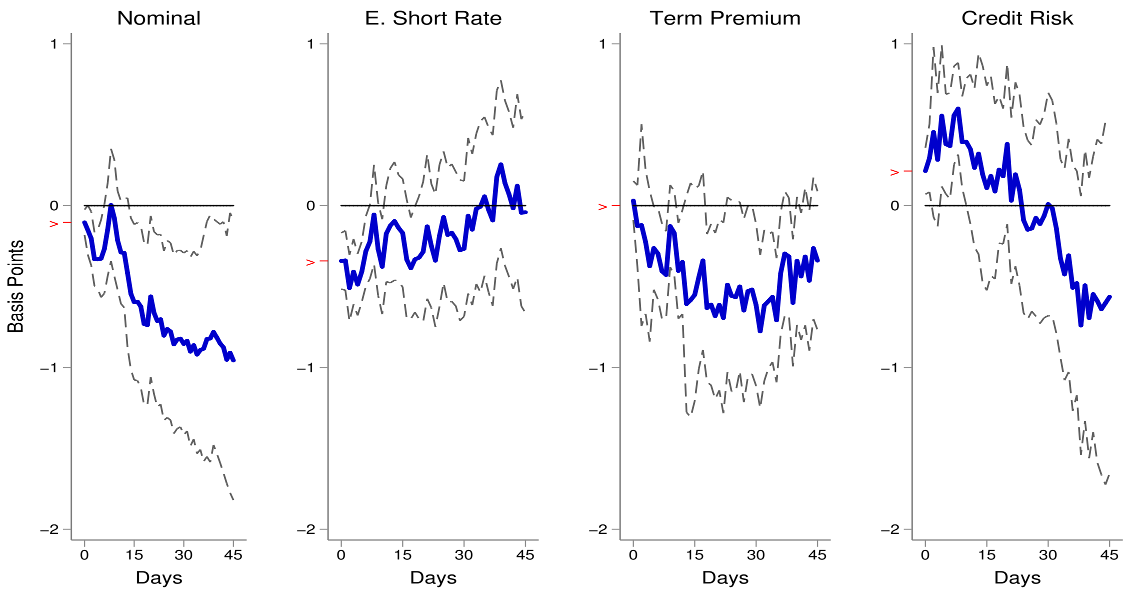
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year emerging market (EM) 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 high-frequency 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 13. Response of the EM Yield Curve to an Asset Purchase Surprise: 2009-2019



(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 (EM) 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 high-frequency 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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Appendix

[Go2ToC]

A Trend Inflation as a Proxy for Long-Term Inflation Forecasts

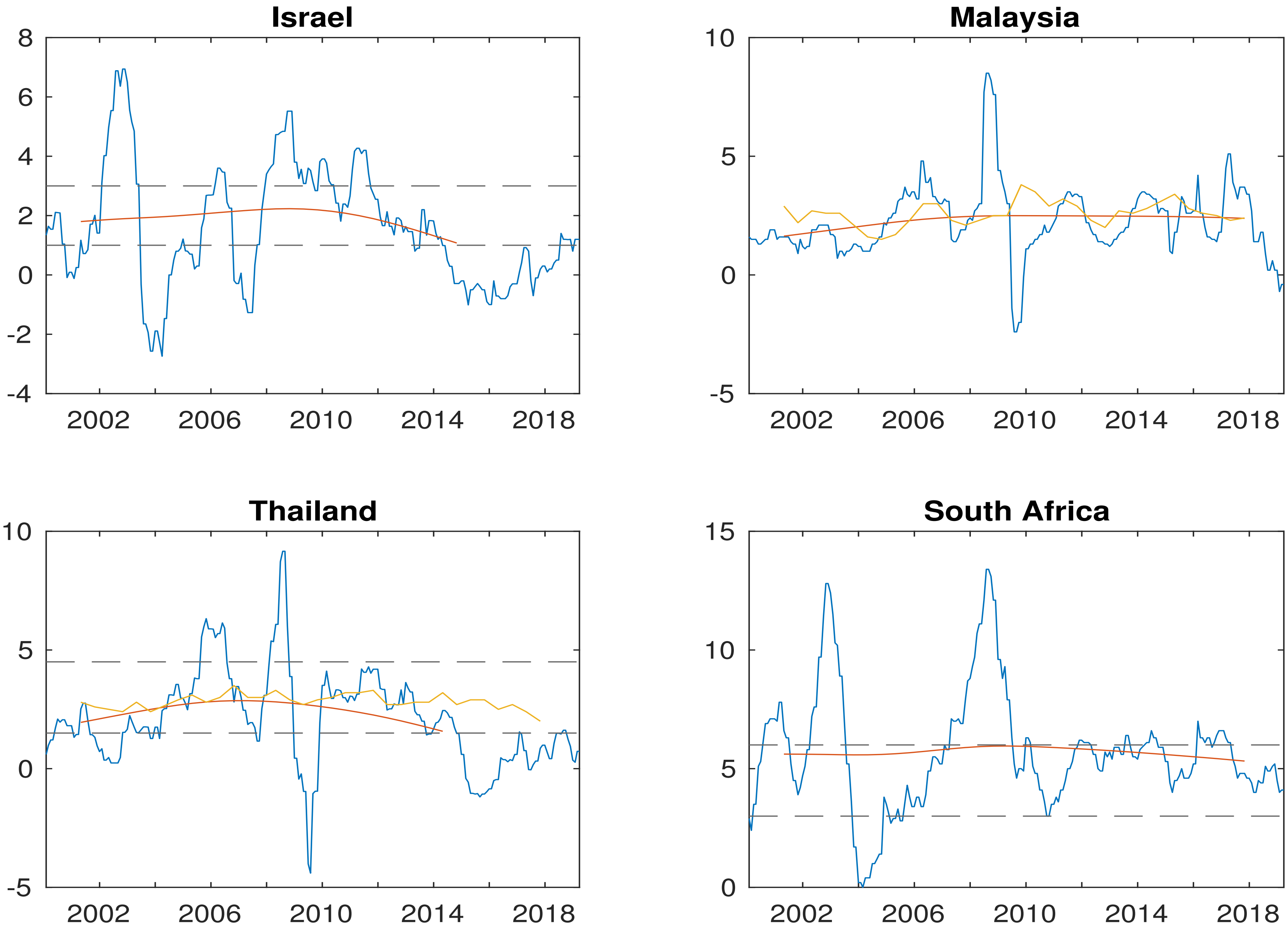
An advantage of the small open economy approach is that it only requires forecasts for inflation, or a proxy in the case of countries with no long-term forecasts available as is the case for Israel and South Africa.

Inflation expectations are hoped to match measures of inflation that exclude unexpected shocks and better reflect the inflation environment. Different measures of core inflation exist. I use the inflation trend obtained by applying the Hodrick-Prescott filter to the series of realized inflation of each country. Of course, the filter is sensitive to the sample period used. The resulting trend can also be outside of the target inflation band due to the innate dynamics of the series, which would be at odds with survey data (see figure 1).

Unlike other countries, there is no marked upward or downward trend in the inflation of Israel nor South Africa during the sample period. For each country, trend inflation is calculated for the whole period but only considered within the time range for which survey data is available for the rest of the countries, and as long as the trend is within the inflation target band.

