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Arnaud Mehl

The yield curve as a predictor and emerging economies

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Arnaud Mehl[1]

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Abstract

This paper investigates the extent to which the slope of the yield curve in emerging economies predicts domestic inflation and growth. It also examines international financial linkages and how the US and euro area yield curves help to predict. It finds that the domestic yield curve in emerging economies contains in-sample information even after controlling for inflation and growth persistence, at both short and long forecast horizons, and that it often improves out-of-sample forecasting performance. Differences across countries are seemingly linked to market liquidity. The paper further finds that the US and euro area yield curves also contain in- and out-of-sample information for future inflation and growth in emerging economies. In particular, for emerging economies with exchange rates pegged to the US dollar, the US yield curve is often found to be a better predictor than the domestic curves and to causally explain their movements. This suggests that monetary policy changes and short-term interest rate pass-through are key drivers of international financial linkages through movements at the low end of the yield curve.

Key words: emerging economies, yield curve, forecasting, international linkages
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Arnaud Mehl

The yield curve as a predictor and emerging economies

Tiivistelmä

Tässä työssä tutkitaan, kuinka hyvin tuottokäyrän muoto ennustaa inflaatiota ja talouskasvua kehittyvillä markkinoilla. Työssä selvitetään myös, voidaanko Yhdysvaltain ja euroalueen tuottokäyriä käyttää kehittyvien talouksien kehityksen ennustamiseen. Tulosten mukaan sekä lyhyen että pitkän aikavälin ennusteita tehtäessä on hyödyllistä käyttää kehittyvien talouksien omia tuottokäyriä, vaikka inflaation ja talouskasvun persistenssi otettaisiinkin huomioon. Myös estimointijakson ulkopuolella ennusteet paranivat tuottokäyriä käyttämällä. Tulosten erot eri maiden välillä näyttävät riippuvan markkinoiden likviditeetistä. Myös Yhdysvaltain ja euroalueen tuottokäyrät auttavat ennustamaan kehittyvien talouksien inflaatiota ja kasvua sekä estimointijakson aikana että sen jälkeen. Etenkin sellaisissa maissa, joiden valuutta on kytketty dollariin, Yhdysvaltain tuottokäyrä ennustaa inflaatiota ja kasvua paremmin kuin näiden maiden omat tuottokäyrät. Tämän tuloksen mukaan rahapolitiikan muutokset ja lyhyiden korkojen välittyminen ovat avaintekijöitä kansainvälisessä rahataloudellisessa integraatiossa.

Asiasanat: kehittyvät taloudet, tuottokäyrä, ennustaminen, integraatio

1 Introduction

In the last two decades, international financial markets have integrated to an extent unprecedented in history. This process has profound implications for the transmission of shocks, both across financial asset prices and to the real economy.

In this respect, the body of literature on the role of asset prices – including interest rates, stock returns, dividend yields and exchange rates – as predictors of inflation and growth is large and clearly of interest to policy making.[1] As highlighted in a recent survey of this literature (Stock and Watson, 2003), one of the main objects of study, and the one which has proved most useful for forecasting, is the slope of the yield curve. It has attraced particular interest of late, as its inversion in the US triggered a lively debate on whether it signaled a recession. In this context, the usefulness of the slope of the yield curve as a predictor of future growth has been challenged forcefully (Greenspan, 2005; Estrella, 2005a and 2005b; Bernanke, 2006).

A salient trait of the literature is the strong emphasis it places on the US economy. And indeed, international evidence has remained scarce and limited to a handful of other industrial countries. Evidence for emerging economies has been virtually nil, in particular, for the very reason that domestic bond markets have started to deepen significantly only since the turn of the millennium (IMF, 2002, 2003, 2005 and 2006; Mehl and Reynaud, 2005; Jeanne and Guscina, 2006). To my knowledge, this paper is the first attempt to investigate in a systematic and comparative manner the usefulness of the slope of the yield curve as a predictor of both inflation and growth in an array of emerging economies.

But the key contribution of the paper lies elsewhere. Quite strikingly, the literature has paid little attention to international financial linkages so far, perhaps due to its focus on domestic developments in the US. Possible linkages include the ability of the US or euro area yield curve to help predict inflation and growth in emerging economies, in particular. Another example is the potential spillovers from the US or euro area yield curve to the yield curves of smaller, possibly emerging, economies. Clearly such issues are of growing policy relevance, given the recent emphasis on global financial issues and spillovers in the ongoing discussions on the future of the international monetary system and the IMF

[1] The use of financial prices as business cycle indicators dates back as far as Burns and Mitchell (1935) who included both stock prices and interest rates in a list of leading economic indicators.

(IMFC, 2006). Again, only a couple of studies have touched on these issues (Plosser and Rouwenhorst, 1994; Bernard and Gerlach, 1998). Those earlier contributions ignored inflation and focused on a small number of industrial economies.[2] Yet, as regards the slope of the yield curve, international financial linkages are also pronounced – if not more so – for emerging economies. Their small economic size makes the US or euro area a possible determinant of their domestic inflation and growth. For this reason, the yield curve in the US or euro area can be expected to have some predictive power also for inflation and growth in emerging economies. These can further be expected to convey better information on the future impact of common shocks, since the US and euro area debt security markets are more liquid than those of the emerging economies. Finally, the US dollar or euro is given a prominent role in the exchange rate policy of many of these economies. This magnifies the pass-through from US or euro area policy interest rates to their domestic interest rates. This in turn contributes to potential co-movements between the slope of the yield curve in the US or euro area and the slope of the domestic yield curve.

