Bond Risk Premia in Emerging Markets: Dynamics, Comovement and Drivers

M. Pavel Solís M. *

This draft: June 6, 2020

Abstract

This paper studies the sovereign bond yields of 15 emerging markets. I overcome common concerns in analyzing these yields, like credit risk and small sample sizes, by using synthetic local currency yield curves to account for credit risk and survey forecasts of economic activity to address the small sample problem. I document that bond risk premia in emerging markets is time-varying. Moreover, I decompose the nominal yields into an expected future short-term interest rate, a term premium and a credit risk premium. I find that the bond yields of emerging markets comove mainly driven by the term premia, rather than by the expected short rate or the credit risk premia. In fact, the global component of term premia is highly linked to the U.S. term premia, whereas its idiosyncratic component is countercyclical.

Keywords: Synthetic yield curves, term premium, credit risk, emerging markets, affine term structure models, international spillovers.

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

*Address: Wyman Park Building 544E, 3400 N. Charles Street, Baltimore, MD 21218, United States. Email: msolism1@jhu.edu.

1 Introduction

[Go2ToC]

- Outline: establish time-varying risk premia in EMs (C-P regressions), account for credit risk (D-S), model time-varying *term* premia (ATSM, constant volatility), estimation (Guimaraes), analyze results (drivers of credit and term premia).
- Improve the literature review part.
- Reference for theoretical explanations of why EM can default *in LC*: small cost to default in LC if already defaulted in FC, if external debt of firms is large don't want to default in FC.
- Review cases of actual default. Papers by Reinhart, database BoC-BoE, S&P annual report on sovereign defaults.
- Why doing this is useful/necessary? To improve the conduct of MP in EMEs: appropriately characterizing expectations, TP and credit risk.
- Applications: portfolio allocation, MP, risk management.

Financial conditions across countries are widely believed to be interconnected. Yet, the extent to which the local financial conditions in emerging markets are interrelated has barely been explored, in part due to data availability. Around the turn of the millennium, these countries used to issue bonds at short maturities and in foreign currency.

This paper asks whether and to what extent the local currency sovereign yields of emerging markets are interconnected. This is important for two reasons. First, emerging markets play an increasingly important role in the global economy. Second, bonds denominated in local currency have become an important source of funds for emerging markets over the last two decades (Du and Schreger, 2016b; Ottonello and Perez, 2019; Galli, 2020). Therefore, improving our understanding of how their local financial conditions are interrelated will help in assessing the vulnerabilities of the global financial system.

Sovereign yields compensate investors for different motives, thus decomposing them provides further insights about the extent to which they are interconnected. An important consideration is that, contrary to the debt issued by advanced countries, international investors demand a credit risk premium to hold the bonds issued by emerging markets to compensate them for the risk of not receiving the promised payments.[1] Indeed, even though countries can, in theory, print their own currency to avoid defaulting on their debt, emerging markets are prone to default (Reinhart and Rogoff, 2011; Erce and Mallucci, 2018).[2] Theoretical explainations for these episodes include Du and Schreger (2016b) and Galli (2020).

The no-credit-risk assumption is key to decompose the bond yields of advanced countries into a future expected short-term interest rate and a term premium that compensates investors for locking their money for the life of the bond. To account for credit risk in the bond yields of emerging markets, I use synthetic local currency yield curves, in essence, the U.S. yield curve swapped into each local currency and, therefore, akin to the U.S. issuing bonds in that currency.[3] They can be seen as the yield curves free of credit risk in each emerging market and, thus, decomposed into a future expected short rate and a term premium via an affine term structure model as in Cochrane and Piazzesi (2008). The difference between the actual yields and the synthetic ones captures the credit risk premium in each country (Du and Schreger, 2016a).

Accounting for credit risk allows me to decompose the actual bond yields of emerging markets into three parts: an expected future short-term interest rate, a term premium and a credit risk premium. This decomposition enables policymakers and practitioners to refine their analysis of the transmission of monetary policy in emerging markets as well as their risk management and asset allocation.[4] For instance, the results show that a

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

[2]Examples of actual defaults in local currency debt include El Salvador (2017), Ecuador (2008), Argentina (2001), Russia (1998); and in 1999 after an earthquake, Turkey retroactively taxed its debt.

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

[4]Examples of applications include simulations of the yield curve components for scenario analysis, investment allocation based on the term premium, and the effects of monetary policy decisions.

quarter of the 10-year yield of emerging economies (around 175 basis points on average) is due to the term premium, more than double the size of the credit risk premium.

The main findings of the paper are that the bond yields of emerging markets do indeed comove, and that this comovement is mainly driven by the term premia. In fact, the term premia is more globally connected than the credit risk premia and the expected short rates. The strong factor structure of the term premia of emerging markets is consistent with the evidence for advance countries (Adrian, Crump, Durham, and Moench, 2019).

The analysis then focuses on the determinants of the term premia in emerging markets. The results show that both global and domestic factors are important drivers of the term premia. Specifically, the global component of the term premia is highly linked to the U.S. term premium, whereas its idiosyncratic component is countercyclical. In fact, an increase in the unemployment rate or domestic inflation is associated with an increase in the term premia. Meanwhile, the effect of the exchange rate is in line with the risk-taking channel of exchange rates (Hofmann, Ilhyock, and Shin, 2019), according to which a currency appreciation is associated with easier financial conditions and compressed sovereign bond spreads.

The literature harness the synthetic yields in different contexts. Du, Tepper, and Verdelhan (2018c) used them to show that there are persistent and systematic deviations from covered interest parity (CIP), reflecting a higher regulatory burden for financial intermediaries. The CIP deviations in sovereign yields have different interpretations for different countries. Du, Im, and Schreger (2018b) show that CIP deviations reflect differences in the convenience yield of advanced countries relative to the U.S., whereas Du and Schreger (2016a) show that CIP deviations capture a credit risk premium for emerging markets. Rather than concentrating on CIP deviations, this paper focuses on the synthetic yields themselves and exploits them to decompose the bond yields of emerging markets. This paper therefore contributes to the large literature on term structure models by pioneering their application on synthetic yield curves, and to the literature that decomposes the bond yields of emerging markets (Blake, Rule, and Rummel, 2015; Adrian, Crump, Durham, and Moench, 2019) by correcting for credit risk.

This paper also contributes to the literature on the international comparison of sovereign yields (Dahlquist and Hasseltoft, 2016; Adrian et al., 2019), which has mainly focused on advanced economies. It also extends the work of Wright (2011) by considering emerging markets in the international comparison of term premia. On the effects of U.S. monetary policy shocks, the paper extends the results in Gilchrist, Yue, and Zakrajšek (2019) by studying not only the effects on the yield curve but on its components,[5] it also extends the results in Curcuru, Kamin, Li, and Rodriguez (2018) by analyzing the effects of the components of the U.S. yield curve on the components of the yields of emerging markets.

The rest of the paper proceeds as follows. The next section explains how to construct the local currency yield curves. Section 3 describes the affine term structure model. Section 4 reports the yield decompositions and the evidence on comovement. Section 5 studies the U.S. monetary policy spillovers to the bond yields in emerging markets. The last section concludes.

2 Local Currency Yield Curves

[Go2ToC]

- Include reference for small counterparty risk in XCS.

This section explains how to construct the LC yield curves. It first explains how the nominal and synthetic yield curves are obtained, followed by a description of the different data sources. The synthetic yield curve will be decomposed into an expected future short-term interest rate and a term premium in the next section.

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 for each maturity (see Du, Im, and Schreger, 2018a).

[5] Hofmann et al. (2017) already study the link between the U.S. monetary policy, the exchange rate and credit risk premium in emerging markets.

The forward premium compensates for the expected depreciation of a currency.[6] The key assumption behind this approach is that the U.S. yield curve is free of default risk and therefore 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 of one year and larger, the forward premium is calculated using cross-currency swaps (XCS) since outright forwards are less liquid.[7] 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 London interbank offered rate in USD), and then swap them into fixed-rate cash flows in USD using interest rate swaps. Both types of swaps are liquid and collateralized instruments and so the bilateral counterparty risk in XCS is small.

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

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

Instead of relying on the U.S. yield curve and XCS rates, zero-coupon nominal yields, $y_{t,n}^{LC}$, can be derived from the actual quotes of the bonds traded in the market. At the same time, the construction of the synthetic yield curve $\widetilde{y}_{t,n}^{LC}$ does not require knowledge of the nominal yield curve $y_{t,n}^{LC}$.[8]

According to the CIP condition, the nominal (direct) and the synthetic (indirect) LC

[6] In this paper, the exchange rate is expressed in LC per USD. An increase in the exchange rate thus represents a LC depreciation.

