

Decomposing the Sovereign Yield Curves of Emerging Markets

M. Pavel Solís M. *

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Abstract

This paper decomposes the sovereign bond yields of 15 emerging markets. Two common concerns in analyzing these yields are credit risk and small sample sizes. I overcome these concerns by using synthetic local currency yield curves to account for credit risk and survey forecasts to address the small sample problem. This allows me to decompose the bond yields into an expected future short-term interest rate, a term premium and a credit risk premium. I exploit this decomposition to analyze the dynamics of bond yields in emerging markets. First, these yields comove and their risk premia is time-varying. The comovement is mainly driven by the term premium, whose size more than doubles the credit risk premium. In fact, the term premia is more globally connected than the credit risk premia and the expected short rates. Further, the global component of term premia is highly linked to the U.S. term premia, whereas its idiosyncratic component is countercyclical. Second, [a recent reduction in term premia owes in part to declining inflation uncertainty among emerging markets.] Finally, U.S. monetary policy shocks mainly affect component(s): [1, 2, 3].

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*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.
- Check: literature on other topics.

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. Not so long ago, these countries used to issue bonds at short maturities and in foreign currency. Indeed, the international comparison of sovereign yields has mainly focused on advanced economies.

This paper decomposes the local currency sovereign yields of emerging markets and compares their properties against advanced countries, which is relevant 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 their sovereign yields will help in assessing the vulnerabilities of the global financial system.

Bond yields compensate investors for different motives; decomposing them thus provides further insights about their dynamics. However, not all sovereign bonds are equal. Contrary to the debt issued by advanced countries, international investors demand a credit risk premium to hold bonds issued by emerging markets 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 explanations for these episodes include [Du and Schreger \(2016b\)](#) and [Galli \(2020\)](#).

To account for credit risk in the bond yields of emerging markets, I use synthetic local currency yield curves, which essentially swap the U.S. yield curve into a local currency, something 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, which can thus be decomposed into a future expected short-term interest rate and a term premium like the yield curves of advanced countries. The term premium compensates investors for the uncertain return of locking their money over the life of the bond. The difference between the actual yields and the synthetic ones captures the credit risk premium in emerging markets ([Du and Schreger, 2016a](#)).

I also use long-term survey forecasts when decomposing the sovereign yields of emerging markets. Decompositions of the yield curves of advanced countries are open to debate. Affine term structure models are the standard tool to make such decompositions ([Cochrane and Piazzesi, 2008](#)), but they are known to be unstable. The high persistence of bond yields results in small sample bias ([Kim and Orphanides, 2012](#)). Different so-

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

²Examples 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.

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

lutions have been proposed in the literature.⁴ [Guimarães \(2014\)](#) finds that surveys on interest rate forecasts provide robust decompositions of the U.S. and U.K. yield curves.⁵ Surveys are especially relevant for emerging markets because they help to overcome two common concerns, small sample sizes and regime changes.

I decompose the sovereign bond yields of emerging markets into an expected future short-term interest rate, a term premium and a credit risk premium. A quarter of the 10-year yield of emerging economies, for instance, is due to the term premium (around 175 basis points on average), whose size more than doubles the credit risk premium. This decomposition will enable 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 strategies.⁶ Further, it would be interesting to see whether the term premium captures risks to monetary policy and the credit risk premium captures risks to fiscal policy in emerging markets.

I exploit the decomposition to better understand the dynamics of bond yields in emerging markets. First, these yields comove and their risk premia is time-varying. The comovement is mainly driven by the term premium. In fact, the term premia is more globally connected than the credit risk premia and the expected short rates. Further, the global component of term premia is highly linked to the U.S. term premia, whereas its idiosyncratic component is countercyclical. 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](#)). On the other hand, 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.

⁴They include restrictions on parameters ([Duffee, 2010](#)) ([Bauer 2018](#)), bias-corrected estimators ([BRW 2012](#)) and complementing the information of bond yields with survey forecasts of future interest rates ([Kim and Wright, 2005](#); [Kim and Orphanides, 2012](#)).

⁵For 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, even with a sample starting in 1972, which includes the U.S. Great Inflation period.

⁶Applications include analysis of the effects of monetary policy decisions, simulations of the yield curve components for scenario analysis and investment allocation based on the term premium.

This paper 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 and addressing the small sample problem. Du, Tepper, and Verdelhan (2018c) used synthetic yields to show that there are persistent and systematic deviations from covered interest parity (CIP), reflecting a higher regulatory burden for financial intermediaries. 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 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. Moreover, the paper extends the results in Gilchrist, Yue, and Zakrajšek (2019) by studying the effects of U.S. monetary policy shocks not only on sovereign yields but on its components,⁷ as well as the results in Curcuru, Kamin, Li, and Rodriguez (2018) by analyzing the effects of the U.S. yield curve components on the components of the yields of emerging markets.

The rest of the paper proceeds as follows. Section 2 explains how to construct the local currency yield curves. Section 3 describes the affine term structure model. Section 4 reports the yield decompositions and their analysis. Section 5 studies U.S. monetary policy spillovers to the bond yields of emerging markets. The last section concludes.

2 ⁷ Holman et al. (2018) have studied the link between the U.S. monetary policy, the exchange rate and credit risk premium in emerging markets.

- Include reference for small counterparty risk in XCS.
- Cite paper by Chernov et al. on risky US yield curve.

This section explains how to construct the local currency (LC) yield curves of emerging markets. It 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 at each maturity (see [Du, Im, and Schreger, 2018a](#)). The forward premium compensates investors for the expected depreciation of a currency, an increase in the exchange rate when it is expressed in LC per U.S. dollar (USD), as is used throughout this paper. The key assumption behind this approach is that the U.S. yield curve is free of default risk; as such, it serves as the benchmark for all the other countries in the sample.