Figure A.1 shows the realized and trend inflation for Israel and South Africa, and compares them with those of Malaysia and Thailand, two countries with a similar pattern for inflation (i.e. no marked trend) and for which survey data is available. Trend inflation seems to be a good proxy for the long-term inflation forecasts of Israel and South Africa. Finally, since the 5-year and long-term forecasts closely follow each other (see figure 1), I use trend inflation for both tenors.

Figure A.1. Trend versus Long-Horizon Forecasts of Inflation



B Connectedness of Yield Components

Figure B.1 shows that the connectedness index for the yields of emerging markets fluctuates around 30%, with notable spikes around the taper tantrum episode in 2013, and after the 2016 U.S. presidential election. In contrast, Adrian et al. (2019) report that the index fluctuates around 80% for advanced countries.

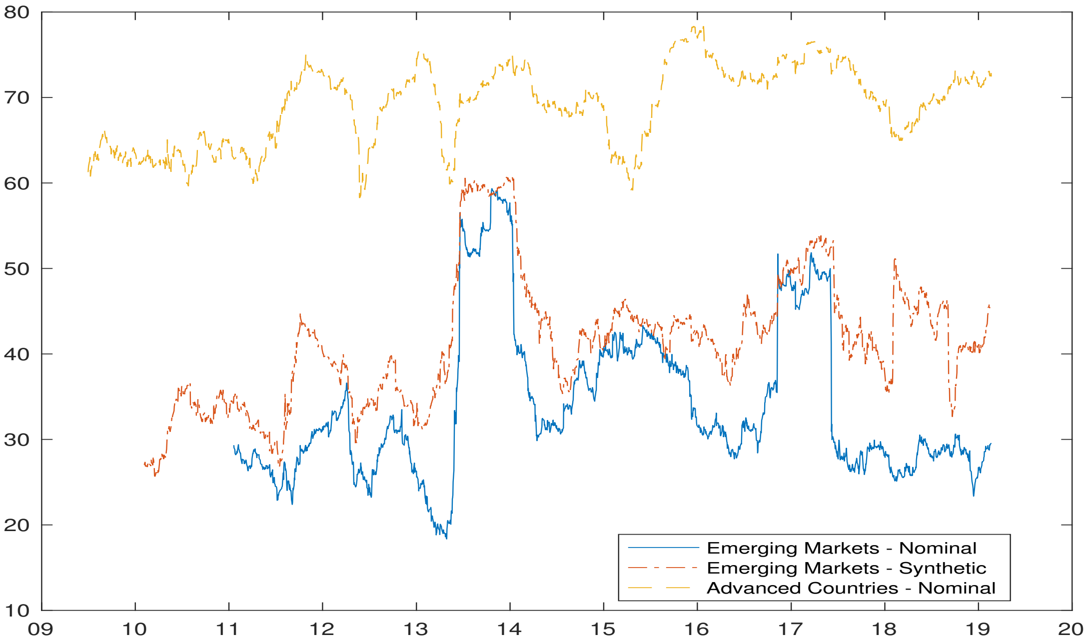
The evidence of highly connected yields in advanced countries and low connected yields in emerging markets is consistent with a view in which global bond markets essentially operate under a core-periphery structure, in which the bond markets of advanced countries constitute the (highly interconnected) core and those of emerging markets represent the (less connected) periphery. Countries in the periphery are in turn connected to the network mainly through countries in the core.[59] According to this view, shocks to emerging market yields are mainly idiosyncratic—reflected in less comovement—so what matters for them are not spillovers originating in other emerging markets but in advanced countries.

The connectedness index for the yields of emerging markets shows no clear trend for either the nominal or synthetic yields nor their components. In contrast, Adrian et al. (2019) document that the increase in the connectedness of the yields of advanced countries has been driven by an increase in the connectedness of their term premia. Nevertheless, the term premia in emerging markets has been slightly more connected since 2013, whereas the credit risk compensation is relatively less connected (see figure B.1b). In fact, the level of the index for the synthetic yields tends to be higher than that for the nominal yields (see figure B.1a), suggesting that credit risk is indeed a more idiosyncratic component of the yields.

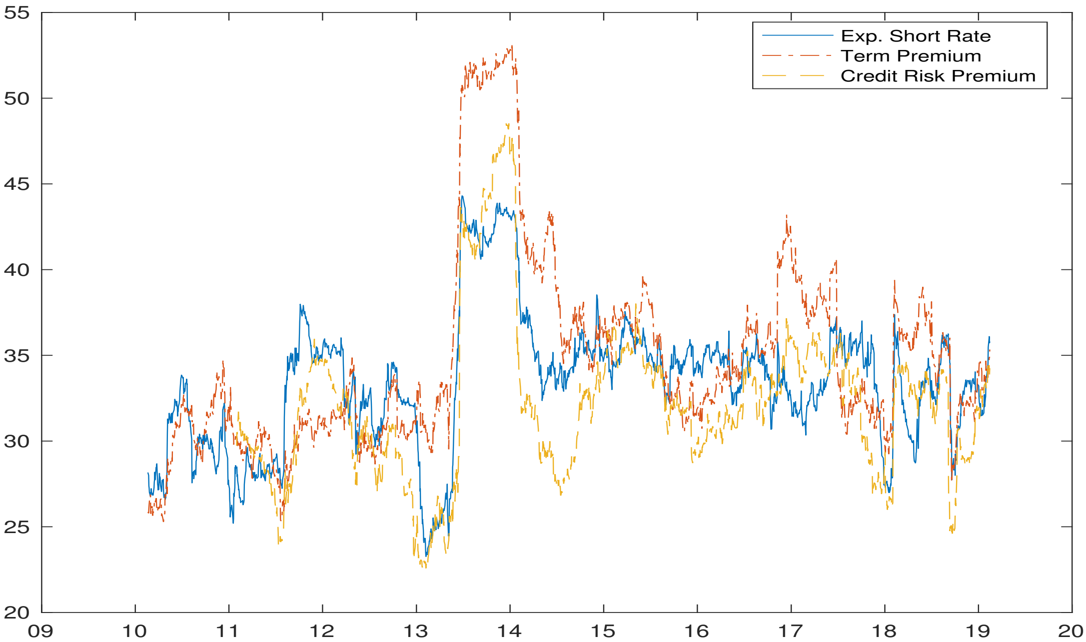
Finally, notice that the low connectedness among the yields of emerging markets supports estimating the term structure models for their yield curves separately (as it has been done in the paper) rather than jointly.

[59] The core-periphery structure has been shown to be a good description of different networks in economics and finance.

Figure B.1. Connectedness of Emerging Market 10-Year Yields



(a) Nominal and Synthetic Yields



(b) Nominal Yield Components

Notes: This figure plots the connectedness index of Diebold and Yilmaz (2014) for the 10-year nominal yields of emerging markets. Panel (a) compares the connectedness of nominal yields (solid line) against that of synthetic yields (dashed-dotted line) and the nominal yields of advanced countries (dashed line). Panel (b) compares the connectedness of each component of the nominal yields: the expected future short rate (solid line), the term premium (dashed-dotted line) and the credit risk compensation (dashed 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 10-year nominal yields and each of their components. The index for some components has a shorter history because its computation requires a balanced panel and the components do not start on the same date (e.g. the construction of the synthetic curves does not involve nominal yields).