[7] Although credit default swaps (CDS)—financial derivatives aimed to protect investors against default by a bond issuer—capture credit risk in the medium to long term, they are not used in this paper for several reasons (Palladini and Portes, 2011). First, credit risk is not eliminated since it shifts from the bond issuer to the CDS seller, i.e. there is counterparty credit risk. Second, there is not enough clarity on the definition of a credit event; for instance, borrowers can intentionally circumvent the CDS payout. Third, since investors do not need to hold the underlying bond to buy a CDS, there is the chance for market manipulation.

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

interest rates should be equal. CIP thus implies that an issuer should be able to borrow directly or indirectly (synthetically) in LC at the same yield. Du, Tepper, and Verdelhan (2018c) show, however, that there are persistent and systematic deviations from CIP. The spread between the nominal and synthetic yields ($y_{t,n}^{LC} - \widetilde{y}_{t,n}^{LC}$) therefore measures CIP deviations in sovereign yields. Du, Im, and Schreger (2018b) show that these CIP deviations reflect differences in the convenience yield of advanced countries relative to the U.S. Nevertheless, CIP deviations have a different interpretation for emerging markets. Du and Schreger (2016a) argue that the nominal-synthetic spread captures a credit risk premium in the sovereign yields of emerging markets.[9] Whereas the nominal yields of advanced countries are usually considered free of default risk, it is reasonable for the nominal yields of emerging markets to include a credit risk premium. In fact, since the components of the synthetic yield in equation (1) are risk-free, it can be seen as the borrowing rate paid by a hypothetical issuer in LC with no default risk. The nominal-synthetic spread in emerging markets therefore captures the credit risk premium.

2.2 Construction of Nominal Yield Curves [Go2ToC]

To estimate the nominal yield curve $y_{t,n}^{LC}$, I use the Bloomberg Fair Value (BFV) curves. These curves report coupon-equivalent par yields. The BFV par rates are converted into continuously-compounded rates (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 is no BFV curve. For Brazil and Israel, Bloomberg provides zero-coupon yields with coupon-equivalent compounding. I convert these yields, known as IYC curves, into continuously-compounded yields.[11]

The resulting continuously-compounded zero-coupon curve is what this paper refers

[9] For instance, CDS rates are highly correlated with the CIP deviations of emerging markets but not with the CIP deviations of advanced countries.

[10] As a robustness check, I estimate the nominal yield curves from actual prices for some of the countries in the sample. These estimated yield curves follow those reported by Bloomberg closely.

[11] For some EMs, 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 AEs and, compared to the BFV curves, the short end of the IYC curves behaves differently for some countries and dates.

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 (EMs) and, to compare the results, 10 advanced economies (AEs).[12] The countries are selected based on data availability. AEs are sometimes split into two groups to assess whether the type of advanced country matters. The first group (non-U.S. G3) is comprised by Germany, Japan and the United Kingdom, and the rest of the countries comprises the second group (A-SOE), which are basically advanced small open economies, arguably more directly comparable to emerging markets.

Yields are observed at the end of each month from January 2000 to January 2019.[13] Even though the end date is the same for all countries, the starting dates for emerging markets vary per country (between January 2000 and November 2006). There are therefore at least 10 years of data for each emerging market; although this is a reasonable time period for the estimation of the affine term structure model discussed in section 3, there may be too few interest rate cycles per country in the sample, an issue addressed with surveys of professional forecasters (see section 3.4). The dataset includes yields with maturities of 3 and 6 months, and 1 through 10 years, ranging from a minimum of eight to a maximum of twelve maturities per country. 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.

The nominal yield curves for all but two countries are obtained from the BFV and IYC curves, as explained in section 2.2.

The construction of the LC synthetic yield curves involves data from the U.S. yield

[12]The 15 EMs 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 AEs are: Australia (AUD), Canada (CAD), Denmark (DKK), Germany (EUR), Japan (JPY), Norway (NOK), New Zealand (NZD), Sweden (SEK), Switzerland (CHF) and the United Kingdom (GBP). For each country, the currency identifier is shown in parenthesis.

[13]Since the U.S. yield curve is the benchmark for the synthetic yield curves, these are the last business dates of each month according to the U.S. calendar.

curve and the forward premium for different maturities, as explained in section 2.1. Data for the U.S. zero-coupon yield curve is obtained from two sources. For maturities of one through ten years, the yields come from the dataset constructed by Gürkaynak, Sack, and Wright (2007) (hence GSW).[14] Treasury securities with less than one year to maturity are less actively traded than others. The estimates from the Center for Research in Security Prices (CRSP) are thought to be more robust at the short end of the curve (see Goliński and Spencer, 2019). Specifically, the 3- and 6-month yields are the annualized 13- and 26-week rates (bid/ask average) in the CRSP Risk-Free Rates Series.[15]

As mentioned before, how the forward premium is calculated depends on the maturity. To compute the forward premium 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. For all the countries in the sample, the data for these swap curves comes from Bloomberg.[16]

3 Methodology

[Go2ToC]

- References for solutions to identification problem.

This section describes the discrete-time affine term structure model used to estimate the dynamics of the sovereign yield curves for the countries in the sample, discusses the identification problem of the model parameters and presents the survey data used in the estimation of the model for emerging markets.

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

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

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

3.1 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 $y_{t,n} = -\ln P_{t,n}/n$. Thus, the one-period continuously compounded risk-free rate is $r_t = -\ln P_{t,1}$.

The no-arbitrage assumption implies the existence of a strictly positive stochastic discount factor (SDF), M_{t+1}, that prices all assets. Accordingly, the bond price today equals the expectation, conditioned on all current information, of tomorrow's discounted price, it is thus recursively defined as follows:[17]

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

where $\mathrm{E}_t^{\mathbb{P}}[\cdot]$ denotes the conditional expectation 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, which is defined as follows:

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

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

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

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

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

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

follows

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

where δ_0 is a scalar and δ_1 is a 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 the pricing factors:

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

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

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

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

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

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

where λ_0 is a K $\times$ 1 vector and λ_1 is K $\times$ K matrix of parameters.

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

[18] To obtain the price coefficients can be computed recursively as follows after combining the no-arbitrage condition and the functional form for bond prices.

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

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

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

$$M_{t+1} = \exp\left(-r_t - \frac{1}{2}\lambda_t'\lambda_t - \lambda_t'\nu_{t+1}^{\mathbb{P}}\right), \tag{11}$$

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

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

where $A_n^{\mathbb{P}} = -\frac{1}{n}A_n$, $B_n^{\mathbb{P}} = -\frac{1}{n}B_n$, and where in turn 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 instead the parameters of the law of motion of the pricing factors under the physical $\mathbb{P}$ measure.

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

$$y_{t,n}^{e} = A_n^{e} + B_n^{e} X_t,$$

where $A_n^e = -\frac{1}{n}A_n$, $B_n^e = -\frac{1}{n}B_n$, and where $A_n = \mathcal{A}(\delta_0, \delta_1, \mu^{\mathbb{P}}, \Phi^{\mathbb{P}}, 0, n)$ and $B_n = \mathcal{B}(\delta_1, \Phi^{\mathbb{P}}, n)$ also satisfy the same recursions under $\mathbb{P}$ but setting $\Sigma = 0$ (see Appendix C of Guimarães (2014)).[20] In this sense, having information about $y_{t,n}^e$ could help in identifying the parameters under the $\mathbb{P}$ measure, $\{\mu^{\mathbb{P}}, \Phi^{\mathbb{P}}\}$.

The term premium for maturity n at time t, $tp_{t,n}$, can then be estimated as the

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

[20] The difference between $y_{t,n}^{\mathbb{P}}$ and $y_{t,n}^{e}$ is a convexity term due to Jensen's inequality, which increases with maturity. This term, however, usually becomes relevant for maturities beyond ten years. Further, this term is constant across maturities in homoskedastic models.

difference between the yields obtained under the $\mathbb{Q}$ and $\mathbb{P}$ measures:

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

A key assumption behind this model is that the yield $y_{t,n}$ is risk-free, a reasonable assumption for advanced but not for emerging countries since investors demand a credit risk premium from them (Du and Schreger, 2016a). This implies that the nominal yield $y^{LC}_{t,n}$ of emerging markets is not risk-free, that is why I focus on their synthetic yield $\widetilde{y}^{LC}_{t,n}$ because it aligns better with the risk-free assumption.