The calculation of the forward premium depends on the maturity. For maturities of less than one year, the forward premium is calculated as the annualized difference between the forward and the spot exchange rates. For maturities equal or larger than one year and , the forward premium is calculated using cross-currency swaps (XCS) since outright forwards are less liquid.⁸ 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

⁸Although 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.

flows in USD using cross-currency basis swaps (referenced to the London interbank offered rate in USD), and swap them into fixed-rate cash flows also in USD using interest rate swaps. Both types of swaps are liquid and collateralized instruments and so the bilateral counterparty risk in XCS is small.

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

$$\tilde{y}_{t,n}^{LC} = y_{t,n}^{US} + \rho_{t,n}. \quad (1)$$

In contrast, the actual or nominal zero-coupon yields, $y_{t,n}^{LC}$, can be derived directly from the quotes of the bonds traded in the market. Notice that the construction of the synthetic yield curve $\tilde{y}_{t,n}^{LC}$ does not require knowledge of the nominal yield curve $y_{t,n}^{LC}$,⁹ 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, Tepper, and Verdelhan \(2018c\)](#) show, however, that there are persistent and systematic deviations from CIP. The spread between the nominal and synthetic yields ($y_{t,n}^{LC} - \tilde{y}_{t,n}^{LC}$) therefore measures CIP deviations in sovereign yields. [Du, Im, and Schreger \(2018b\)](#) argue that these CIP deviations reflect differences in the convenience yield of advanced countries relative to the U.S.

CIP deviations have a different interpretation for emerging markets. Whereas the nominal yields of advanced countries are usually considered free of credit risk, it is reasonable for the nominal yields of emerging markets to include a credit risk premium. In fact, emerging markets are prone to default ([Reinhart and Rogoff, 2011](#); [Erce and Mallucci, 2018](#)). The credit risk in the components of the synthetic yields in equation (1) is small, a synthetic yield can therefore be seen as the borrowing rate paid by a hypothetical issuer in LC with no credit risk. [Du and Schreger \(2016a\)](#) indeed show that

⁹For the U.S., $\tilde{y}_{t,n}^{US} = y_{t,n}^{US}$ since there is no forward premium for the USD relative to the USD.

the nominal-synthetic spread captures a credit risk premium in the sovereign yields of emerging markets.¹⁰

2.2 Construction of Nominal Yield Curves

[Go2ToC]

I use the Bloomberg Fair Value (BFV) curves to estimate the nominal yield curve $y_{t,n}^{LC}$. These curves report coupon-equivalent par yields, thus I convert those par rates into continuously-compounded rates (see [Gürkaynak, Sack, and Wright, 2007](#)) to obtain the implied zero-coupon curves.¹¹ 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 convert these yields, known as IYC curves, into continuously-compounded yields.¹² The resulting continuously-compounded zero-coupon curve for each LC 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 (EMs) and, to compare the results, 10 advanced economies (AEs).¹³ The countries are selected based on data availability. AEs are sometimes split into two groups to assess whether the type of country plays a role. 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

¹⁰For instance, CDS rates are highly correlated with the CIP deviations of emerging markets, unlike the CIP deviations of advanced countries.

¹¹As a robustness check, I estimate the nominal yield curves from actual prices for some of the countries in the sample following [Nelson and Siegel \(1987\)](#). These estimated yield curves follow those reported by Bloomberg closely.

¹²For 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 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.

¹³The 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.

(A-SOE), which are basically advanced small open economies, arguably more directly comparable to emerging markets.

The dataset comprises nominal and synthetic yields obtained as explained in section 2.2. The yields are observed at the end of each month from January 2000 to January 2019.¹⁴ Even though the sample ends on the same date for all countries, the starting dates vary per country. All the yields for advanced countries start no later than September 2001. 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. Therefore, there are at least 10 years of data for each emerging market.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 in the sample. This small sample problem is thus salient for emerging markets, an issue that is addressed with surveys of professional forecasters in section 3.4.

The yields have maturities of 3 and 6 months, and 1 through 10 years, ranging from a minimum of 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 who do not issue bonds for, say, 20 or 30 years 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).¹⁶ Treasury securities with less than one year to maturity are less actively traded than longer-maturity ones. The estimates from the Center for Research in Security Prices (CRSP) are thought to be more robust at the short end of the curve ([Duffee, 2010](#)). Specifically, the 3- and 6-month yields are the annualized 13-

¹⁴Since the U.S. yield curve is the benchmark for the synthetic yield curves, these dates are the last business days of each month according to the U.S. calendar.

¹⁵The only exception is Turkey for which its nominal yields with a maturity of up to 10 years start on June 2010. Nevertheless, its synthetic yields start on May 2005.

¹⁶Available at: <https://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html>.

and 26-week rates (bid/ask average) in the CRSP Risk-Free Rates Series.¹⁷

As mentioned before, the calculation of the forward premium depends on 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.¹⁸

3 Methodology

[\[Go2ToC\]](#)

- References for each part of the ATSM (existence of SDF, existence of Q measure, recursive coefficients, etc.).
- References for solutions to identification problem.
- Caveats for surveys. Kim and Orphanides.

This section describes the discrete-time affine term structure model that is used to estimate the dynamics of the sovereign yield curves for the countries in the sample. It then discusses the difficulty in identifying the parameters in the model and how survey data helps in the identification.

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 $y_{t,n} = -\ln P_{t,n}/n$. In particular,

¹⁷The 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.