This paper makes four contributions to the existing literature. First, it examines the usefulness of the slope of the yield curve as a predictor of domestic inflation and growth using a sample of 14 emerging economies over the last decade. Second, it investigates whether the slope of the yield curve in the US or euro area helps predict inflation and growth in these economies. Third, it tests whether the information contained in the yield curve of some of the emerging economies stems from the US or euro area yield curve in the first place. Lastly, it tests whether movements in the emerging market yield curves that are purely country-specific contain useful information for future inflation and growth beyond that already embodied in foreign-driven movements.

The paper finds that the domestic yield curve has in-sample information content in emerging economies, even after controlling for inflation and growth persistence, at both short and long forecast horizons. Moreover, adding the yield curve to a simple autoregressive process often improves out-of-sample forecasting performance, suggesting that it includes genuine information for forecasting in real time. There are also signs that differences across countries are linked to market liquidity. In examining international financial linkages, the paper finds that the US or euro area yield curve has in-sample information

[2] A very recent (unpublished) research project conducted under the supervision of Campbell Harvey dwells on the usefulness of the US yield curve to predict growth in a small number of emerging economies (China, Korea, Mexico and Taiwan). However, it does not resort to formal statistical tests and ignores inflation. It also looks at graphical correlations between the US yield curve and the yield curve of other industrial economies, thereby excluding emerging economies (Alpha Team, 2006).

content for future inflation and growth in emerging economies and that it often improves out-of-sample forecasting performance. In particular, for emerging economies with exchange rates pegged to the US dollar, the US yield curve is often found to be a better predictor than these economies' own domestic curves and to causally explain their movements. Lastly, movements in the emerging market yield curves that are purely country-specific often contain no residual information content, in particular for future growth. All in all, the results, which are resilient to a number of robustness checks, suggest that monetary policy changes and short-term interest rate pass-through are key drivers of international financial linkages through movements at the low end of the yield curve.

The remainder of the paper is organised as follows. Section 2 reviews the related literature, highlighting the contribution of the paper. Section 3 presents the methodology and data, and Section 4 describes the results. Section 5 provides some robustness checks and interprets the results. Section 6 concludes and cites areas for future research.

2 Related literature

2.1 Predictive role of the yield curve in industrial countries

Empirical evidence that an inversion of the slope of the yield curve signals a recession dates back to the early 1990s in the US (see, e.g., Mishkin, 1990a, 1990b; Estrella and Hardouvelis, 1991). The standard economic rationale for this finding is that the slope of the yield curve is a monetary policy indicator. Monetary tightening results in short-term interest rates that are high relative to long-term interest rates. In turn, high short-term interest rates contribute to slowing the economy (Bernanke and Blinder, 1992). Lower long-term yields may further reflect lower real yields, due to expectations of slower output growth (see e.g. Arnwine, 2004), which leads to further lowering of the yield curve at the long end of the maturity spectrum. In line with this, the yield curve has predicted every post-war recession in the US, with only one false signal, prior to the credit crunch and slowdown in production of the late 1960s (Estrella, 2005b).[3]

[3] In particular, the yield curve inverted before both the 1990-91 and 2001 recessions. In early 2006, the yield curve also inverted shortly ahead of mounting signs of an economic slowdown in the US.

The reliability of the yield curve as a predictor has been challenged recently. Greenspan (2005) argues that many factors can affect its slope, including the gap between near-term and long-term inflation expectations or near-term and long-term risk premia. Yet, all these factors do not have similar implications for future growth. For instance, as he recalls, the yield curve flattened sharply from 1992 to 1994, shortly before the US economy entered its longest expansion of the post-war period. In his view, a flattening of the yield curve might well also signal a deceleration in inflation accompanied by a favourable growth outlook, e.g. once the impact of an adverse oil price shock has dampened. Likewise, a decline in distant-horizon risk premia might indicate that investors are willing to bear more risk. In such a case, a flattening of the yield curve may indicate an easing of financial conditions, which stimulates future growth.[4] Beyond the US, evidence on the ability of the yield curve to help predict future growth for other countries has so far been scarce and limited to a handful of other industrial countries so far (Plosser and Rouwenhorst, 1994; Bonser-Neal and Morley, 1997; Kozicki, 1997; Estrella and Mishkin, 1997; Estrella, Rodrigues, and Schich, 2003). Overall, the results tend to confirm that the slope of the yield curve has predictive power for growth in these countries as well, at least in-sample.