C Supplementary Tables

D Supplementary Figures

Table C.1. Drivers of the Emerging Market 5-Year Nominal Yield and Its Components

	Nominal	E. Short Rate	Term Premium	Credit Rirsk
U.S. Term Premium	1.35***	1.03***	0.89***	-0.57***
	(0.17)	(0.09)	(0.10)	(0.14)
U.S. E. Short Rate	0.09	0.16***	0.04	-0.11**
	(0.06)	(0.04)	(0.04)	(0.04)
UCSV-Perm	-72.18***	-64.98***	-33.94***	26.73*
	(18.88)	(16.23)	(10.12)	(12.96)
Policy Rate	0.42***	0.40***	0.07***	-0.05*
	(0.03)	(0.02)	(0.02)	(0.02)
Inflation	13.78***	2.50	7.05***	4.23*
	(2.56)	(1.96)	(1.52)	(1.68)
Unemployment	20.96***	2.62	7.52***	10.82***
	(3.13)	(2.00)	(1.43)	(1.96)
LC per USD (Std.)	30.99***	26.38***	15.06***	-10.45**
	(4.99)	(3.55)	(2.92)	(3.45)
Log(Vix)	69.29***	-8.29	21.02**	56.55***
	(11.02)	(12.06)	(7.95)	(10.33)
Log(EPU U.S.)	10.20*	-1.04	-0.83	12.06**
	(4.91)	(2.92)	(2.49)	(3.72)
Log(EPU Global)	-69.38***	-44.62***	-19.53*	-5.23
	(16.03)	(7.07)	(9.35)	(10.29)
Global Ind. Prod.	1.95*	0.34	-0.27	1.88*
	(0.80)	(0.88)	(0.32)	(0.82)
Fixed Effects	Yes	Yes	Yes	Yes
Lags	4	4	4	4
No. Countries	15	15	15	15
Observations	2192	2192	2192	2192
R^2	0.75	0.75	0.42	0.28

Notes: This table reports the estimated slope coefficients of panel data regressions of the 5-year nominal yields and their components 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 the nominal, the expected short rate, the term premium and the credit risk compensation. All 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 activity index based in industrial production from 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 C.2. Drivers of the Emerging Market 1-Year Nominal Yield and Its Components

	Nominal	E. Short Rate	Term Premium	Credit Rirsk
U.S. Term Premium	2.15***	2.78***	0.19	-0.83*
	(0.40)	(0.33)	(0.31)	(0.37)
U.S. E. Short Rate	-0.00	-0.02	0.07*	-0.05
	(0.04)	(0.03)	(0.03)	(0.04)
UCSV-Perm	-57.36**	-75.22***	-14.15	32.01
	(21.66)	(20.48)	(14.09)	(21.50)
Policy Rate	0.74***	0.70***	0.13***	-0.09**
	(0.03)	(0.04)	(0.03)	(0.03)
Inflation	8.87***	-0.07	8.62**	0.32
	(2.49)	(2.86)	(2.72)	(2.84)
Unemployment	7.07*	0.72	-2.75	9.11***
	(2.77)	(1.88)	(1.81)	(2.20)
LC per USD (Std.)	25.63***	23.37***	18.69***	-16.43**
	(4.64)	(5.83)	(4.80)	(5.20)
Log(Vix)	43.84***	-12.75	-10.96	67.54***
	(9.16)	(15.59)	(10.77)	(12.71)
Log(EPU U.S.)	5.96	0.51	-10.08**	15.53**
	(3.38)	(4.78)	(3.06)	(5.22)
Log(EPU Global)	-54.69***	-42.17***	-8.56	-3.96
	(12.19)	(10.86)	(10.09)	(14.80)
Global Ind. Prod.	1.88*	-0.44	-2.30**	4.62***
	(0.75)	(0.95)	(0.86)	(0.83)
Fixed Effects	Yes	Yes	Yes	Yes
Lags	4	4	4	4
No. Countries	15	15	15	15
Observations	2192	2192	2192	2192
R^2	0.82	0.76	0.25	0.21

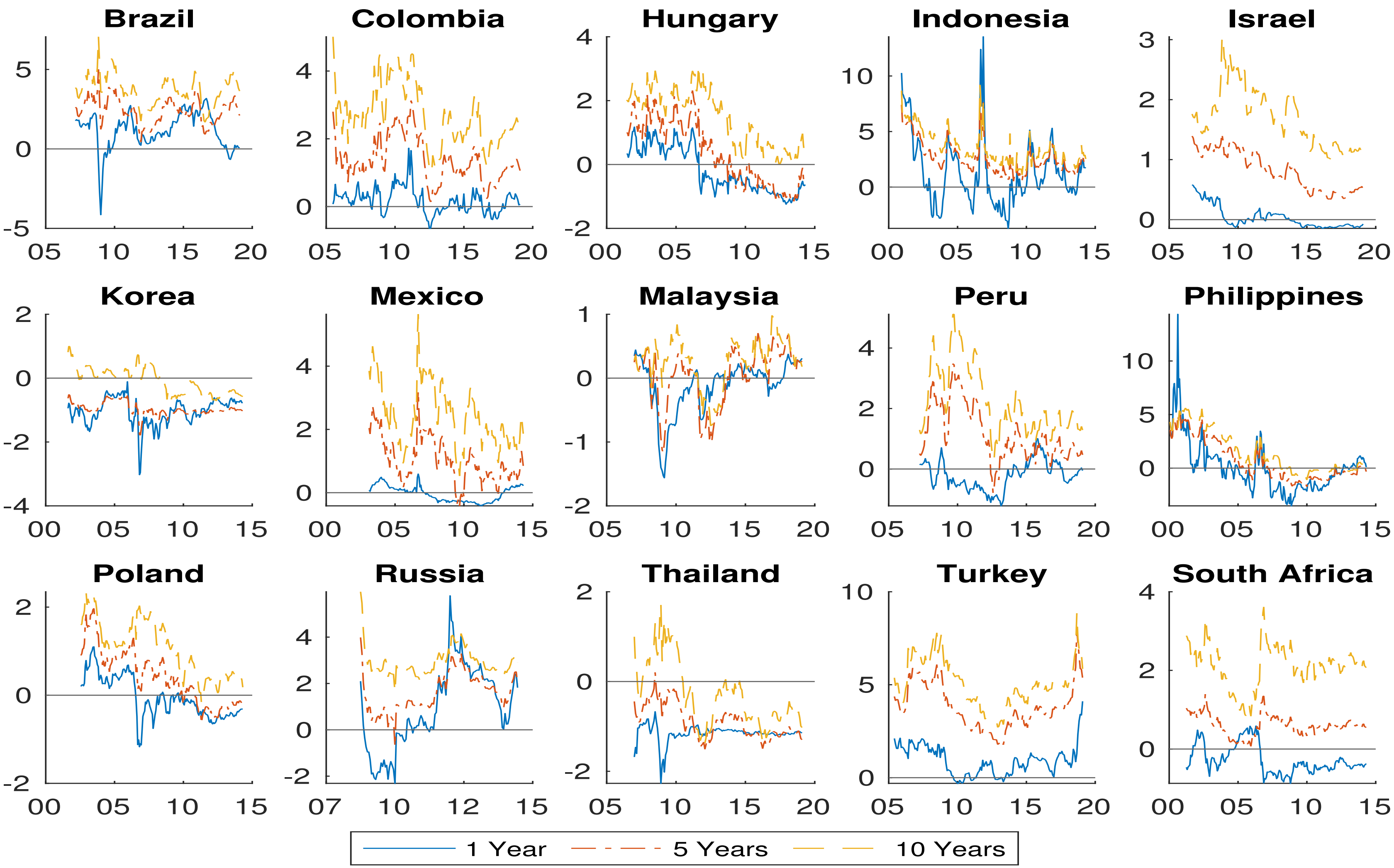
Notes: This table reports the estimated slope coefficients of panel data regressions of the 1-year nominal yields and their components on selected explanatory variables. The sample includes monthly data for 15 emerging markets starting in 2000:1 and ending in 2019:1. The dependent variables are the nominal, the expected short rate, the term premium and the credit risk compensation. All 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 activity index based in industrial production from 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 C.3. Descriptive Statistics of U.S. Monetary Policy Surprises