¹⁸A 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.

the one-period continuously compounded risk-free rate is $i_t = y_{t,1} = -\ln P_{t,1}$.

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

$$P_{t,n} = E_t^{\mathbb{P}} [M_{t+1} P_{t+1,n-1}], \quad (2)$$

where $E_t^{\mathbb{P}}[\cdot]$ 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, which is defined as follows:¹⁹

$$P_{t,n} = E_t^{\mathbb{Q}} [\exp(-i_t) P_{t+1,n-1}]. \quad (3)$$

A discrete-time affine term structure model assumes that the dynamics of a $K \times 1$ 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} :

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

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

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

$$i_t = \delta_0 + \delta_1' X_t, \quad (5)$$

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

¹⁹Since the price at maturity of a zero-coupon bond is 1, recursive substitution of equations (2) and (3) imply that today's price equals the conditional expectation of the product of SDFs over the life of the bond and..., $P_{t,n} = E_t^{\mathbb{P}} [\prod_{j=1}^n M_{t+j}]$.

the pricing factors:

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

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

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

where $A_n^{\mathbb{Q}} = -\frac{1}{n}A_n$, $B_n^{\mathbb{Q}} = -\frac{1}{n}B_n$, where in turn the scalar $A_n = \mathcal{A}(\delta_0, \delta_1, \mu^{\mathbb{Q}}, \Phi^{\mathbb{Q}}, \Sigma, n)$ and the $1 \times K$ vector $B_n = \mathcal{B}(\delta_1, \Phi^{\mathbb{Q}}, n)$ are loadings that satisfy the recursive equations:²⁰

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

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

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 an 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:

$$\lambda_t = \lambda_0 + \lambda_1 X_t, \quad (9)$$

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

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

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

²⁰The price coefficients can be computed recursively after combining the no-arbitrage condition and the functional form for bond prices.

Finally, the SDF is conditionally lognormal:²¹

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

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 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 physical \mathbb{P} measure instead.

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 $A_n^e = -\frac{1}{n} A_n$, $B_n^e = -\frac{1}{n} B_n$, where in turn $A_n = \mathcal{A}(\delta_0, \delta_1, \mu^{\mathbb{P}}, \Phi^{\mathbb{P}}, 0, n)$ and $B_n = \mathcal{B}(\delta_1, \Phi^{\mathbb{P}}, n)$ also satisfy the same recursions under \mathbb{P} but setting $\Sigma = 0$ (see Appendix C of [Guimarães \(2014\)](#)).²² In this sense, information about $y_{t,n}^e$ could help in identifying the parameters under the \mathbb{P} measure, $\{\mu^{\mathbb{P}}, \Phi^{\mathbb{P}}\}$, as discussed in section 3.4.

Finally, the term premium for maturity n at time t , $\tau_{t,n}$, can then be estimated as the difference between the yields obtained under the \mathbb{Q} and \mathbb{P} measures:²³

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

A key assumption behind this model is that the yield $y_{t,n}$ is credit-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 while the nominal

²¹The law of motion of the vector of state variables in equation (10) and the SDF in equation (11) can be formalized separately or jointly (see [Gürkaynak and Wright, 2012](#)). For instance, in a utility maximization framework, the SDF is usually interpreted as the intertemporal marginal rate of substitution.

²²The 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. In practice, however, this term usually becomes relevant for maturities beyond ten years. Further, in homoskedastic models this term is constant across maturities.

²³Note 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.

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

3.2 Identification Problem

[Go2ToC]

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

This identification problem owes to the high persistence of bond yields, which results in small sample bias (Kim and Orphanides, 2012). Accordingly, 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, 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 surveys on interest rate forecasts in the estimation (Kim and Wright, 2005; Kim and Orphanides, 2012). Guimarães (2014) compares the three approaches and concludes that surveys provide robust decompositions of the U.S. and U.K. yield curves; for instance, 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 sample periods, unlike the other alternatives.

The importance of survey data is particularly relevant to get reliable decompositions for the bond yields of emerging markets since they help to overcome small sample sizes and regime changes.²⁴ First, the sample size for these countries is relatively shorter,

²⁴In 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.

compared with estimations of the U.S. yield curve. Second, since the early 2000s there has been a considerable reduction in the inflation rates of many emerging markets, a phenomenon that can be considered as a regime change. Structural breaks is one of the reasons U.S.-focused studies use different sample periods. However, the term premia estimated with a sample starting in 1972—including the U.S. Great Inflation period—complemented with survey data is consistent with those obtained with shorter samples (Guimarães, 2014).

Survey data, however, is not a panacea. Surveys have both good and bad (not marginal investor, infrequent) properties. Surveys might not represent the market expectations or the expectations of the marginal investor.

3.3 Survey Data

[Go2ToC]

Unfortunately, there is no source for long-term forecasts for the short rate of emerging markets. They can be inferred, however, from existing data and Taylor rule-type regressions, in the spirit of Wright (2011) for advanced countries.

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 2017.²⁵

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:

$$i_t = \beta_0 + \beta_i i_{t-1} + \beta_\pi \pi_t + \beta_g g_t + \epsilon_t, \quad (13)$$

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

²⁵The 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.

the Bank 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 $n = 1, 2, \dots, 5, 10$ for inflation and real GDP growth.²⁶ The expected future policy rate is then calculated as:²⁷

$$i_{t,n}^{survey} = \frac{\hat{\beta}_0}{1 - \hat{\beta}_i} + \frac{\hat{\beta}_\pi}{1 - \hat{\beta}_i} \pi_{t,n}^{survey} + \frac{\hat{\beta}_g}{1 - \hat{\beta}_i} g_{t,n}^{survey}. \quad (14)$$

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

An alternative way to use the surveys from Consensus Economics is to assume that the emerging markets in the sample are small open economies, and so their real interest rate would be determined abroad. The forecast for the local short rate would then 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 approach requires to define the international real short rate and to have long-term forecasts for it. As before, the U.S. can be the benchmark for all emerging markets. Long-term forecasts for it can be obtained as the difference between the respective forecasts for the short-term nominal interest rate and inflation. This approach will be included in a future version of this paper.