A number of studies, including some of those mentioned above, also consider the predictive value of the slope of the yield curve for inflation. According to the Fisher equation, the nominal interest rate reflects market expectations of both future inflation and the real rate for a given maturity. The slope of the yield curve should therefore reflect expected changes in inflation and, in line with this, Mishkin (1990b) finds predictive content of the US yield curve for domestic inflation. Jorion and Mishkin (1991) as well as Mishkin (1991) reach similar conclusions with a sample of 10 industrial economies. However, much of this early work, which claims to find predictive content, did not control for lagged inflation. But inflation is highly persistent and once lags are included, the marginal predictive power of the yield curve, i.e. the information content of future inflation over and above that embodied in past inflation, is reduced drastically, as shown in Bernanke and Mishkin (1992), Estrella and Mishkin (1997), Kozicki (1997) and Stock and Watson (2003).

[4] Bernanke (2006) concurs in saying that the inversion of the US yield curve of early 2006 is not necessarily a

2.2 (Absence of) evidence for emerging economies

Reflecting on the scarcity of comparative evidence available on the role of the yield curve as a predictor for inflation and growth, Stock and Watson concluded their survey of the literature by saying that the “universality [of this issue] is unresolved” (Stock and Watson, 2003, p. 801). In particular, evidence for emerging economies has been virtually nil, for the very reason that bond markets have started to deepen significantly only since the turn of the millennium. The development of domestic debt security markets in these economies in the very recent years reflects their efforts to self-insure against ‘sudden stops’ and reversals in international capital flows following the string of crises of the 1990s (IMF, 2002, 2003, 2005 and 2006; Mehl and Reynaud, 2005; Jeanne and Guscina, 2006). Indeed, from a macroeconomic perspective, domestic debt markets were seen by policy makers in emerging countries as an alternative source of financing to cushion against lost access to external funding. Moreover, from a microeconomic perspective, deeper domestic debt markets were expected to extend the menu of instruments available to address currency and maturity mismatches, which reduces the risk of financial crisis. For all these reasons, local authorities have engaged in deliberate efforts to develop domestic debt markets. Reflecting these efforts, the stock of domestic debt securities issued by emerging economies has almost doubled relative to GDP in the last ten years, to more than 40% in 2004. Many economies have managed to extend debt duration and even place issues with long maturities (Mehl and Reynaud, 2005; Jeanne and Guscina, 2006). With the passage of time, data on long-term domestic interest rates – and benchmark yield curves – have now become more widely available.

2.3 International financial linkages

More importantly, a striking feature of the literature is that it pays little attention to international financial linkages, perhaps due to the heavy focus on US domestic developments. Yet, financial markets have become increasingly integrated internationally, although the nature of this integration and the transmission channels are not always well understood. A

signal of a recession to come.

growing strand of literature has attempted to analyse international financial spillovers. But this literature has largely ignored the slope of the yield curve.[5]

In particular, the possible spillovers from the slope of the yield curve in the US or euro area to the slopes of yield curves of smaller, eg emerging, have not been considered. The same holds true for the ability of the slope of the US or euro area yield curve to predict inflation and growth in these economies. However, these issues are of growing policy interest. They feature prominently in the ongoing discussions on the future of the international monetary system and the IMF mandate. For instance, as indicated in the last Communiqué of the International Monetary and Financial Committee of the Board of Governors of the IMF, the Fund's surveillance should have "a new focus … on multilateral issues, including global financial issues, and especially the spillovers from one economy on others" (IMFC, 2006).

Again, to my knowledge, only a couple of studies have touched on these issues. Plosser and Rouwenhorst (1994), using time series techniques, find evidence that the slope of the US yield curve significantly helps predict growth in both Germany and the U.K. (and vice versa). Bernard and Gerlach (1998), using probit estimation, find that the slope of the yield curve in the US and Germany significantly helps to predict recessions in other G7 countries, the UK and Japan in particular. Those earlier contributions have two notable features, however. First, they have ignored inflation altogether. Second, and more importantly, they focused on a small number of industrial economies. Yet, when it comes to the slope of the yield curve, international financial linkages are also pronounced for emerging economies. Their small economic size makes the US or euro area a possible determinant of their domestic inflation and growth. For this reason, the yield curve in the US or euro area can be expected to have some predictive content also for inflation and growth in emerging economies. It can further be expected to convey better information on the future impact of common shocks, given that the US and euro area debt security markets are more liquid than those of the emerging economies. Lastly, the US dollar (or euro) is given a prominent role in the exchange rate policy of many of these economies. This magnifies the pass-through from US or euro area policy interest rates to their domestic interest rates. In turn, this contributes to potential co-movements between the slope of the yield curve in the US

[5] For instance, Hamao, Masulis and Ng (1990), King, Sentana and Wadhwani (1994) as well as Lin, Engle and Ito (1994), detect some spillovers from the US to Japanese and UK equity markets, both for returns and in particular for conditional volatility. Moreover, the seminal papers by Engle, Ito and Lin (1990) and Andersen and Bollerslev (1998) find strong spillovers in foreign exchange markets. A recent contribution by Ehrmann, Fratzscher and

or euro area and the slope of the domestic yield curve. And indeed, recent evidence from Frankel et al. (2004), Shambaugh (2004) and Obstfeld et al. (2005) suggest that countries with pegged exchange rates follow base-country interest rates more than countries with a float, in particular if they have lifted capital controls. In other words, having fixed exchange rates forces countries to follow the monetary policy of the base country.