3.2 Identification Problem

[Go2ToC]

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

This identification problem is due to the high persistence of bond yields, which results in small sample bias (Kim and Orphanides, 2012; Guimarães, 2014). Accordingly, the dynamics of the state vector will tend to mean-revert too quickly, overestimating the stability of the expected path of the short rate and, thus, attributing much of the variability in yields to fluctuations in the term premium.

Different solutions have been proposed to address this identification problem, including restrictions on parameters (Duffee 2010, Bauer 2018), bias-corrected estimators (BRW 2012) and adding information from survey forecasts in the estimation (Kim and Wright, 2005; Kim and Orphanides, 2012; Guimarães, 2014). Guimarães (2014) compares the three approaches and concludes that surveys provide robust decompositions of the yield curves in the U.S. and the U.K. For instance, he finds that the term premia estimated with the aid of surveys remain essentially the same after varying the number of pricing factors (from 3 to 5) and the sample periods.

The results in Guimarães (2014) are particularly relevant for emerging markets for two reasons. First, compared to the usual sample size in estimating the U.S. yield curve, the sample size in emerging markets is relatively shorter. Second, since the early 2000s there has been a considerable reduction in the inflation rates of many emerging markets, which can be considered as a regime change. This is one of the reasons studies focusing on the U.S. use different sample periods. Guimarães (2014) shows that even with a sample starting in 1972—including the U.S. Great Inflation period— the estimated term premia using surveys is consistent with those obtained with shorter samples. Since surveys help to overcome both small sample sizes and regime changes, they are especially pertinent to get reliable decompositions for the bond yields of emerging markets.[21]

3.3 Survey Data [Go2ToC]

There is no source for long-term forecasts for the future policy rate of emerging markets. However, they can be inferred from existing data and Taylor rule-type regressions.

Twice a year Consensus Economics provides 1- through 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. This data is available from March 2001 to October 2017.[22]

To obtain the embedded expectations for the policy rate in the survey responses, I first estimate the following model with quarterly data for each emerging market:

$$r_t = \beta_0 + \beta_r r_{t-1} + \beta_\pi \pi_t + \beta_y g_t + \epsilon_t, \tag{13}$$

where r_t is the policy rate, π_t is the year-on-year consumer inflation and g_t is the year-on-year real GDP growth; β_r is a smoothing parameter that improves the fit of the model to the data. The information for r_t is obtained from the policy rate statistics of the Bank

[21]In addition to supplementing the information from bond yields in the estimation of affine term structure models, surveys can also be used to obtain a model-free estimate of the term premium, calculated as the difference between the long-term interest rate and the expected future short rate from surveys (over the same horizon). This model-free estimate serves as a robustness check for the term premia obtained from the affine model.

[22]The availability of data varies by country; for example, data for the Philippines starts in 2009, whereas data for Latin American countries ends in October 2013. Survey data for Israel and South Africa is not available.

for International Settlements, and the data for inflation and real GDP growth comes from Bloomberg.

I then assume that the estimated parameters from equation (13) apply to each of the survey maturities $n = 1, 2 \ldots, 5, 10$ for inflation and real GDP growth, and thus the expected future policy rate is calculated as:[23]

$$r_{t,n}^{survey} = \frac{\hat{\beta}_0}{1-\hat{\beta}_r} + \frac{\hat{\beta}_\pi}{1-\hat{\beta}_r}\pi_{t,n}^{survey} + \frac{\hat{\beta}_y}{1-\hat{\beta}_r}g_{t,n}^{survey}. \tag{14}$$

I account for the uncertainty in the estimation of r_t^{survey} when estimating the survey-augmented affine model. The model-free estimate for the n-period term premium is obtained as the difference between $y_{t,n}^{LC}$ and $r_{t,n}^{survey}$.

In principle, there is an alternative way to use the surveys from Consensus Economics to aid in the estimation of the affine model. The emerging markets in the sample can be assumed to be small open economies and so their real interest rate would be determined abroad. Accordingly, the forecast for the local short rate would be equal to the forecast for the international short-term real interest rate plus the forecast for inflation at each of the available maturities. This, however, not only requires to define the international short-term real interest rate but also to rely on long-term forecasts for it.

3.4 Estimation [Go2ToC]

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

The JSZ normalization allows for the near separation of the model's likelihood function into the product of the $\mathbb{P}$ and $\mathbb{Q}$ likelihood functions, and reduces the dimension of the parameter space from $(\delta_0, \delta_1, \mu^{\mathbb{Q}}, \Phi^{\mathbb{Q}}, \Sigma)$ to $(r_\infty^{\mathbb{Q}}, \lambda^{\mathbb{Q}}, \Sigma)$, where $r_\infty^{\mathbb{Q}}$ 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 $\Phi^{\mathbb{Q}}$.

[23] Under stationarity, $\mathrm{E}(r_t) = \mathrm{E}(r_{t-1})$. The long-term forecasts are allocated to the 10-year maturity.

The affine model can be estimated using the JSZ normalization following a two-stage procedure. First, the $\mathbb{P}$ parameters are estimated by OLS of the VAR in equation (10) using the K principal components of the synthetic yield curve $\widetilde{y}_{t,n}^{LC}$. This provides initial values for the maximum likelihood estimation of the matrix Σ. Then, taking $\hat{\mu}^{\mathbb{P}}$ and $\hat{\Phi}^{\mathbb{P}}$ as given, the $\mathbb{Q}$ parameters can be estimated by maximum likelihood. The two-stage estimation is used to estimate the affine model for the advanced countries in the sample.

For emerging markets, however, the model presented in section 3.1 is augmented with survey expectations of the short rate.[24] The model is augmented with the survey expectations on the last day of the month for which the data was published.[25] Notice that yield curve data is monthly whereas survey data is available twice a year.

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

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

$$\mathbf{y}_t = \mathbf{A} + \mathbf{B}X_t + \mathbf{\Sigma}_Y \mathbf{u}_t, \tag{15}$$

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

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

[24] I do not have access to survey data for the advanced countries in the sample. However, they are not the main focus of this paper; in fact, the affine model is estimated for them just for comparison purposes. Moreover, the results in this paper 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.

[25] 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.

number of survey forecasts S as follows:

$$\begin{bmatrix} \mathbf{y}_t \\ \mathbf{y}_t^S \end{bmatrix} = \begin{bmatrix} \mathbf{A} \\ \mathbf{A}^S \end{bmatrix} + \begin{bmatrix} \mathbf{B} \\ \mathbf{B}^S \end{bmatrix} X_t + \begin{bmatrix} \mathbf{\Sigma}_Y \mathbf{u}_t & \mathbf{0} \\ \mathbf{0} & \mathbf{\Sigma}_S \mathbf{u}_t^S \end{bmatrix} \tag{16}$$

where $\mathbf{y}_t^S$ is a $\mathrm{S} \times 1$ vector of survey forecasts, $\mathbf{A}^S$ 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 (2018) in two aspects. First, I use the estimated parameters from the JSZ normalization as initial values for the Kalman filter. Second, I assume homoskedasticity in yields and survey errors, so that $\mathbf{\Sigma}_Y = \sigma_y I_{\mathrm{N}}$ and $\mathbf{\Sigma}_S = \sigma_s I_{\mathrm{S}}$, where I_{N} and I_{S} are $\mathrm{N} \times \mathrm{N}$ and $\mathrm{S} \times \mathrm{S}$ identity matrices, respectively. This reduces the number of parameters to be estimated.

Finally, survey data helps to discipline the model but, at the same time, relying too much on it can be counterproductive due to, for instance, measurement error[26] and overfitting. To strike a balance between these two considerations, I follow Kim and Wright (2005) in not estimating σ_s, it is instead kept fixed at a conservative level of 75 basis points. This essentially means that survey data is considered a noisy measure of policy rate expectations.[27]

4 Results

[26] Consensus Economics does not report long-term forecasts for the policy rate of emerging markets.

[27] Check: The estimates are similar though when σ_s is estimated.

[Go2ToC]

- Add website for Excel file with tickers.
- Units or deviation with respect to what for RMSE table.
- Include summary statistics of the ATSM fitted curves to give a feeling about the data.
- Include macro factors when estimating the dynamics of the vector of state variables in equation 10.
- When considering the spillover effects of the monetary policy in the U.S., use a better measure of shocks (e.g. changes in futures of the fed funds rate around monetary policy announcements) and differentiate conventional from unconventional monetary policy.