3.4 Estimation

[Go2ToC]

Affine term structure models can be estimated by maximum likelihood, but the convergence to the global optimum has been traditionally subject to computational challenges and multiple local optima. [Joslin, Singleton, and Zhu \(2011\)](#) (hence JSZ) propose a normalization of the affine model that improves the convergence to the global optimum of the likelihood function.²⁸

The JSZ normalization allows for the near separation of the model's likelihood function

²⁶The long-term forecasts are allocated to the 10-year maturity.

²⁷Under stationarity, $E(i_t) = E(i_{t-1})$.

²⁸The model can also be estimated using linear regressions (see [Adrian, Crump, and Moench, 2013](#)) but the model is overidentified. [Goliński and Spencer \(2019\)](#) correct for this based on JSZ.

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 $(i_{\infty}^{\mathbb{Q}}, \lambda^{\mathbb{Q}}, \Sigma)$, where $i_{\infty}^{\mathbb{Q}}$ is the short rate under \mathbb{Q} in the long-run and $\lambda^{\mathbb{Q}}$ is a $K \times 1$ vector of ordered eigenvalues of $\Phi^{\mathbb{Q}}$.

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

As mentioned before, to estimate the model presented in section 3.1, the relevant yield curve for advanced countries is the nominal one $y_{t,n}^{LC}$, whereas for emerging markets it is the synthetic one $\tilde{y}_{t,n}^{LC}$. In addition, the model for emerging markets is augmented with survey forecasts of the short rate.²⁹ The model is augmented with survey data on the last day of the month for which the data was published.³⁰ 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 is well-suited to handle missing data. The transition equation is the law of motion of the pricing factors under the \mathbb{P} measure given in equation (10). The dimension of the observation equation varies depending on the availability of survey data.

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

$$\mathbf{y}_t = \mathbf{A} + \mathbf{B}X_t + \Sigma_Y \mathbf{u}_t, \quad (15)$$

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

²⁹The 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.

³⁰From 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.

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

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

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

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

Finally, although survey data helps to discipline the model, relying too much on it can be counterproductive due to, for instance, measurement error³¹ and overfitting. To strike a balance between these two considerations, I follow [Kim and Orphanides \(2012\)](#) in fixing σ_s at a conservative level of 75 basis points. This essentially means that survey data is seen as a noisy measure of expectations for the short rate.³²

4³¹ **Results** [Coreia and Economics](#) does not report long-term forecasts for the short rate of emerging markets.

³² When σ_s is estimated, it averages 24 basis points. In this case, for most of the countries in the sample, the estimated term premia remains largely the same.

- 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 curves³³ to assess the benefit of using synthetic curves. The macroeconomic and financial variables used in section 5 are downloaded from Bloomberg.

4.1 Descriptive Results

Assessment of the fit: 3 first PCs explain more than 99.5% and 99.9% of the variation in synthetic and nominal yields for EMs and AEs respectively. However, level plays a relatively bigger role in AEs, while slope and curvature play a relatively bigger role in EMs. Plot of 10Y yObs vs yQ.

³³In each case, assuming that the curve used is risk-free.

Assessment of the components:

LCCS vs CDS Mention explicitly.

Patterns - Global tendency of declining TPs for AEs and EMs. More pronounced for AEs. - TPs related to local events. - Which country has the highest/lowest TP? Countries w/ largest positive TP: COP, IDR, PHP, RUB, TRY. Countries w/ lowest negative TP: BRL, KRW, PHP, PLN, THB. - For which countries TP decline more? HUF, IDR, KRW, PHP, PLN, THB. Reversals: MXN, RUB, TRY - Did those countries change their MP framework (IT, independence)? HUF, IDR and PHP adopted IT in Jun-2001, Jul-2005 and Jan-2002, KRW operationally independent since 2003. HUF and PLN accepted into the EU in Apr-2003. - For which country the decline is not justified by declining inflation? K flows role? For BRL and TRY, TP decline b/w 2008 and 2013 even when their inflation expectations were increasing.

yP vs surveyCBP Careful that CBP surveys was constructed and not relying on it too much. When there is differences bw sy-yP vs CBP surveys, there are differences in TPs (ssb-tp and sy-tp). ssb-yP tracks reasonably well CBP surveys, it does it much better than sy-yP. This is what explains the differences in TP (ssb-tp and sy-tp). Key differences for: HUF (now declining trend), MYR (now $TP < 0$), MXN (now yP reacts to TT not TP), PHP (now $TP < 0$), THB (now $TP < 0$), TRY (now $TP > 0$). Cases HUF, MXN, MYR, PHP: w/o surveys implied expectations of rate (yP) were too low and so TP too high. W/ surveys expectations were higher and so TP lower.

TPsynt vs TPsvy Similar to checking yP vs surveyCBP. TPsynt tracks TPsvy very closely.