	Mean	Std. Dev.	Min.	Max.	Obs
Target Surprises (abs. values)	2.7	6.7	0.0	46.5	162
Target Surprises > 0	2.9	3.5	0.0	14.4	47
Target Surprises < 0	-4.9	9.8	-46.5	-0.3	63
Forward Guidance Surprises (abs. values)	6.0	6.5	0.0	54.6	162
Forward Guidance Surprises > 0	5.4	4.9	0.0	24.9	89
Forward Guidance Surprises < 0	-6.7	8.0	-54.6	-0.0	73
Asset Purchase Surprises (abs. values)	2.2	3.5	0.1	29.9	86
Asset Purchase Surprises > 0	1.9	2.2	0.1	10.3	41
Asset Purchase Surprises < 0	-2.5	4.4	-29.9	-0.1	45

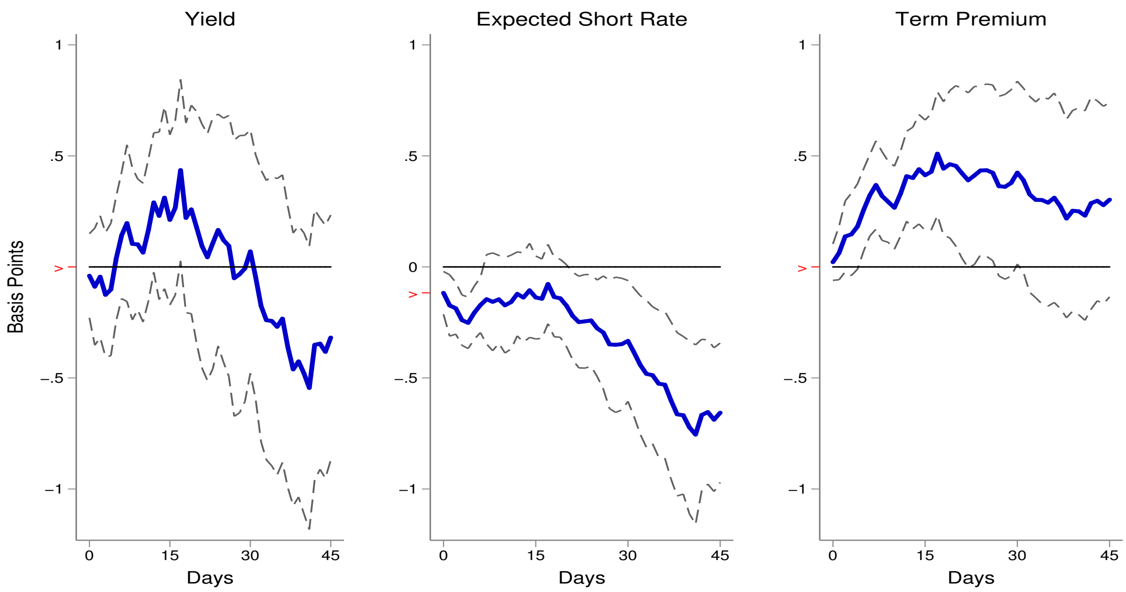
Notes: This table reports the average, the standard deviation, the minimum and the maximum values on monetary policy announcement days for the target, forward guidance and asset purchase surprises, see section 5.2 for the definitions. Asset purchase surprises are considered from October 2008 onwards. Target and forward guidance surprises span the whole sample period from January 2000 to January 2019.

Figure D.1. Term Structure of Term Premia

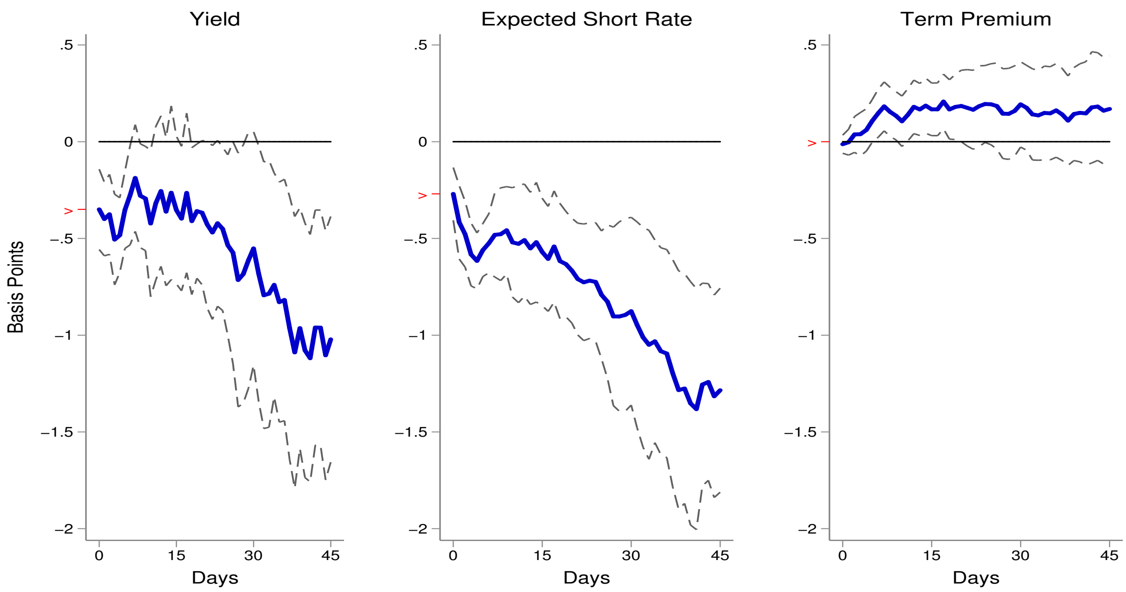


Notes: This figure plots the estimated term premia for 1 year (solid line), 5 years (dashed line) and 10 years (dash-dotted line).