The aim of this paper is to decompose the synthetic yield curves of emerging markets, which in turn provides a decomposition of their nominal yield curves. I use two benchmarks to assess the relevance of the results. First, I compare the estimated term premia for emerging markets to those of advanced economies. Second, I compare the term premia obtained from both nominal and synthetic yield curves[28] to assess the benefit of using synthetic curves. The macroeconomic and financial variables used in section 5 are downloaded from Bloomberg.

4.1 Emerging Markets Bond Risk Premia [Go2ToC]

4.2 Yield Curve Decompositions [Go2ToC]

[28] In each case, assuming that the curve used is risk-free.

	Nominal	Synthetic
EM	0.15	0.48
AE	0.13	0.08

Table 1. Fit of Affine Term Structure Models.

4.3 Assessment of Term Premia Estimates [Go2ToC]

4.4 Sovereign Yield Comovement

4.5 Estimated Synthetic Yield Curves

An affine term structure model is estimated for each country using the JSZ normalization and the two-stage procedure described in section 3.4. The VAR model in equation (10) is estimated using the first three principal components (PCs) of the synthetic yield curves. Consistent with the empirical evidence that uses nominal yield curves,[29] on average more than 99% of the variation in synthetic yields is explained by those three factors for all emerging markets.

Table 1 summarizes the fit of the models. The table shows the average root mean square fitting error in annualized percentage points of nominal and synthetic yields for emerging markets and advanced economies.[30] As can be seen, the fit of the model for the nominal curves of both groups of countries is similar. The fit for the synthetic curves of advanced countries slightly improves relative to the fit for their nominal curves, while that for emerging markets declines. It is worth mentioning that the latter is driven mainly by two countries, Brazil and Indonesia, whose root mean square fitting error is slightly above 2%.[31] This requires further inspection of the synthetic yield curves of these two countries.[32]

[29] Litterman and Scheinkman (1991) first report this and refer to the PCs as level, slope and curvature.

[30] For each country, the root mean square fitting error is calculated as the square root of the average (across months and maturities) squared difference between the observed yields and the fitted yields from the estimated affine term structure model.

[31] Although not as high, the root mean square fitting error for Peru and Philippines is also above average at around 0.64 and 0.54, respectively.

[32] In some special cases, outliers may need to be dropped in some periods to be able to fit the curve for the rest of the points.

	Nominal	Synthetic	Expected	Term Premium	CIP Dev
EM	7.10	6.11	4.29	1.74	0.85
A-SOE	3.48	3.52	1.54	1.97	-0.23
G-3	2.41	2.13	0.52	1.60	0.15

Table 2. 10-Year Yield Decomposition (%).

4.6 Nominal Yield Curve Decomposition

Once the affine term structure model is estimated for each country, I can compute the term premia for each maturity (as explained in section 3.1) and, in turn, decompose both the synthetic as well as the nominal yield curves.[33] In particular, the synthetic yield curve is decomposed into the expectation of the future short-term interest rate and a term premium. In addition to those two, the third element in the decomposition of the nominal yield curve is the deviation from CIP.

Table 2 shows the simple average across countries of the decomposition of the 10-year yields.[34] Several patterns emerge from the table. The values for the deviations from CIP (CIP Dev) are in line with the results reported by Du and Schreger (2016a) and Du et al. (2018b) referred to as the LC credit spread (LCCS) for emerging markets and the convenience yield for advanced countries, respectively. Note that the estimated term premium is higher on average than the CIP dev for the three groups of countries; it is almost 90 basis points higher for emerging markets, almost 150 basis points higher for Germany, Japan and the United Kingdom and more than 200 basis points for the advanced small open economies. Thus, the term premium plays a relatively bigger role than CIP deviations in the dynamics of sovereign bond yields.

While the main component of the nominal yield curve of emerging markets is the expectation of the future short-term interest rate, for advanced countries the main component is the term premium. That is, the term premium plays a relatively bigger role in the dynamics of the sovereign bond yields of advanced countries than those of emerging

[33] Although term premia estimates are calculated for all maturities, only the 10-year maturity is reported in what follows for the sake of brevity.

[34] The numbers in the table do not add up exactly for two reasons: (1) the term premium is obtained using equation (12), that is it uses the fitted synthetic yield curve, while the table reports the observed synthetic yield curve for the column 'Synthetic', and (2) the sample period for the yield curves might differ slightly to that of the CIP deviations.

markets.

Finally, note that for the subset of small open economies it is cheaper to borrow directly in their own currency (since CIP Dev is negative), unlike what is seen for emerging markets.

4.7 Term Premia: Nominal or Synthetic Yield Curve?

Affine term structure models are usually estimated using nominal yield curves on the assumption that they are free of default risk. Du et al. (2018c) show that deviations from covered interest parity are non-negligible. Therefore, there is a wedge between the nominal ($y^{LC}_{t,n}$) and synthetic ($\widetilde{y}^{LC}_{t,n}$) yield curves given by the LCCS in the case of emerging markets and by the convenience yield in the case of advanced economies. Does this wedge bias the estimation of term premia? Equivalently, does it matter which curve is used to estimate the term premia? We can answer these questions by fitting the model described in section 3.1 to both curves and compare the estimates.

Table 3 show the average term premia across groups of countries obtained by using the nominal and the synthetic yield curves. For advanced countries, the difference between the two is less than or equal to 10 basis points on average, while for emerging markets is more than 40 basis points. To assess whether the term premium estimates from the two curves are statistically different from each other, I perform a t-test for the equality of means (with unequal variances) between them for each country. The null of equal means is rejected at the 5% significance level for all emerging markets except Hungary and Malaysia. However, the null is only rejected for four advanced economies (Australia, Denmark, Japan and New Zealand). This shows that there are gains by using synthetic yield curves to account for credit risk when estimating the term premia, especially for emerging markets.

The evidence in tables 2 and 3 shows that, although sometimes used interchangeably, the terms 'risk premium' and 'term premium' are not the same thing, at least not for emerging markets, since *both* the term premium and the LC credit spread play an important role in the dynamics of the risk premium in the bond yields of emerging economies.

	Nominal	Synthetic
EM	2.17	1.74
A-SOE	2.03	1.97
G-3	1.70	1.60

Table 3. 10-Year Term Premium Comparison (%).

4.8 Stylized Facts of EM Term Premia

I use the U.S. term premium as a benchmark to compare the behavior of the term premia in emerging markets. Two frequently cited estimates of the U.S. term premium are Kim and Wright (2005) (hence KW) and Adrian, Crump, and Moench (2013). Analysis of the estimates of the U.S. term premium shows that: (1) it is time-varying; (2) it has declined over time; (3) its sign changed from positive to negative in recent years; and (4) increases during periods of uncertainty and vice versa. Common explanations for the decline in the U.S. term premium include an increased demand of U.S. assets by global investors, and the effects of the the large-scale asset purchases conducted by the the Federal Reserve in response to the Great Recession. Regarding the change in the sign of the term premium, Campbell, Sunderam, and Viceira (2017) argue that it is explained by a flip in the sign of the correlation between stocks and bonds; when investors changed their perception of bonds as hedges of stock investments, the correlation between the two assets turns negative which drives down the term premium. Finally, the U.S. term premium increased around the onset of the Great Recession (September 2008), the taper tantrum (June 2013), and the 2016 U.S. presidential election (November 2016), while it declined after the first unexpected announcement of the quantitative easing program by the Fed (March 2009) -which was seen as helping to reduce some of the uncertainty at the time-.

The 10-year term premia estimates for emerging markets are plotted in Figure 1. It is worth highlighting some regularities observed in the figure: (1) term premia in emerging markets are time-varying; (2) the estimates are sensible, i.e. they fluctuate between -1% and $+6\%$; (3) there appears to be co-movement in the term premia of some countries; (4) they behave similar to the U.S. term premium around key dates; (5) there is a slight downward trend in the term premia of some countries; (6) the term premia in emerging markets can be negative during some periods, but not to the level seen for the U.S.