Implications of decomposition: event dates (QE-TT), seems to be the reason why $TP \neq 0$ (timing) Phenomenon of $TP \neq 0$ is for EMs not AEs, especially after QE. The effects of US influencing local conditions abroad depend on the context. If the EM does not need the stimulus, it might need to resort to macro prudential tools. But if the stimulus is needed, it can benefit from it. TT had three effects in other countries: increase in TP, increase in short rate expectations (yP), decrease in yP. Plot ssb-yP-QE USTP reacted similarly to TPs of AEs and EMs.

Is there a trend in yP? There seems to be a downward trend in AEs but not in EMs.

is EM real rates similar? Is there a trend? Compare yP, svycpi, realrt For many countries it fluctuates around 0 and 1%. BRL and MXN are the exception, their real rates fluctuate around 6 and 2.5%.

bond risk premia = TP + CR yEsynt and yEnom w/ surveys are similar (closer than w/o surveys). BRP is defined as TPsynt+LCCS. TPnom is highly correlated w/ BRP. Thus when estimate ATSM using nominal yields, the resulting ‘term premia’ is actually a risk premia that mixes together a TP and a LCCS. TP and RP are not the same thing for EMs. Importance of LCCS and TP changed for: HUF, KRW (TP-¿LCCS) Both: MYR, PHP, PLN, THB LCCS is more important for: BRL TP is more important for: COP, IDR, ILS, MXN, PEN, RUB, TRY, ZAR Is regional (Asian and European) or global?

YC decomposition For most of the countries yP is the largest component and is relatively stable. Reflecting IT regime?

Correlations of components with alternative measures TPsynt correlates positively with the residual from 10Y on 2Y and yP correlates positively with 2Y.

TP correlations (reasonable TP estimate) vs BRP corrs In general, TPsynt correlates negatively with LCCS and positively with INF, USTP and the VIX. TPsynt of COP and MXN correlates positively with EPU. For KRW it comove negatively, its LCCS is what comoves positively with the EPU. Correlation of EM TP w/ USTP is 62% and AE TP w/ USTP is 77%. Correlation of EM TP w/ VIX is 32% and AE TP w/ USTP is 37%.

commonalities (TPs, yP, LCCS) all, ST vs LT. A global factor plays a role in the variation of both AEs and EMs to varying degrees. Yields and YC components are not as tightly connected in EMs as they are in AEs. Pooling all yields together, there is a global-level factor that explains around 50% of the variation in EMs and 90% in AEs. This is similar for the 1Y yields, whereas for the 10Y yields, a global factor explains around 95% in AEs and 40% in EMs. These percentages are largely the same after the GFC. A global factor explains around 40% of the variation of all 3 components of yield in EMs. For AEs, yP 90% and TP 80%. After the GFC, the variability explained by a global factor increased for the TP in AEs and for yP and TP in EMs. The role of a

global component for ST yields is larger than for the LT yields, but a global component is more relevant for the components of the LT yields than of the ST ones.

How much the US factor explains TP? Is there a non-US common factor? 10Y USyP and USTP explain around 70% of the variation in yP and TP in AEs; for EMs, they explain 30% and 40%, respectively. after the GFC, these numbers largely remained for the TP and decline for yP.

A non-US common factor explains b/w 50 and 85% of the variation in yP and TP both ST and LT. These percentages fluctuate b/w 35 and 50%. The importance of a non-US factor slightly increase after the GFC.

These results show that while the yields of EMs are globally connected, they are less so than the yields of AEs. Several factors can explain these patterns. Some of them include segmented markets, capital controls, home bias, regional differences. Local factors therefore seem to play a bigger role in the yields of EMs, and its components, than they do for AEs.

4.2 Emerging Markets Bond Risk Premia, Yield Curve Decompositions

[\[Go2ToC\]](#)

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,³⁴ on average more

³⁴[Litterman and Scheinkman \(1991\)](#) first report this and refer to the PCs as level, slope and curvature.

	Nominal	Synthetic
EM	0.15	0.48
AE	0.13	0.08

Table 1. Fit of Affine Term Structure Models.

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.³⁵ 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%.³⁶ This requires further inspection of the synthetic yield curves of these two countries.³⁷

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.³⁸ 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

³⁵For 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.

³⁶Although 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.

³⁷In 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.

³⁸Although term premia estimates are calculated for all maturities, only the 10-year maturity is reported in what follows for the sake of brevity.

	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 (%).

yields.³⁹ 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 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

³⁹The 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.

	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 (%).

nominal ($y_{t,n}^{LC}$) and synthetic ($\tilde{y}_{t,n}^{LC}$) 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.

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.

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 2018⁴⁰ translated into a higher term premium.

⁴⁰On 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.