Figure D.2. Response of the U.S. Yield Curve to a Target Surprise: 2000-2008



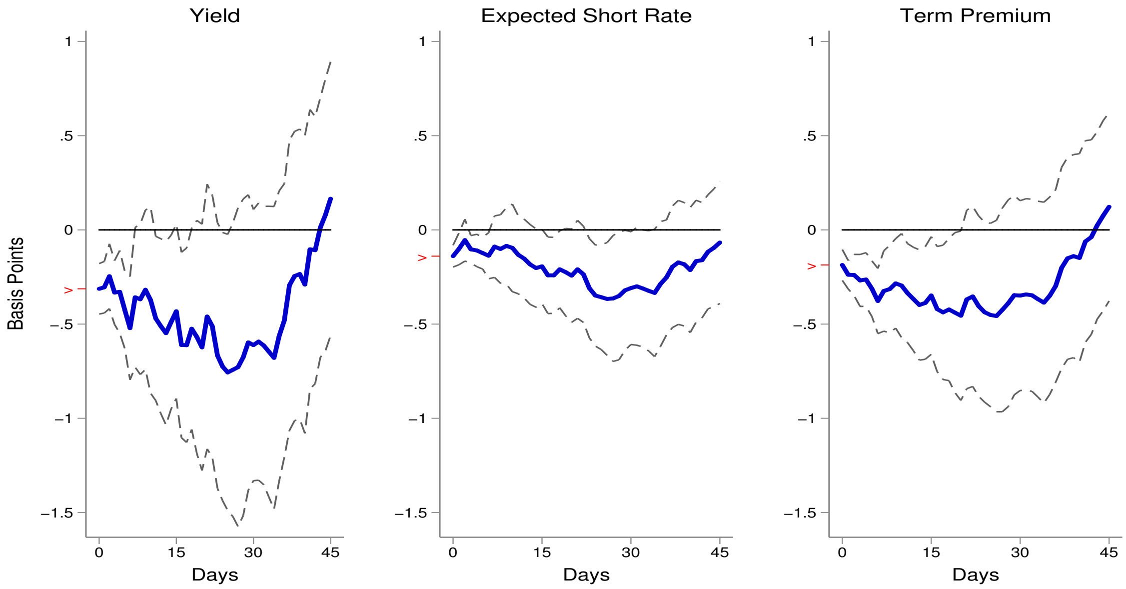
(a) 10-Year Yield



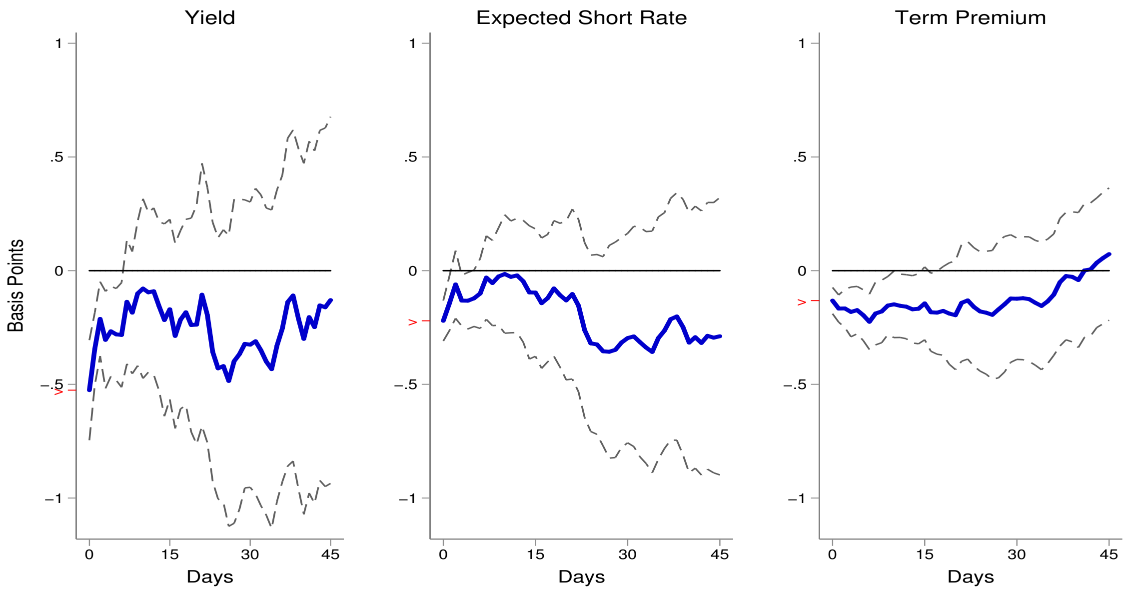
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year U.S. yields and their components to a target surprise. The U.S. yield is the zero coupon yield from Gürkaynak et al. (2007). The yield is decomposed into an expected future short-term interest rate and a term premium following Kim and Wright (2005). Target surprises are identified using high-frequency 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 D.3. Response of the U.S. Yield Curve to a Forward Guidance Surprise: 2000-2008