2.4 Contribution

Against this background, this paper makes four contributions to the existing literature. First, it makes use of a sample of 14 emerging economies to investigate the usefulness of their yield curve slopes as a predictor of domestic inflation and growth over the last decade. Second, it investigates whether the slope of the yield curve in the US or euro area helps to predict inflation and growth in these economies. Third, it tests whether the information contained in the slope of the yield curve of some of the emerging economies stems from the yield curve in the US or euro area in the first place. Lastly, it tests whether movements in the emerging market yield curves that are purely country-specific contain useful information for future inflation and growth beyond that already embodied in foreign-driven movements. In other words, the paper assesses the extent to which monetary and financial conditions in the US or euro area, as captured by the yield curve, spill over to the emerging market world. In essence, it is closest to Chinn and Frankel (2005) who analyse spillovers from US interest rates to the industrialised world. Their evidence indicates that short-term nominal interest rates have been largely driven by the US although, since the advent of Monetary Union, long-term real rates in the US and euro area have tended to influence each other. This paper innovates on two grounds relative to them by moving the analysis from (i) interest rate levels to the slope of the yield curve and (ii) the industrialised world to emerging economies.

Rigobon (2005) looks at money, bond, equity markets and exchange rates in the United States and euro area and also finds substantial international spillovers, both within and across asset classes.

3 Methodology and data

3.1 Econometric specification

To investigate the usefulness of the slope of the yield curve in emerging economies as a predictor of domestic inflation and growth, I follow the standard methodology surveyed by Stock and Watson (2003). The slope of the yield curve, denoted X_t, is defined as the difference in period *t* between the yield on the long-term domestic government bond (in local currency), denoted r_t^l, and that on the short-term domestic treasury bill (in local currency), denoted r_t^s

$$X_t \equiv r_t^l - r_t^s$$

Inflation and growth, the two variables to forecast, are both denoted Y_t. They are initially defined as the growth rate over the next month of the consumer price index (*cpi*) and the industrial production index (*ipi*), respectively

$$Y_t = 1{,}200 \times \ln(cpi_{t+1} / cpi_t)$$
$$\text{or} \quad Y_t = 1{,}200 \times \ln(ipi_{t+1} / ipi_t)$$

where the factor of 1,200 standardises the units to annual percentage growth rates.[6]

<u>(i) In-sample measures of predictive content</u>

Predictive content is measured with a linear regression relating the future value of *Y* to the current value of *X*. There is an important caveat to bear in mind, however. If the *Ys* are serially correlated, which is typical for inflation and growth (both being fairly persistent variables), their own past values are useful predictors themselves. Therefore, it remains uncertain that the slope of the yield curve offers marginal predictive content, i.e. embodies information beyond that already captured in past values of inflation and growth. Moreover, other past values of the slope of the yield curve might have predictive power as well. As suggested in Stock and Watson (2003), this leads to a linear regression in which lagged values of both X_t and Y_t appear:

[6] Note that, due to limitations arising from the time span of my data (around 10 years), I discarded real GDP, which is available at the quarterly frequency only, as this would have left a small number of degrees of freedom.

$$Y_{t+1} = \beta_0 + \beta_1 X_{t-k} + \sum_{i=0}^{p} \alpha_i Y_{t-i} + u_{t+1} \quad k = 0,...T$$

where β_0, β_1, α_is are unknown parameters, u_{t+1} an error term and where the maximal lags are of order *T* and *p*, respectively. If $\beta_1 \neq 0$, the k^{th} lag of the slope of the yield curve can be used to forecast the value of inflation or growth. This equation applies to forecasts 1-period ahead but is straightforwardly extended to multistep-ahead forecasts. To that end, Y_{t+1} is replaced with the corresponding *h*-period ahead value, with cumulative growth or inflation over the next *h* months being defined respectively as

$$Y_{t+h}^{h} = \frac{1{,}200}{h} \times \ln(cpi_{t+h} / cpi_t)$$

and $$Y_{t+h}^{h} = \frac{1{,}200}{h} \times \ln(ipi_{t+h} / ipi_t)$$

in annual percentage rates. Following again Stock and Watson (2003), the *h*-step ahead forecasting regression which uses the k^{th} lag of the slope of the yield curve can be written as

$$Y_{t+h}^{h} = \beta_0 + \beta_1 X_{t-k} + \sum_{i=0}^{p} \alpha_i Y_{t-i} + u_{t+h}^{h} \quad k = 0,...T \qquad (1)$$

Since the data are overlapping by construction, the error term in (1) is serially correlated (and contains a moving-average term of order *h*-1). For this reason, the test of predictive content based on (1), i.e. the test of $\beta_1 = 0$, needs to be computed with consistent standard errors using the Newey and West (1987) correction for heteroskedasticity and autocorrelation (Plosser and Rouwenhorst, 1994).[7]

An additional caveat to bear in mind is that the slope of the yield curve may reflect – on top of an expected inflation and real yield component – a risk premium component, which would weaken its predictive power. To the extent that the latter does not vary over time, it is picked up in the constant term β_0, however. Yet, the risk premium may well be time-varying. For instance, there is evidence that the decline in long-term bond yields in the euro area has recently been driven largely by declining term premia, which explains