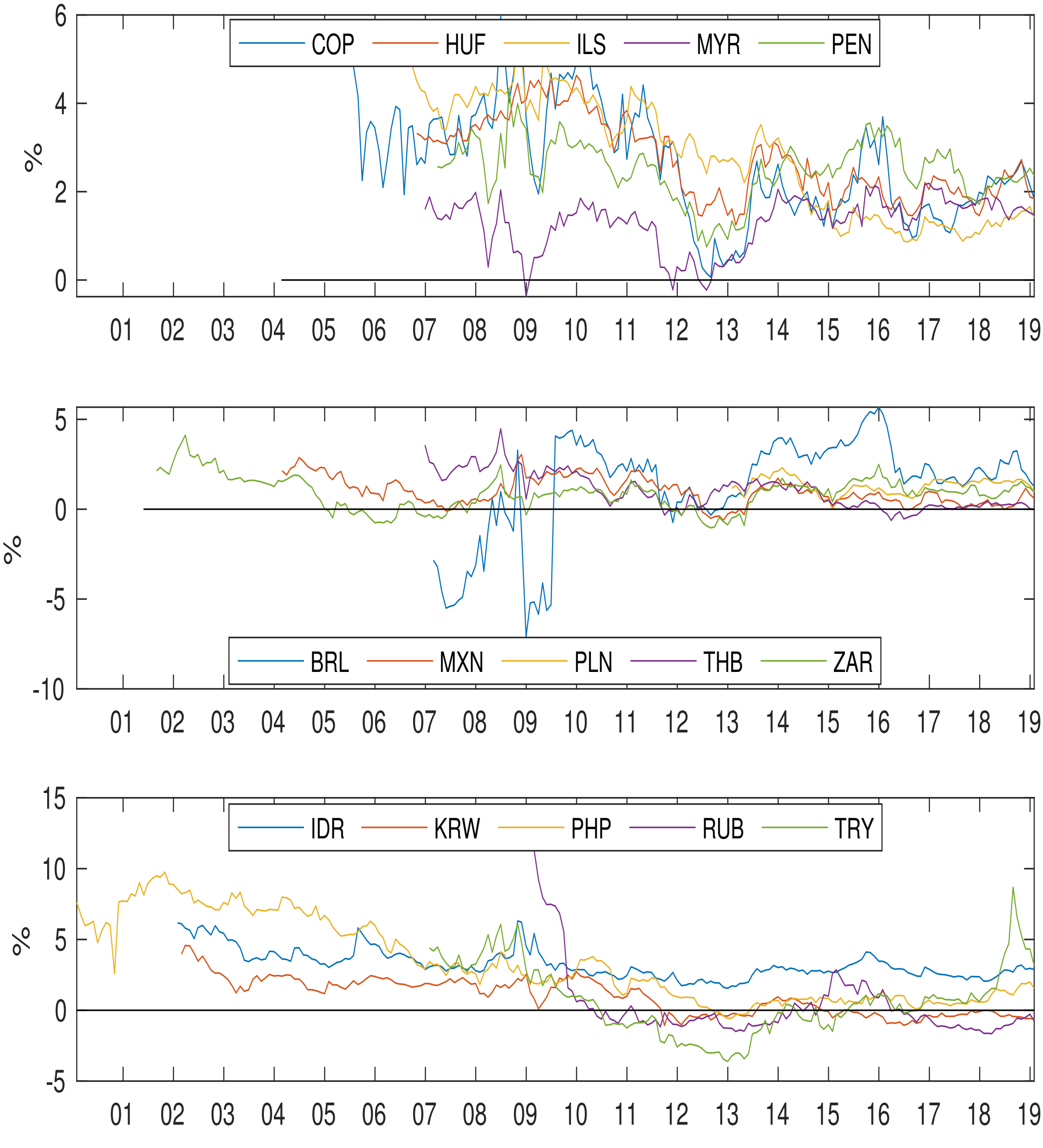

Figure 1. Estimated 10-Year Term Premia: Emerging Markets.

Special cases include that of Brazil whose term premium turn negative around the Great Recession and that of Russia whose term premium declined considerably. These cases might be reflecting local conditions and deserve further analysis. Consider, for example, the case of Turkey towards the end of the sample, where relevant events in

2018[35] translated into a higher term premium.

In addition to Brazil, Russia and Turkey, the term premia of most Asian countries has been in negative territory for some period of time. Moreover, with the exception of Brazil and South Africa, the term premia of emerging markets being negative is a phenomenon observed after the Great Recession.

For comparison purposes, Figure 2 shows the 10-year term premia estimates for advanced economies using synthetic yield curves. A clear downward trend is observed for all countries. This is consistent with the empirical evidence that uses nominal yield curves; Wright (2011) shows a declining trend in term premia for most of these countries going back to the 1990s and argues that it reflects a reduction in inflation uncertainty.

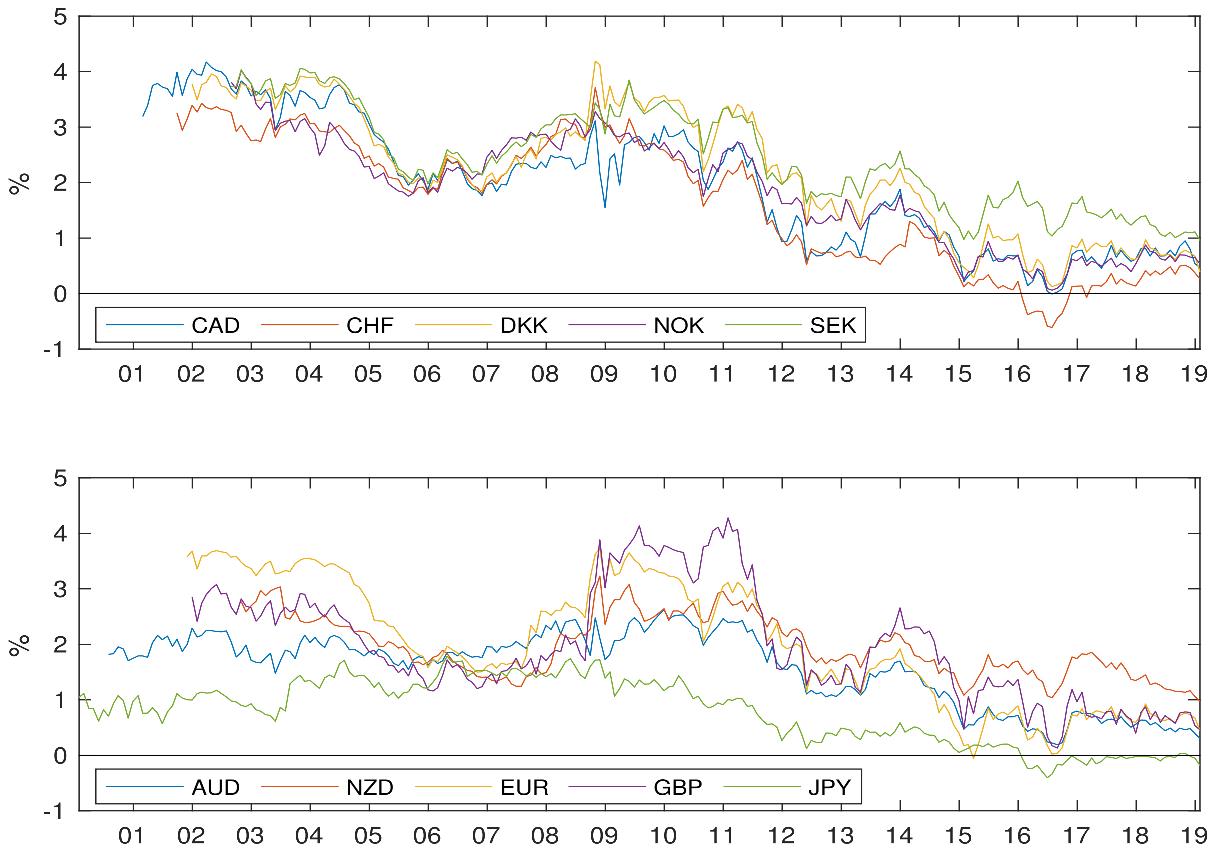

Figure 2. Estimated 10-Year Term Premia: Advanced Economies.

Note that although the term premia of most advanced countries seem to reflect a common factor, that of Japan behaves differently probably reflecting the fact that Japan was at the zero lower bound before the other countries.

[35]On June 24, 2018, Recep Tayyip Erdogan won the presidential election. On October 2, 2018, the journalist Jamal Khashoggi disappeared after he visited the consulate of Saudi Arabia in Istanbul.