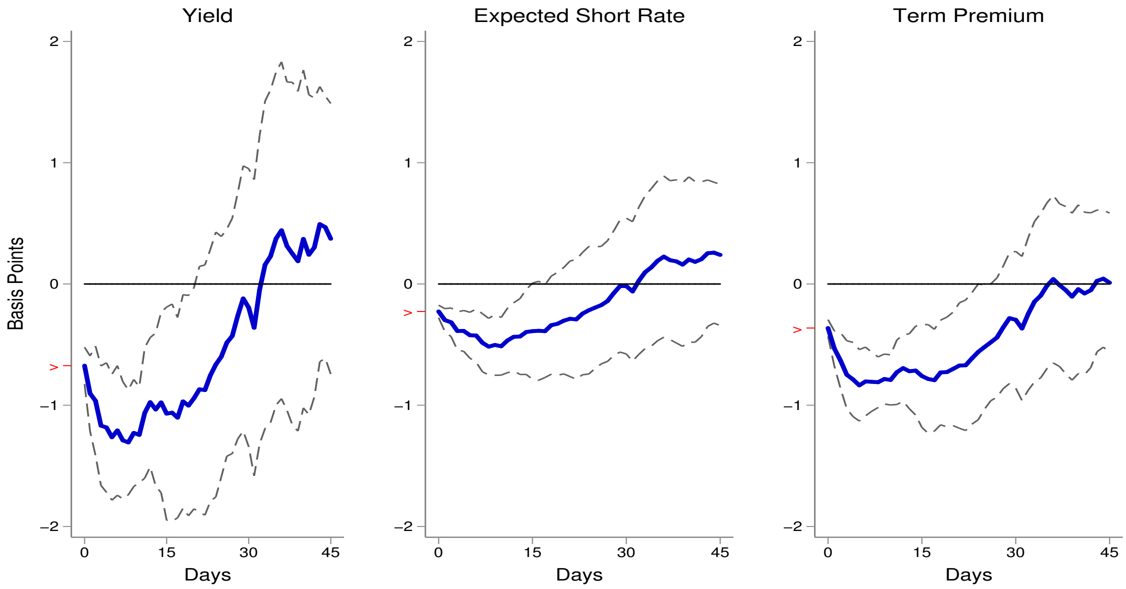
(a) 10-Year Yield



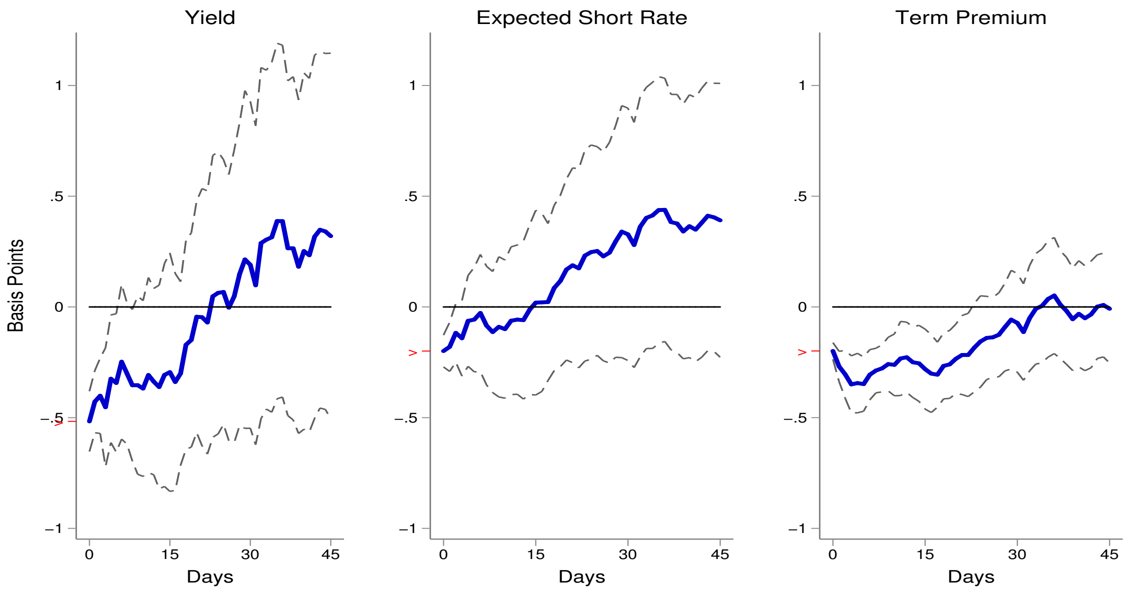
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year U.S. yields and their components to a forward guidance surprise. The U.S. yield is the zero coupon yield from Gürkaynak et al. (2007). The yield is decomposed into an expected future short-term interest rate and a term premium following Kim and Wright (2005). Forward guidance surprises are identified using high-frequency 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 D.4. Response of the U.S. Yield Curve to a Forward Guidance Surprise: 2009-2019



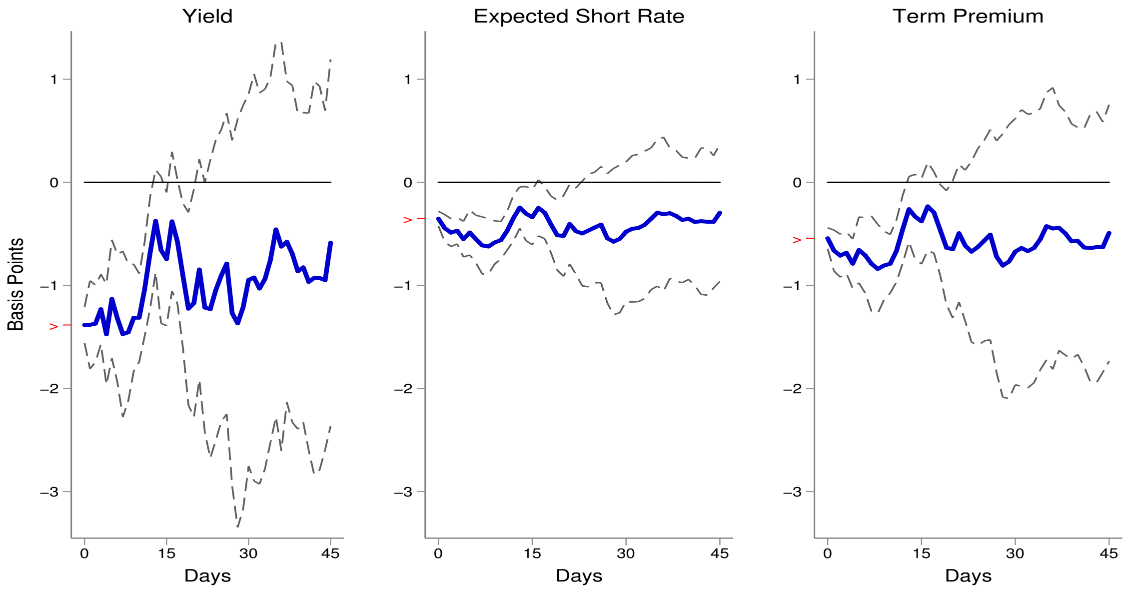
(a) 10-Year Yield



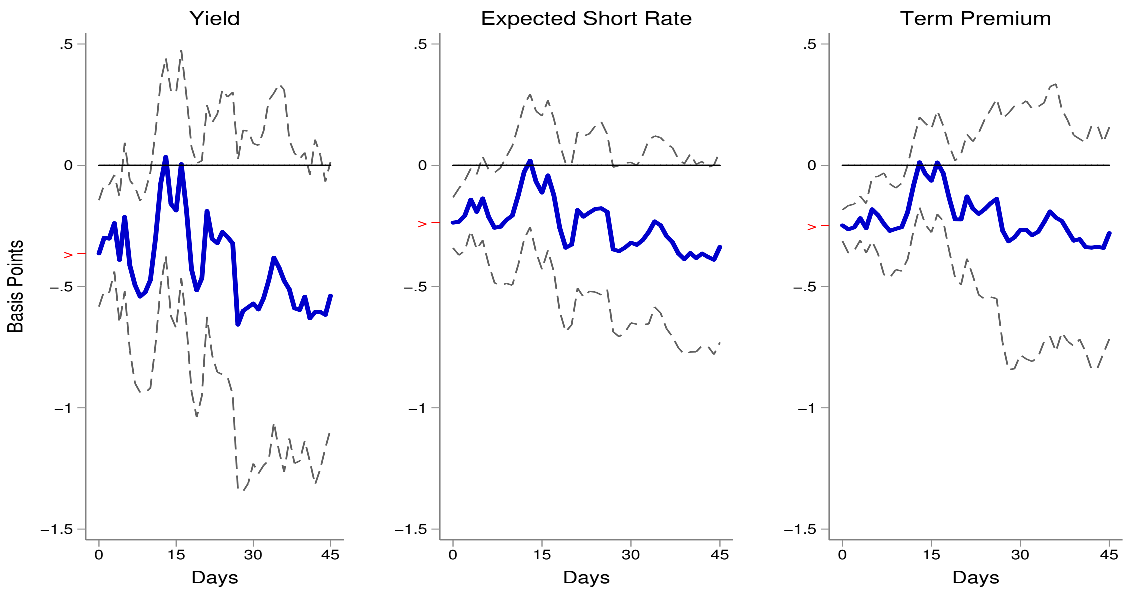
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year U.S. yields and their components to a forward guidance surprise. The U.S. yield is the zero coupon yield from Gürkaynak et al. (2007). The yield is decomposed into an expected future short-term interest rate and a term premium following Kim and Wright (2005). Forward guidance surprises are identified using high-frequency 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 D.5. Response of the U.S. Yield Curve to an Asset Purchase Surprise: 2009-2019