[7] The correction ensures that the covariance matrix is both consistent and positive semi-definite. An alternative specification is to use *k* lags of *X* in (1), possibly removing insignificant ones, although interpretation becomes more challenging. The selected specification has the advantage of readily providing an estimate of the response of

their historically low levels. In turn, this could also explain why the plain spread between long-term and short-term interest rates seems to have lost much of its predictive power for future real GDP growth, so that correcting for risk premia variations improves forecasting power (Werner, 2006). A further implication is that a fall in risk premia leading to a flattening – and possibly an inversion – of the yield curve that coincides with an acceleration in inflation or growth may lead to a negative estimate for β_1, contrary to what standard theory would predict. In a similar vein, supply shocks may also flip the sign of the correlation between yield curve slope and inflation. Hardouvelis and Malliaropulos (2004) find evidence that the slope of the US yield curve is negatively related to the future level of inflation for horizons between one quarter and one and a half year ahead (which is close to this paper's forecast horizon). Using a general equilibrium model of a monetary economy with sticky prices, they explain this as resulting from of consumption smoothing in connection with a permanent positive productivity shock, which simultaneously increases consumption and output and reduces prices.

(ii) Pseudo out-of-sample measures of predictive content

Pseudo out-of-sample forecasts are tantamount to real-time forecasting simulations. Estimation is carried out by resorting only to data available prior to the forecast. As such, it is a yardstick to stress test whether the slope of the yield curve is genuinely useful for prediction. Following again Stock and Watson (2003), a standard way to measure pseudo out-of-sample forecast performance is to compute the mean squared forecast error of a candidate forecast (denoted forecast *i*), relative to a benchmark (denoted forecast 0). Here, I use the autoregressive part of (1), as benchmark and the full model as the candidate forecast. This measures whether the slope of the yield curve is better than a simple AR process as a predictor of inflation and growth, and so has marginal out-of-sample forecasting power. Let $\hat{Y}^h_{0,t+h|t}$ and $\hat{Y}^h_{i,t+h|t}$ be the benchmark and *i*th candidate pseudo out-of-sample forecasts of Y^h_{t+h}, using data through time $T_1 - 1$. Then, the *h*-step ahead mean squared forecast error ($MSFE^h$) of the candidate forecast, relative to that of the benchmark forecast, is

future inflation and growth to past changes in the slope of the yield curve. The latter, which can be also used as a rule-of-thumb when taking the yield curve as a leading indicator, is of clear relevance from a policy perspective.

$$\frac{\frac{1}{T_2 - T_1 - h + 1}\sum_{t=T_1}^{t=T_2-h}(Y_{t+h}^h - \hat{Y}_{i,t+h|t}^h)^2}{\frac{1}{T_2 - T_1 - h + 1}\sum_{t=T_1}^{t=T_2-h}(Y_{t+h}^h - \hat{Y}_{0,t+h|t}^h)^2}$$

where T_1 and $T_2 - h$ are respectively the first and last dates of the pseudo out-of-sample forecast (so that forecasts are made for dates $t = T_1 + h, \ldots T_2$). If the relative MSFE^h is less than unity, then the candidate forecast is considered to outperform the benchmark.

The statistical significance of the difference in forecast performance is tested with the Diebold-Mariano (1995) statistic. Taking the pair of squared forecast errors from the two competing models $(e_{0,t}^2, e_{i,t}^2)$; $t = 1,\ldots, n$ with ($n = T_2 - T_1 - h$), the null hypothesis of equality of expected forecast performance is

$$E(e_{0,t}^2 - e_{i,t}^2) = 0$$

Defining $d_t = e_{0,t}^2 - e_{i,t}^2; t = 1,\ldots n$, the test is based on the sample mean

$$\bar{d} = n^{-1}\sum_{t=1}^{n} d_t$$

As the sequence of forecast errors follows a moving average process of order (h – 1) – i.e. autocorrelations of order h or higher are zero (Harvey et al. 1997) – the variance of $\bar{d}$ is asymptotically

$$V(\bar{d}) \approx n^{-1}\left[\gamma_0 + 2\sum_{k=1}^{h-1}\gamma_k\right]$$

where γ_k is the k-th autocovariance of d_t. The Diebold-Mariano test statistic is then

$$DM = [\hat{V}(\bar{d})]^{-1/2}\,\bar{d} \quad \text{with} \quad DM \overset{a}{\sim} N(0,1)$$

The test statistic is calculated for the 6-month ahead forecasts (with forecast error series of 24 – 6 = 18 observations).[8]

[8] I could not calculate the test statistics for 12-month and 18-month ahead forecasts, as these would produce too-small forecast error series, with 12 and 6 observations, respectively (see, e.g. Harvey et al. 1997, Table 1 p. 285, who do not report the results of their size tests on the standard Diebold-Mariano and their modified Diebold-Mariano statistics for forecasts 8 periods ahead and above and with less than 16 observations). Estimating the models with a shorter time period prior to out-of-sample forecasting is clearly not a solution, as this would likely result in inconsistent estimates, especially for those countries whose data sample starts fairly late in the 1990s and barely spans a full business cycle.