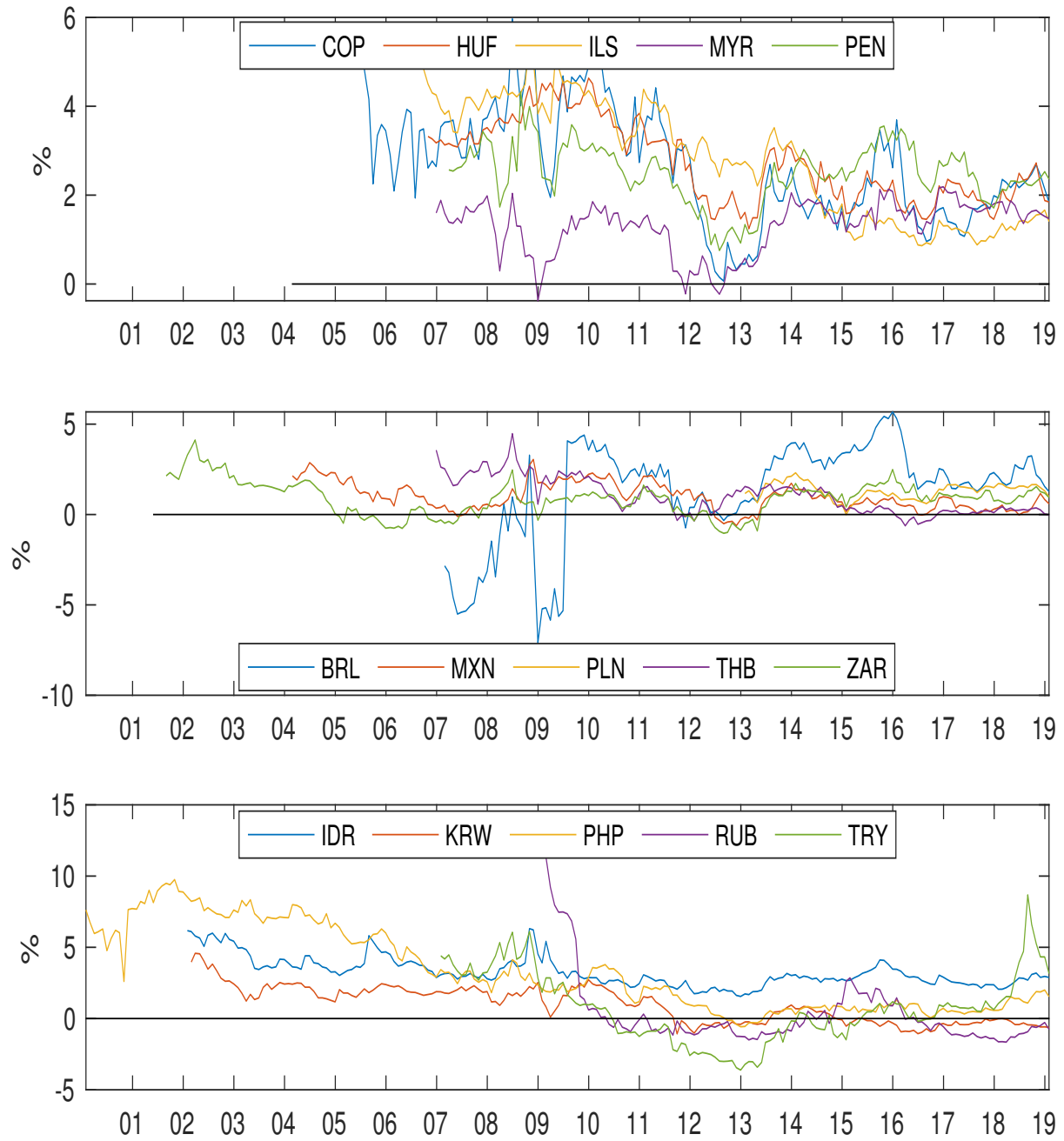


Figure 1. Estimated 10-Year Term Premia: Emerging Markets.

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.

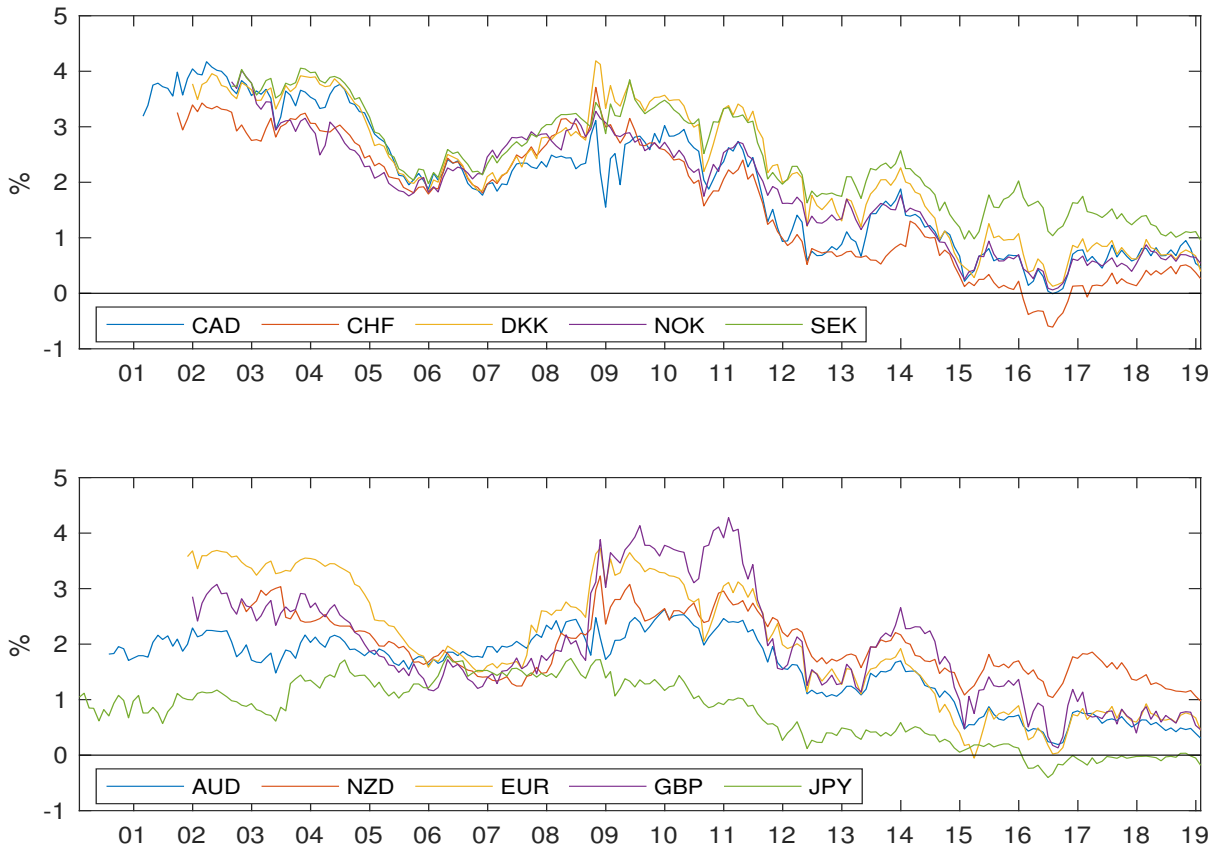


Figure 2. Estimated 10-Year Term Premia: Advanced Economies.