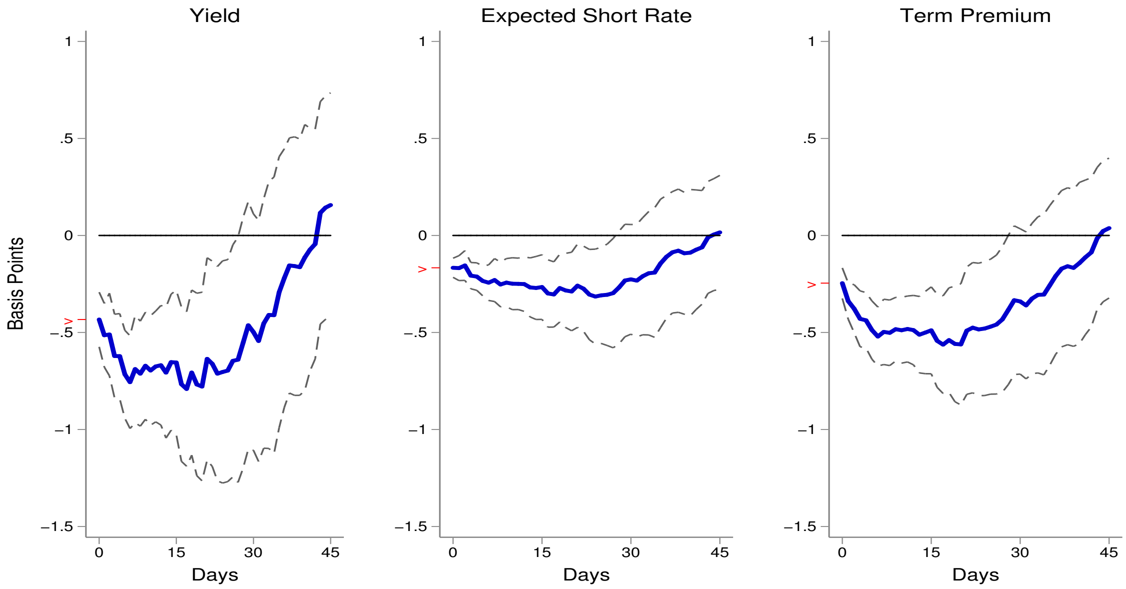
(a) 10-Year Yield



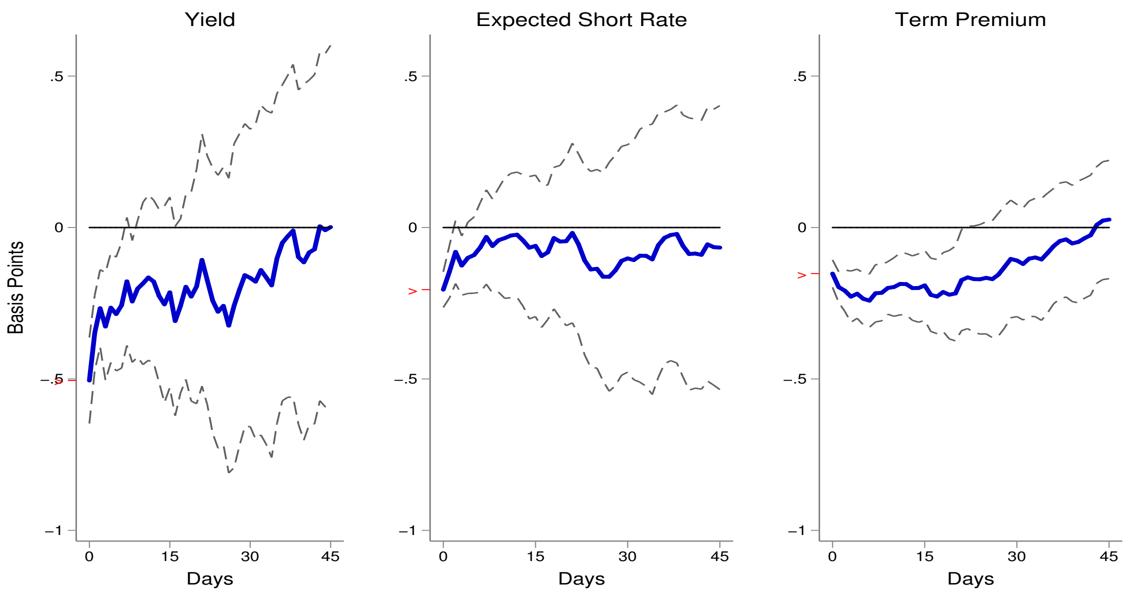
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year U.S. yields and their components to an asset purchase surprise. The U.S. yield is the zero coupon yield from Gürkaynak et al. (2007). The yield is decomposed into an expected future short-term interest rate and a term premium following Kim and Wright (2005). Asset purchase surprises are identified using high-frequency 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 D.6. Response of the U.S. Yield Curve to a Forward Guidance Surprise: 2000-2019