(iii) International financial linkages

To test for the existence of international financial linkages, I first replace the slope of the yield curve in emerging economies X_t by that in the US or euro area, denoted X_t^*, in equations (1):

$$Y_{t+h}^h = \beta_0 + \beta_1 X_{t-k}^* + \sum_{i=0}^{p} \alpha_i Y_{t-i} + u_{t+h}^h \quad k = 0,...T \tag{2}$$

The specification measures the predictive power of the slope of the yield curve in the US and euro area for future growth and inflation in emerging economies. Note that having both X_t and X_t^* on the right-hand side of the equation would result in a misspecification, as these are potentially collinear (see below a discussion of equation 3). As mentioned above, this predictive content may stem from (i) the larger economic size of the US or euro area, which makes it an important component of foreign demand; (ii) the deeper US or euro area debt security markets, which leads to a greater ability of its yield curve to convey information on the future impact of common shocks; and (iii) the prominent role played by the US dollar (or euro) in the exchange rate policy of many of these economies, which magnifies the interest rate pass-through. The MSFE criterion is used to test whether the slope of the yield curve in the US or euro area is a better predictor of inflation and growth in emerging economies than is either a simple autoregressive process or the domestic yield curve.

Subsequently, I test whether part of the information contained in the slope of the yield curve of some of the emerging economies stems from the yield curve in the US or euro area in the first place. To this end, I instrument the slope of the yield curve in an emerging economy by that of the US or euro area. The fitted series, denoted $\hat{X}_t$ captures the movements in the slope of the yield curve of the emerging economy that are explained by movements in the slope of the yield curve in the US or euro area or by common shocks.

$$Y_{t+h}^h = \beta_0 + \beta_1 \hat{X}_{t-k} + \sum_{i=0}^{p} \alpha_i Y_{t-i} + u_{t+h}^h \quad k = 0,...T \tag{3}$$

To assess whether correlations between yield curves can be – in some instances – interpreted as causal, I also use Granger causality tests to detect signs that the US or euro area curve is exogenous.

Lastly, I add to the regression the residual of the first-stage regression (which can be interpreted as a country-specific component) when the US or euro area yield curve is found to be a satisfactory instrument. This allows testing of whether *all* the information contained in the slope of the yield curve of the emerging economy stems from the yield curve in the US or euro area in the first place. Denoting this residual as ε_t, yields

$$Y_{t+h}^{h} = \beta_0 + \beta_1 \hat{X}_{t-k} + \beta_2 \varepsilon_{t-k} + \sum_{i=0}^{p} \alpha_i Y_{t-i} + u_{t+h}^{h} \quad k = 0,...T \tag{4}$$

where $\beta_2 = 0$ suggests that country-specific movements in the emerging market yield curve have no residual information content for future inflation and growth beyond that contained in foreign-driven movements and $\beta_2 \neq 0$ indicates that they contain some information.

An alternative way to approach the issue would be to use a dynamic factor model to estimate global and country-specific unobserved components in the dynamics of emerging economy yield curves. However, the US or euro area yield curve can be regarded as a significant part of this global component already, and my methodology has several advantages. First, the US or euro area yield curve is observable and interpretable. Second, using it allows me to focus on its forecasting power and to relate my paper to the earlier literature directly. Third and last, a disadvantage of factor models is that the estimated components are statistical constructs, which raises challenges for interpretation.

3.2 Data

My sample includes 14 emerging market economies, namely: Brazil, Czech Republic, Hong Kong, Hungary, India, Korea, Malaysia, Mexico, Philippines, Poland, Saudi Arabia, Singapore, South Africa and Taiwan. Data for the consumer price index, industrial production index, and slope of the yield curve were taken from the Bank for International Settlements, Bloomberg and Global Financial Data. The slope of the yield curve is defined as the difference between the yield on the 5-year domestic government bond in local currency and that on the 3-month treasury bill in local currency. In particular, the 5-year maturity was the longest one common to all the countries (see Table 1 for an overview).[9] Due to availability constraints, exceptions for the long end include Brazil (for which I use the yield on the 3-year domestic government bond in local currency), Mexico (3-year domestic government bond in local currency) and Taiwan (10-year domestic government bond in

[9] I also take German rates as a proxy for euro area rates, both at the long and the short end of the yield curve. Admittedly, since the advent of the euro, the money market swap rate has increasingly gained benchmark status at the short end of the maturity spectrum. However, it is available only since 1999 only, which would have

local currency). Likewise, exceptions for the short end include Korea (3-month time deposit rate, as sovereign issuance of money maket instruments has been scarce) and Taiwan (1-month treasury bill yield). Also due to data scarcity in emerging economies, the long-term yields are not always derived from zero-coupon bonds. Moreover, the maturity of the benchmark bond is occasionally not strictly constant, although it is always that closest to the reference maturity. Lastly, data on the long-term interest rate for the Philippines pertain to the primary market (unlike the others, which all refer to secondary market prices).