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.

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%.⁴¹ 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 ⁴¹ Even if we use the model-based decomposition of the nominal yield curve, the correlation with the survey-based term premia is equal to 85%.

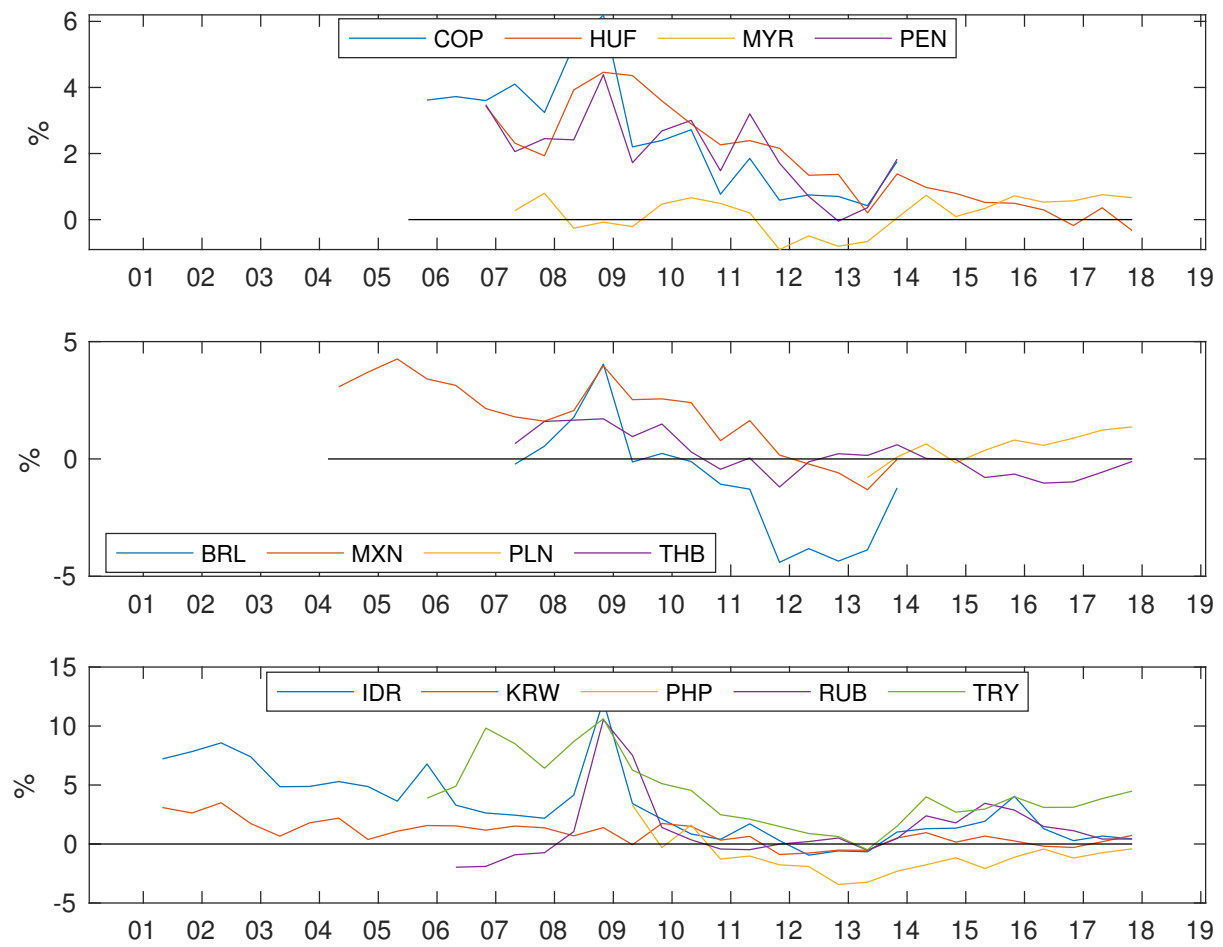


Figure 3. Survey-Based 10-Year Term Premium Estimates

	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

[\[Go2ToC\]](#)

- Contrast 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

$$tp_{it} = \alpha_i + \beta' z_{it} + u_{it}. \quad (17)$$

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 (0.41)		0.65*** (0.21)	0.14 (0.17)	
FFR	0.08 (0.11)		0.22** (0.10)	0.12 (0.10)	
USTP10	1.55*** (0.28)			1.22*** (0.16)	
Return S\&P	-0.01 (0.01)		0.00 (0.01)		
Return Oil	-0.00 (0.00)		0.00 (0.00)		
INF		0.26*** (0.05)	0.22*** (0.05)	0.21*** (0.05)	0.222*** (0.0400)
UNE		0.22*** (0.07)	0.21*** (0.06)	0.13** (0.05)	0.137** (0.0583)
IP		-0.02 (0.01)	-0.02 (0.01)	-0.02* (0.01)	-0.0193** (0.00792)
Return FX		0.02** (0.01)	0.02* (0.01)	0.02* (0.01)	0.0199* (0.0103)
Return Stocks		0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.000373 (0.00751)
Constant	1.04 (1.27)	-1.40* (0.67)	-3.18*** (0.93)	-0.84 (0.76)	1.235* (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

4.1). 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.