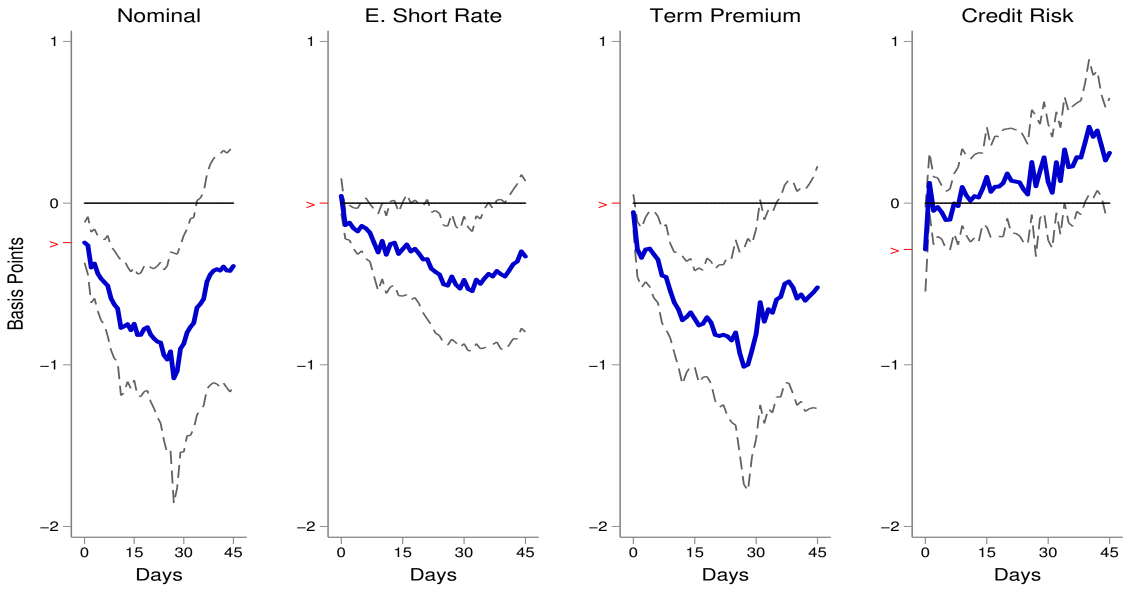
(a) 10-Year Yield



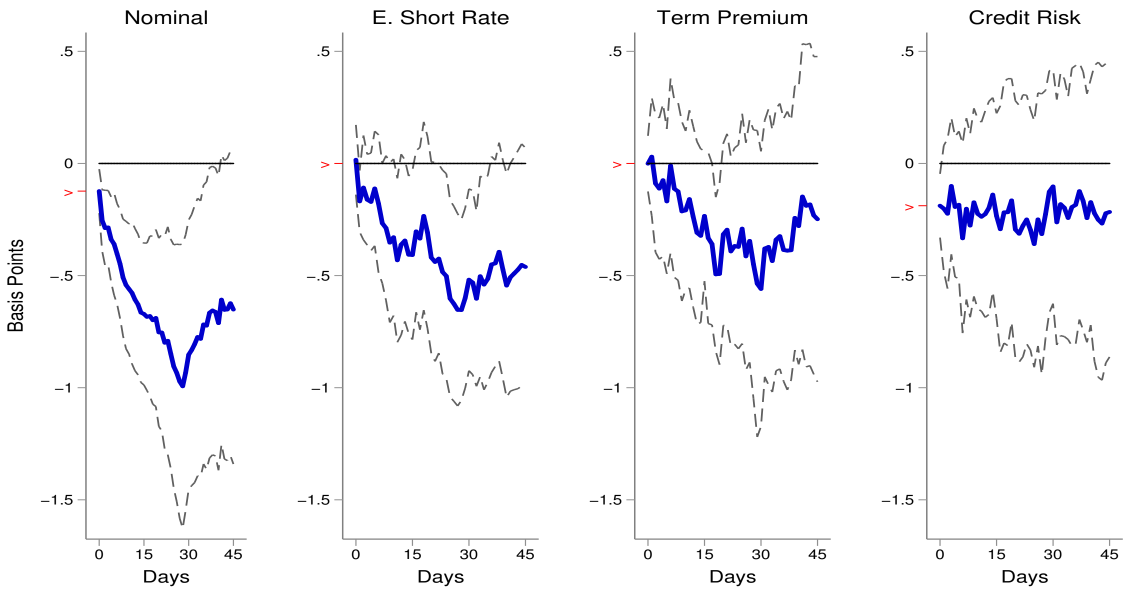
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year U.S. yields and their components to a forward guidance surprise. The U.S. yield is the zero coupon yield from Gürkaynak et al. (2007). The yield is decomposed into an expected future short-term interest rate and a term premium following Kim and Wright (2005). Forward guidance surprises are identified using high-frequency 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 D.7. Response of the EM Yield Curve to a Forward Guidance Surprise: 2000-2019



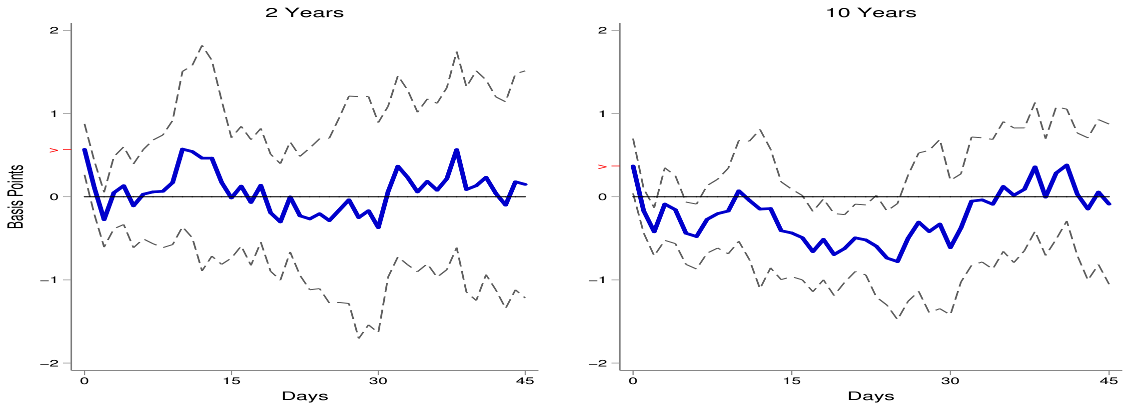
(a) 10-Year Yield



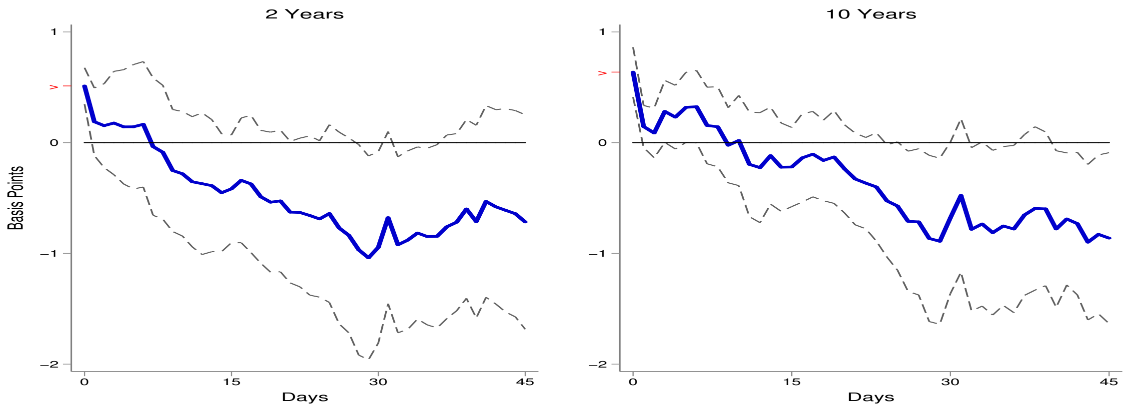
(b) 2-Year Yield

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year emerging market (EM) 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 high-frequency data around Fed's monetary policy announcements, see section 5.2 for details. The 90% confidence bands are based on Driscoll–Kraay standard errors.

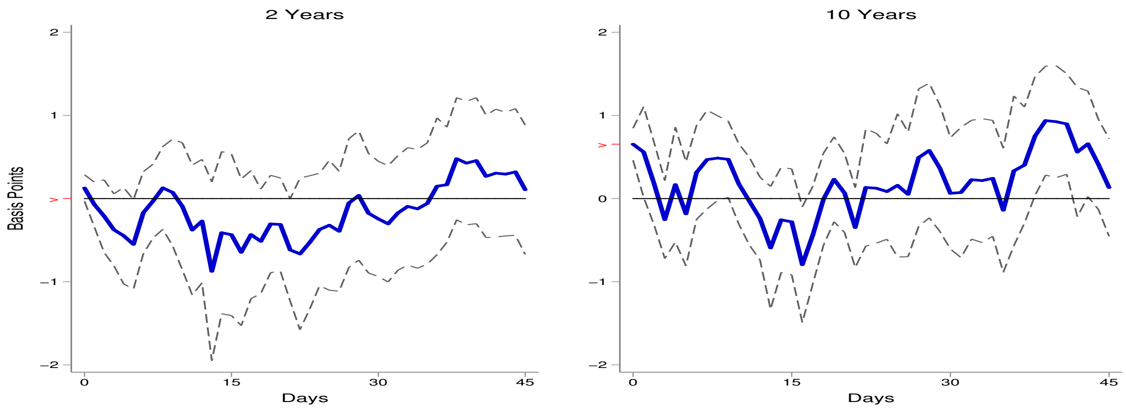
Figure D.8. Response of the Forward Premium to U.S. Monetary Policy Surprises



(a) Target Surprise: 2000-2008



(b) Forward Guidance Surprise: 2000-2019



(c) Asset Purchase Surprise: 2009-2019

Notes: This figure shows the response following Jordà (2005) of the 10- and 2-year forward premium for emerging markets to U.S. monetary policy surprises. The forward premium is calculated using cross-currency swaps, which are in turn constructed using cross-currency basis swaps and interest rate swaps, see section 2.1 for details. The target, forward guidance and asset purchase surprises are identified using high-frequency 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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Todo list