According to KW, the 10-year term premium estimate for the U.S. has been negative for most of the time since mid-2011, fluctuating between -1% and 0. Of the advanced countries considered, only Switzerland and Japan have experienced more than one month with a negative term premium, compared to several emerging markets, mainly Korea, Russia and Turkey. In particular, before the taper tantrum there was a tendency of declining term premia for emerging markets, which for some countries actually turned out negative.

4.8.1 Term Structure of Term Premia

In addition to comparing the term premia across countries, one can also compare them across maturities per country. In general, the term premium increases with maturity. As one would expect, when long-term bonds are seen as riskier than short-term bonds, investors would require a higher compensation for holding long-term bonds. This pattern, however, is not universal as can be seen in Figure 4 in the Appendix, which shows two examples of this, namely Korea and Mexico. Therefore, the exceptions for the general pattern are observed in both emerging and advanced countries since the KW estimates also show that after the Great Recession, the 1-year U.S. term premium has been above the 5- and 10-year term premia at some points.

4.8.2 Common Factors in Term Premia

To see whether there are common factors influencing the term premia in emerging markets, Table 4 shows the proportion of the total variation in the 10-year term premia explained by their first three PCs. To consider all countries, the starting date is December 2006. The first three PCs explain more than 80% of the variation in the term premia of emerging markets and more than 98% for advanced countries. This evidence highlights the importance of considering global factors as drivers of the term premia. But at the same time, the evidence for emerging markets shows that both domestic and common factors seem to be at play as drivers of their term premia.

	Jun-2005
EM	65.32
AE	89.17

Table 4. Variation of 10-Year Term Premium Explained by First PC (%)

4.8.3 Survey-Based Term Premia

As already mentioned, one way to check the term premia estimates obtained from affine term structure models is to use survey data since long-term surveys of professional forecasters can be used to obtain a model-free estimate of the long-term term premium. Using this approach, the term premium is calculated as the difference between the long-term interest rate and the survey-expectation of the future short-term interest rate over the same horizon. Since the long-term expectations of the policy rate for emerging markets are not provided by Consensus Economics, they are approximated as explained in section 3.3. As it is also explained in that section, given the persistence of bond yields, surveys can also provide information to help in the identification of the term premium. It is important to acknowledge, however, that surveys might not represent the market expectations or the expectations of the marginal investor.

Figure 3 displays the 10-year (long-term) term premium estimated in this way for most of the emerging markets considered in Figure 1.

With the exception of Brazil during 2012-13, the term premia estimated using survey data are in line with the model-based term premia. In fact, the average correlation between the two is 80.4%.[36] This is reassuring and supports the idea of supplementing the term structure model with survey data to better pin down the term premia in emerging markets, which will in turn provide a more robust decomposition of the nominal yield curve. This will be done in future versions of this paper.

5 International Spillovers of U.S. Monetary Policy

[36] Even for the term premia calculated using the nominal yield curve, the correlation with the survey-based term premia is equal to 85%.

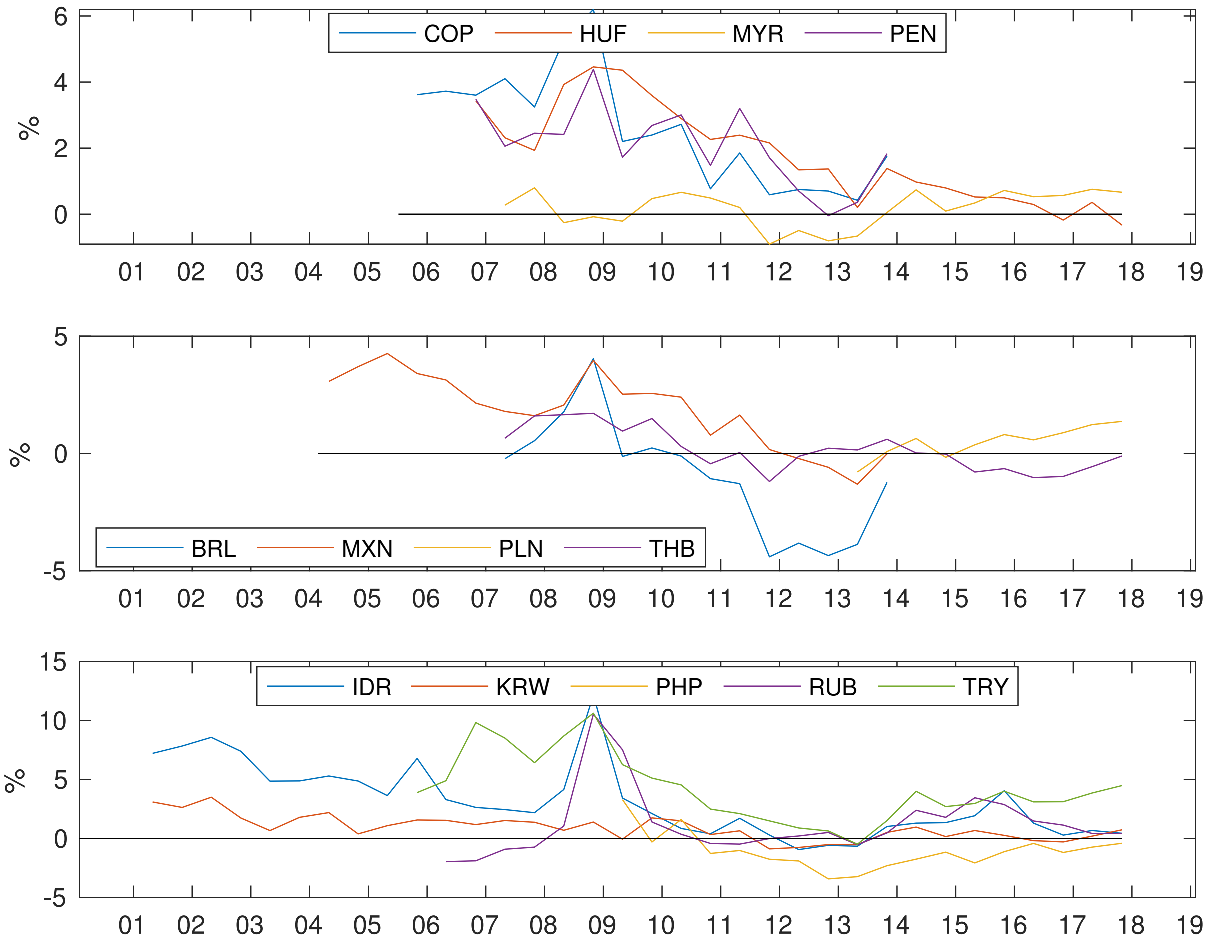

Figure 3. Survey-Based 10-Year Term Premium Estimates

	TP-USTP	TP-CIP Dev
EM	0.60	-0.28
A-SOE	0.80	-0.01
G-3	0.71	-0.29

Table 5. Correlations of 10-Year Term Premia: U.S TP and CIP deviations

[Go2ToC]

- Constrast the reference to Anaya et al. 2017 with Gilchrist, Yue & Zakrajzek (2018) and with Wright et al. (2017).
- Contrast effect of FX with Hofman, Shim and Shin
- Claims about effect of variables on expected part can be tested using the expected part directly as well as forecasts.

Since this is the first time that term premia is estimated using synthetic yield curves, I first present their correlation with variables commonly associated with risk and uncertainty before proceeding to a more formal analysis.

5.1 Relationship with Risk and Uncertainty Measures

To see how the term premia co-moves with variables associated with risk and uncertainty, they are compared against the 10-year U.S. term premium from KW, the LC credit spread from Du and Schreger (2016a) or the convenience yield from Du et al. (2018b), and the economic policy uncertainty (EPU) index proposed by Baker, Bloom, and Davis (2016). The first variable is an indicator of global financial conditions, while the second is an indicator of credit risk for emerging markets or the convenience yield for advanced economies. The EPU index is based on the frequency of articles in local newspapers containing key words such as 'economy', 'uncertainty' and 'central bank'; however, it is only available for 5 of the emerging markets in the sample. Tables 5 and 6 show these correlations.

	BRL	COP	KRW	MXN	RUB
TP-EPU	0.14	0.46	-0.32	0.40	-0.22

Table 6. Correlations of 10-Year Term Premia: Economic Policy Uncertainty Index

The term premia in emerging markets is related to the U.S. term premium but not as tightly linked as those for advanced countries. To assess the relationship of the country-specific component of the term premia with the other two variables, I regress the term premium of each country on the U.S. term premium and use the residuals as the 'idiosyncratic' term premium (i.e. the part of a country's term premium orthogonal to the U.S. term premium).