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Appendix

[\[Go2ToC\]](#)

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

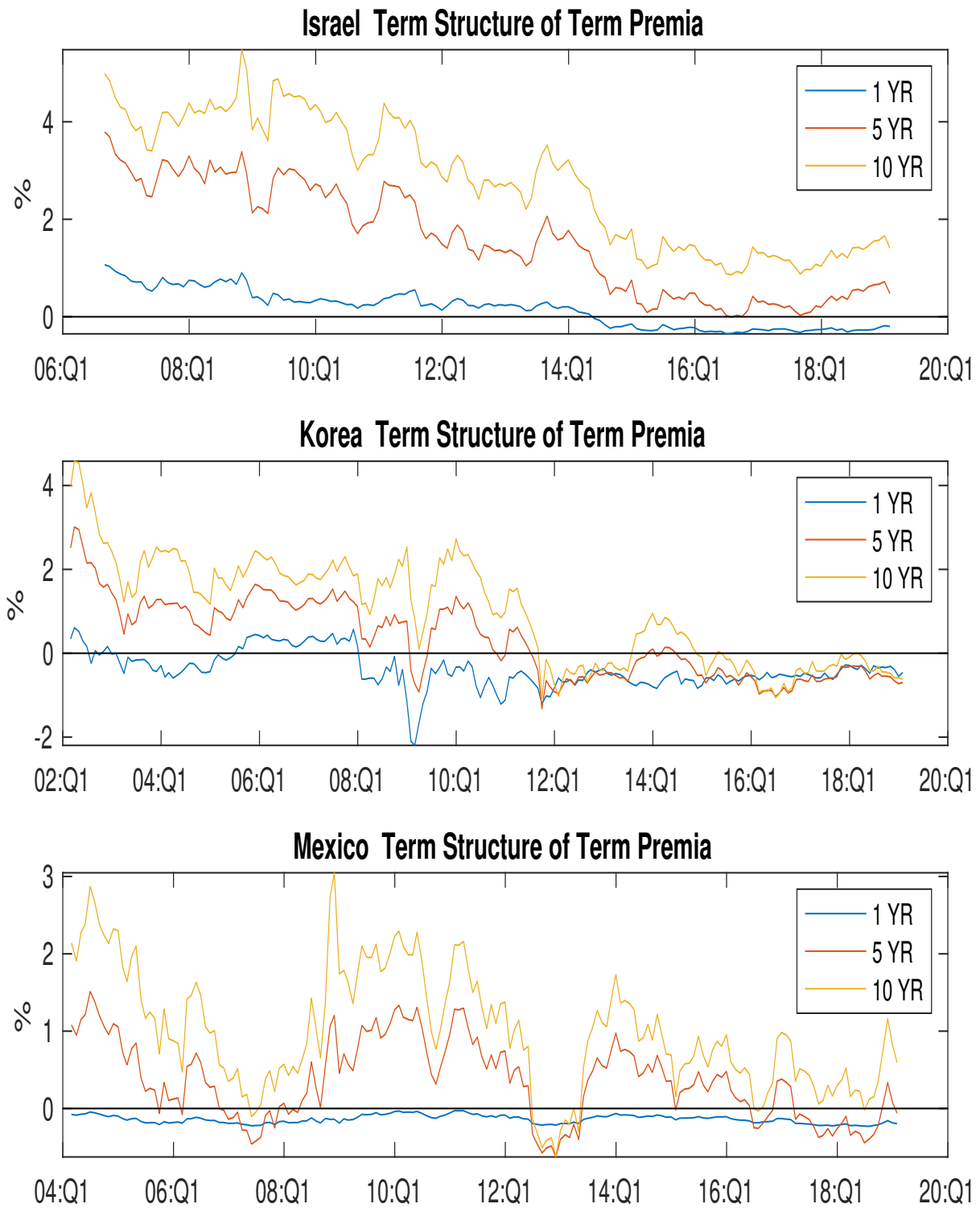


Figure 4. Estimated Term Premia for Different Maturities.

Contents

1	Introduction	2
2	Local Currency Yield Curves	5
2.1	Construction of Synthetic Yield Curves	6
2.2	Construction of Nominal Yield Curves	8
2.3	Yield Curve Data	8
3	Methodology	10
3.1	Term Structure Model	10
3.2	Identification Problem	14
3.3	Survey Data	15
3.4	Estimation	16
4	Results	18
4.1	Descriptive Results	19
4.2	Emerging Markets Bond Risk Premia, Yield Curve Decompositions	22
4.3	Assessment of Term Premia Estimates	22
4.4	Sovereign Yield Comovement	22
4.5	Estimated Synthetic Yield Curves	22
4.6	Nominal Yield Curve Decomposition	23
4.7	Term Premia: Nominal or Synthetic Yield Curve?	24
4.8	Stylized Facts of EM Term Premia	25
4.8.1	Term Structure of Term Premia	29
4.8.2	Common Factors in Term Premia	29
4.8.3	Survey-Based Term Premia	30
5	International Spillovers of U.S. Monetary Policy	30
5.1	Relationship with Risk and Uncertainty Measures	32
5.2	Drivers of Term Premia	34

6 Concluding Remarks	36
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References	39
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Todo list