Table 2 reports selected descriptive statistics on the data. The median inflation rate is around 4.8% per year, which hides some dispersion across the sample. Inflation is virtually nil in both Hong Kong and Singapore, reflecting the deflationary period which followed the Asian crisis, as well as in Saudi Arabia; conversely, it reaches double-digit figures in Mexico and Hungary, possibly reflecting the periods of macroeconomic instability experienced by both countries in the sample period. Moreover, inflation is least volatile in Korea, with a standard deviation of about 1 percentage point, and most volatile in Mexico, with a standard deviation of about 8 percentage points. The median industrial production growth rate stands at around 4.7% per year, with also some dispersion across the sample. Real production decreased over the sample period in both Hong Kong and the Philippines, again reflecting the protracted recession which followed the Asian crisis; conversely, it reaches double-digit figures in Poland, possibly due to real convergence after the output collapse which characterised the early years of transition from planned to market economy. Production is least volatile in India, with a standard deviation of about 2.5 percentage points, and most volatile in Singapore, with a standard deviation of about 12 percentage points. It is also more volatile than inflation. As could be expected, the yield curve is upward-sloping, with a median positive term premium of around 110 basis points across the sample. Two exceptions include Hungary and Poland, where the slope of the yield curve was inverted on average, reflecting the protracted tightening of monetary policy to counter inflationary pressures which both countries experienced over a large part of the sample, and resulting expectations of lower inflation and policy rates going forward.[10] The (occasionally large) standard deviations underscore the significant movements in the slope of the yield curve observed in many countries over the sample period.

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obliged me to discard the earlier part of the sample. Clearly, this is highly unlikely to bias my results, as the 3-month Treasury bill rate is a very close substitute for it (with a correlation coefficient of 0.98 post-1999).

[10] I owe this point to participants of a BIS working group on local currency bond market in emerging economies.

Figure 1 plots the evolution of the slope of the yield curve in the 14 emerging economies over time, which is shown here for the first time in a comparative way. Of particular interest is the flattening – or even inversion – of the slope of the yield curve in many countries since 2004, which seems to echo that observed in the US and euro area in early 2006.

I test for unit roots and double unit roots in the logarithms of both prices and production, using standard augmented Dickey-Fuller (1979) and Dickey-Pantula (1987) tests. It goes without saying that the purpose here is not to determine whether prices and production series are *I*(1) or *I*(2) decisively, an issue far beyond the scope of this paper. This is all the more the case since the time span of the data sample would be too short. Rather, I attempt to gauge which order of differencing is most suitable to provide a satisfactory proxy for the underlying data generating process. All the tests include dummies for seasonal effects and outliers (e.g. due to crisis), as well as a time trend to capture the disinflation or convergence processes which are typical of many emerging economies over the sample period. The lag length of the test is chosen to ensure that the residuals are not autocorrelated, as indicated by the *p*-value of the Ljung-Box's *Q*-statistic at various orders.[11] Tables 3a to 3d report the results. Almost all prices series are found to be *I*(1), with the exception of those of Hungary, which is found to be trend stationary, and of the Czech Republic, which is found to be *I*(2). Likewise, almost all industrial production series are found to be *I*(1), with the exception of that of Hong Kong, which is found to be *I*(2).[12] I treat the slope of the yield curve as *I*(0), in line with the literature (see e.g. Estrella, 2005b, who emphasises that it is "the *level* of the term spread, not the change, not even the source of change", which has best forecasting content).

[11] It is this (country-specific) lag length which is retained in the subsequent estimations (Stock and Watson, 2003, use a fixed – i.e. country non-specific – lag length of 4). I also keep the seasonal dummies and the dummies to control for outliers and crises (the dummy equals 1 in November 2000 for Philippines; from September 1998 to December 1998 for Mexico; May 1998 to June 1998 for Malaysia; January 1998 to April 1998 for Korea; and 0 otherwise).

[12] I also found statistical evidence that inflation in Korea and Taiwan might be trend stationary, albeit at the 10% level of confidence only and that industrial production growth in Malaysia might be trend stationary, albeit at the 10% level of confidence only.

4 Results

4.1 Predictive role of the yield curve in emerging economies

(i) In-sample measures of predictive content

Table 4 gives a summary of results with the slope of the yield curve in emerging economies used as a predictor of domestic inflation and industrial production growth. The estimation is computationally intensive, involving some 16,000 regressions.[13] All the estimates reported are significant at the 5% level of confidence, unless otherwise indicated. The results are reported country by country[14], including the forecast horizon *h* (which ranges from 6 months to 2 years, with 6-month intervals), the slope of the yield curve's longest significant lag *k* (which is allowed to vary from 0 to *T* = 24 months) and β_1, the response of inflation or growth in annual percentage rates over the forecast horizon to a 100 b.p. steepening in the slope of the yield curve. For example, according to the results reported for the US (pro memoria), a 100 basis point steepening of the slope of the domestic yield curve observed 2 years ago is associated with an expected acceleration in inflation by around 40 basis points p.a. over the next 6 months.