The correlation of the term premia with the deviations from CIP is negative. Du and Schreger (2016a) show that the LC credit spread has a low reaction to global variables. This provides a possible explanation for the negative relationship between the term premia and the LC credit spread, since the former seems to react to global factors as is formally tested in the next section. The last column of table 5 shows that once the term premia in emerging markets is purged from the effect of the U.S. term premium, the relationship is still negative but the magnitude declines. The opposite is observed for advanced small open economies but remember that for them the deviations from CIP reflect a convenience yield.

The term premia for Latin American countries show a positive correlation with the EPU index; the correlation for Korea and Russia, however, is negative. The relationship might be related to the fact that after the Great Recession, the term premia for both countries has been negative during a considerable period as shown in figure 1. This can be verified if the EPU index for countries with a similar situation (like Turkey) becomes available. Although the magnitude declines, the sign of the relationship with the idiosyncratic component of the term premia holds suggesting a role for domestic drivers of the term premia.

5.2 Drivers of Term Premia

To study the cyclical properties of term premia in emerging markets formally, I run panel data regressions with a variety of macroeconomic and financial variables as explanatory variables. The macroeconomic variables considered have a monthly frequency; for the financial variables considered (which are available daily) end-of-month values are used.

The panel data regressions have the form

$$tp_{it} = \alpha_i + \beta' z_{it} + u_{it}. \tag{17}$$

where tp_{it} denotes the model-based 10-year term premium of country i in month t, z_{it} is a vector of regressors and α_i denotes country fixed effects. The regressors include global and domestic variables as suggested by the evidence presented in tables 4-6. This is a first step towards understanding the drivers of term premia and, therefore, it is important to acknowledge the potential econometric problems such as endogeneity as well as the effects of the persistence of the variables considered.

The global financial variables include the Cboe's volatility index (VIX), the federal funds rate, the S&P 500 index and the oil price. The VIX and the federal funds rate have been used in the global financial cycle literature (see Rey, 2013) to study the effects of common factors on capital flows. The VIX is usually used as a measure of risk aversion and economic uncertainty and the fed funds rate is a measure of the monetary policy stance in the U.S. Given the sudden spikes in the VIX, it is common to use the $\ln(VIX)$ instead of the VIX directly. For the U.S. monetary policy, the variable used is the effective federal funds rate calculated by the New York Fed.

The domestic variables include inflation, the unemployment rate and industrial production to capture macroeconomic effects. In addition, the exchange rate (LC per USD) and the local stock market index are used as measures of local financial conditions.

Monthly returns, calculated as the log difference of the series, are used for the stock market indexes, the oil price and the exchange rate.

Table 7 reports different specifications of the model in equation (17). The first model

	(1)	(2)	(3)	(4)	(5)
log(Vix)	0.18		0.65***	0.14	
	(0.41)		(0.21)	(0.17)	
FFR	0.08		0.22**	0.12	
	(0.11)		(0.10)	(0.10)	
USTP10	1.55***			1.22***	
	(0.28)			(0.16)	
Return S\&P	-0.01		0.00		
	(0.01)		(0.01)		
Return Oil	-0.00		0.00		
	(0.00)		(0.00)		
INF		0.26***	0.22***	0.21***	0.222***
		(0.05)	(0.05)	(0.05)	(0.0400)
UNE		0.22***	0.21***	0.13**	0.137**
		(0.07)	(0.06)	(0.05)	(0.0583)
IP		-0.02	-0.02	-0.02*	-0.0193**
		(0.01)	(0.01)	(0.01)	(0.00792)
Return FX		0.02**	0.02*	0.02*	0.0199*
		(0.01)	(0.01)	(0.01)	(0.0103)
Return Stocks		0.00	0.00	0.00	0.000373
		(0.01)	(0.01)	(0.01)	(0.00751)
Constant	1.04	-1.40*	-3.18***	-0.84	1.235*
	(1.27)	(0.67)	(0.93)	(0.76)	(0.636)
Observations	2,406	1,969	1,969	1,969	1,969
R-squared	0.29	0.27	0.34	0.49	0.547
Number of Countries	15	15	15	15	15
Country FE	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	No	Yes

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7. Panel Data Regressions. Dep. Variable: EM 10-Year Term Premium (%).

in the table focuses mainly on global variables, while the second one focuses on domestic variables. These two models already shed some light on the driving forces behind the term premia in emerging markets. However, the models with the most explanatory power include both global and domestic variables.

The main global factor is the U.S. term premium, and the two main domestic factors are inflation and unemployment. Holding the other factors constant, an increase in any of these three variables increases the term premia in emerging markets. Note that external conditions have a relevant impact on domestic bond markets since the greatest effect comes from the U.S. term premium. This is in line with the literature studying the global financial cycle that focuses on capital flows. However, the channel does not seem to be through the VIX nor even through the monetary policy of the U.S. directly via the federal funds rate but through the U.S. term premia. Both the VIX and the federal funds rate appear to have a positive effect on the term premia in emerging markets but the effect disappears once the U.S. term premium is included in the regressions. An increase in the U.S. term premium translates into a more than proportional increase in the term premium of emerging markets.

The effect of the domestic variables is in line with what has been found for advanced countries using nominal yield curves. Investors demand a higher term premium during recessions, when the unemployment rate increases. This provides evidence of a counter-cyclical behavior of the term premia in emerging markets. Moreover, the positive effect of inflation on the term premia conforms with the idea that inflation erodes the value of nominal bonds and so in periods of rising inflation investors demand a higher term premium. The effect of both variables is broadly similar across models.

The exchange rate also seems to be playing a role; a depreciation of the local currency is associated with an increase in the term premium. This seems counterintuitive from the perspective of the standard trade-channel effect since emerging markets are usually commodity exporters. However, it is in line with the risk-taking channel of exchange rates found by Hofmann et al. (2017), according to which currency appreciation is associated with easier financial conditions and compressed sovereign bond spreads.

Finally, the effects of the domestic variables remain once one controls for time fixed effects. The effects of those variables remain broadly similar across the different specifications.

6 Concluding Remarks

- Study how the effect of macroeconomic and financial variables on the term premia compare to their effect on the LC credit spread and on the expectation of future short-term interest rates. That is, perform a full decomposition of 'observed' yields (default risk, term premia and expectations of future short-term interest rates) and analyze the effects of said variables on each component. This would extend the analysis done by GilchristYueZakrajsek:2019 on the spillover effects of U.S. monetary policy on LC bonds of emerging markets. Compare also with HofmannShimShin:2017. The set of variables could be extended too (e.g. monetary policy shocks in other advanced economies).

- Perform a more robust analysis of the determinants of term premia in emerging markets and how they differ from those of advanced economies.

- Uncovered interest parity is based on risk-neutrality. Could the risk-neutral yields obtained from the term structure model be used to revisit the findings from the literature on deviations from uncovered interest parity for EMs? This will extend the work done by AngChen:2010.

- Can the findings from this research be used to make a decomposition of the FC-denominated yield curve? Following the same strategy of using synthetic yield curves. Similar to the way it can be done for the U.S. yield curve, the FC yield curve can be swapped into LC, which would allow a comparison between the FC and the LC yield curves. Can this be related to exchange rates and inflation expectations? To sovereign risks?

- The estimated yield curves are an input to the decomposition of the changes in the exchange rates (risk premia, inflation expectations) done by StavrakevaTang:2018b for advanced economies, which could be extended for emerging markets.

- Exploit the cross-section of yields by using a multi-country term structure model in order to improve the precision in the term premia estimates. In future versions, a multi-country affine term structure model may be used in the spirit of JotikasthiraLeLundblad:2015 to exploit information in the cross-section of yield curves.

The sovereign yields of emerging markets comove. I use synthetic yield curve to account for credit risk, which allows me to decompose the nominal yield curves of 15 emerging markets into three three parts: an expectation for the future short-term interest rate, a term premium and a credit risk premium. The comovement in sovereign yields is mainly driven by the term premia.

The term premia in emerging markets for the 10-year maturity is around 175 basis points on average, more than double the size of the credit risk premium. The results are compared to those obtained from surveys of professional forecasters and from advanced countries to establish a set of stylized facts. There are benefits of using synthetic yield curves. For instance, the phenomenon of a negative term premium is not limited to advanced countries. Furthermore, global and domestic factors are important drivers of the term premia in emerging markets. The U.S. term premium is a key common factor having a more than proportional effect on their term premia. The evidence also shows a countercyclical behavior of the term premia as well as a positive relationship with inflation, in line with the idea that it erodes the value of nominal bonds.

The work presented in this paper can be extended in several directions and I will continue working on them. First, as already indicated, the information from survey data can aid in mitigating the identification problem in affine term structure models, which translates into more robust estimates of the term premia. As a consequence, the decomposition of the nominal yield curve will also be more robust so that it can provide useful information for the analysis of monetary policy in emerging markets.

Different models can also be used to assess different characteristics of the data from the synthetic curves. A model that explicitly considers the joint behavior of nominal and real interest rates can allow to further decompose both nominal and synthetic yield curves into the expectation of the future real interest rate and the real term premium. The model can also be supplemented not only with survey data but also with macroeconomic information. Other extensions include models with jumps in yields, which might be applicable to a couple of emerging markets (those with a poor fit mentioned in section

4.3). Given the reaction to common factors, multi-country term structure models might be relevant. To further study the phenomenon of negative term premiums, quadratic term structure models with joint dynamics for stocks and bonds might be useful.

Finally, other improvements can also be included like extending the comparison with advanced economies for the analysis shown in section 5. In particular, analyzing the relationship between the EPU index for those advanced countries for which it is available (Australia, Canada, Germany, Japan, UK and Sweden) to compare it with what is reported for emerging markets, as well as contrasting the results from the panel regressions to advanced countries. More generally, the panel regression analysis can be applied to the other components of the nominal yield curve, namely the expectation part and the LC credit spread. This will provide a broader picture of the relative importance of global and domestic factors on local bond markets.

References

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

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

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

A. P. Blake, G. R. Rule, and O. J. Rummel. Inflation Targeting and Term Premia Estimates for Latin America. *Latin American Economic Review*, 24(1), 2015.

J. Y. Campbell, A. Sunderam, and L. M. Viceira. Inflation Bets or Deflation Hedges? The Changing Risks of Nominal Bonds. *Critical Finance Review*, 6:263–301, 2017.

J. H. Cochrane and M. Piazzesi. Decomposing the Yield Curve. *GBS University of Chicago Working Paper*, 2008.

S. E. Curcuru, S. B. Kamin, C. Li, and M. Rodriguez. International Spillovers of Monetary Policy: Conventional Policy vs. Quantitative Easing. *International Finance Discussion Paper*, 2018(1234), 2018. ISSN 1073-2500.

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

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

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

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

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

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

G. R. Duffee. Term Premia and Interest Rate Forecasts in Affine Models. *Journal of Finance*, 57(1):405–443, 2002. doi: 10.1111/1540-6261.00426.

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

C. Galli. *Inflation, Default Risk and Nominal Debt.* PhD thesis, University College London, 2020.

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

A. Goliński and P. Spencer. Estimating the Term Structure with Linear Regressions: Getting to the Roots of the Problem. *Journal of Financial Econometrics*, pages 1–25, 2019. ISSN 1479-8409.

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

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

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

B. Hofmann, I. Shim, and H. S. Shin. Sovereign Yields and the Risk-Taking Channel of Currency Appreciation. *BIS Working Paper*, 538, 2017.

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

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

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

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

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

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

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

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

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

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

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

Appendix

[Go2ToC]

- Add link to website for Excel file with tickers.
- Add reference to paper that compares YC from Bloomberg for the Euro area.

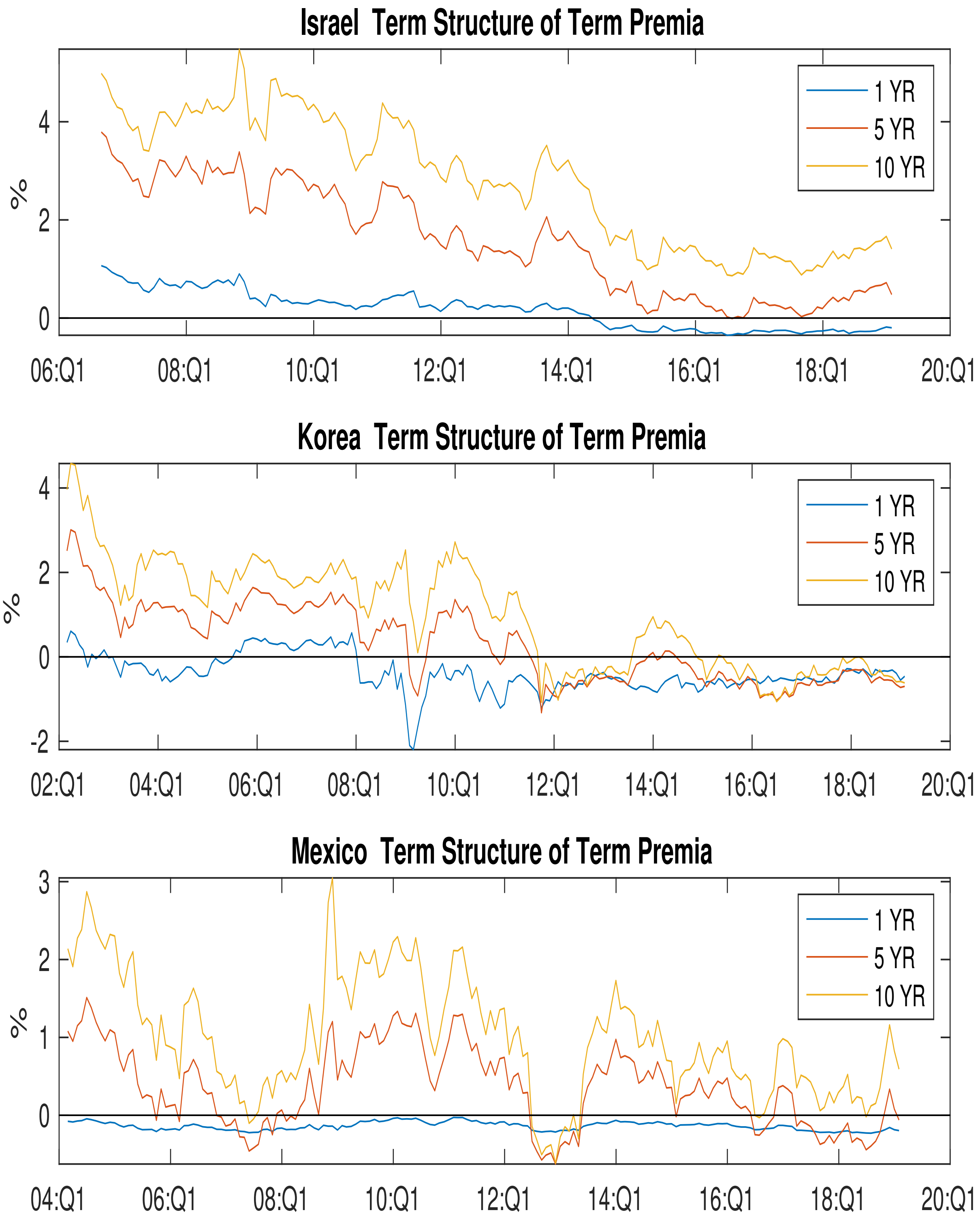

Figure 4. Estimated Term Premia for Different Maturities.

Contents

1 Introduction **2**

2 Local Currency Yield Curves **5**

2.1 Construction of Synthetic Yield Curves 5

2.2 Construction of Nominal Yield Curves 7

2.3 Yield Curve Data 8

3 Methodology **9**

3.1 Term Structure Model 10

3.2 Identification Problem 13

3.3 Survey Data 14

3.4 Estimation 15

4 Results **17**

4.1 Emerging Markets Bond Risk Premia 18

4.2 Yield Curve Decompositions 18

4.3 Assessment of Term Premia Estimates 19

4.4 Sovereign Yield Comovement 19

4.5 Estimated Synthetic Yield Curves 19

4.6 Nominal Yield Curve Decomposition 20

4.7 Term Premia: Nominal or Synthetic Yield Curve? 21

4.8 Stylized Facts of EM Term Premia 22

4.8.1 Term Structure of Term Premia 25

4.8.2 Common Factors in Term Premia 25

4.8.3 Survey-Based Term Premia 26

5 International Spillovers of U.S. Monetary Policy **26**

5.1 Relationship with Risk and Uncertainty Measures 28

5.2 Drivers of Term Premia 30

6 Concluding Remarks **32**

References **35**

Todo list