Overall, the slope of the yield curve in emerging economies is found to have information content for future inflation in almost all the countries.[15] The information content is significant for both short (6 months) and long horizons (2 years). Long lags of the slope of the yield curve – on the order of two years, in some instances – are often found to still have significant predictive power. This suggests that information embodied in the slope of the yield curve, even in the relatively distant past, has relevant content for the future. Moreover, the response of inflation is often positive, in line with expectations (i.e. a steepening of the yield curve is associated with higher expected inflation). This is not always the case, however, as suggested by the results for Brazil, the Czech Republic, Malaysia, Mexico and the Philippines. This may have to do with inflation volatility, which is highest across the

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[13] In other words, a regression for 14 countries × 24 (*k*) lags × 24 (*h*) months, for both inflation and industrial production growth, given the chosen parameterisation (as explained below).

[14] Clearly, an alternative would be to pool the data and use a panel estimator. However, this (i) would make the results not comparable with the previous literature, for which country-by-country estimates is the standard; (ii) is not needed, as the number of observations available per country (around 80 to 120) is already sufficient for efficient estimation and (iii) would likely lead to biased estimates towards emerging Asian coefficients (as emerging Asian economies account for half of the countries in the sample).

[15] Taiwan is an exception, as predictive content for forecast horizons above a year and half is found not to be significant.

sample for some of these countries, variations in risk premia, permanent and positive productivity shocks, or a lack of liquidity in the domestic debt market, which distorts the information signals embodied in security prices. In terms of magnitude, averaging the results across the sample suggests that, beyond a 100 basis point steepening in the slope of the yield curve observed a year and a half ago, inflation is expected to accelerate by around 30 basis points a year ahead (which is close to my estimate for the US).

Likewise, the slope of the yield curve in emerging economies is found to contain information for future industrial production growth in almost all countries.[16] Again, the information content is significant for both short and long forecast horizons, with long lags of the slope of the yield curve still having significant predictive ability. This confirms that information embodied in the slope of the yield curve, even in the relatively distant past, is relevant for the future. Moreover, the response of industrial production growth is often positive, in line with expectations (i.e. a steepening of the yield curve is associated with higher expected growth). This is not always the case, however, as suggested by results for the Czech Republic, Hungary, India, Korea and Singapore, due to industrial production growth volatility, which is highest across the sample for some of these countries (baring India), variations in risk premia, permanent and positive productivity shocks, or lack of liquidity in the domestic debt market, which distorts information signals embodied in security prices. Moreover, in some instances, estimated coefficients are unstable, switching signs across forecast horizons (e.g. Czech Republic, Mexico and South Africa). In terms of magnitude, averaging the results across the sample suggests that, beyond a 100 basis point steepening in the slope of the yield curve observed a year and half ago, industrial production growth is expected to accelerate by around 30 basis points a year ahead.

(ii) Pseudo out-of-sample measures of predictive content

Table 5 reports MSFE based on equation (1), with results for inflation contained in the first column and those for growth in the fourth column. Models are estimated up to December 2003 and used for out-of-sample forecasting from January 2004 to December 2005 at vari-

[16] Malaysia is an exception, as predictive content for forecast horizons below two years is found not to be significant. Predictive content for some forecast horizons is also found not to be significant for India, Philippines and Taiwan. Saudi Arabia had to be dropped from the sample as it has time series for oil production only, not for total industrial production.

ous horizons (6 months, 1 year, 18 months).[17] The order *p* of the autoregressive process is set equal to that used for the unit and double unit root tests, to ensure absence of autocorrelation of the residuals. The (one-sided) *p*-value of the *DM* statistic, which tests whether the reported MSFE is significantly below unity, is reported for the 6-month horizon. For each emerging economy, I used the longest significant lag of the slope of the domestic yield curve, as found in in-sample estimation. The results suggest that for half of the countries in the sample (including Czech Republic, Hungary, India, Korea, Malaysia, Philippines and Poland), adding the slope of the yield curve to a simple AR process improves the out-of-sample forecasting performance for inflation at all horizons. Given how demanding the *DM* test is in a small sample, it is noteworthy that this improvement is even statistically significant at the 6-month horizon for a number of economies. This confirms that, for these economies, the slope of the domestic yield curve embodies genuine information for forecasting future inflation in real time. Conversely, in Mexico, where inflation has been high and volatile over part of the sample, adding the slope of the yield curve to a simple AR process never improves the out-of-sample forecasting performance. This confirms that, for this economy, the slope of the domestic yield curve has no genuine predictive power for future inflation. For the remaining economies, the slope of the domestic yield curve has genuine predictive power for future inflation at certain horizons. Likewise, the results suggest that for a quarter of the countries in the sample (Hong Kong, India and Mexico), adding the slope of the yield curve to a simple AR process improves the out-of-sample forecasting performance for industrial production growth at all horizons. This confirms that, for these economies, the slope of the domestic yield curve contains genuine information for forecasting future growth in real time. Conversely, for Singapore, adding the slope of the yield curve to a simple AR process never improves out-of-sample forecasting performance, while for the remaining economies the slope of the domestic yield curve has genuine predictive power for future growth at certain horizons.

[17] As data for Brazil were available for a short time period (since 2000 only), constraining the number of degrees of freedom, out-of-sample forecasting could be performed at the 6-month horizon only.

4.2 International financial linkages

(i) Predictive role of US or euro area yield curve

Table 6 reports the results when the slope of the yield curve in the US or euro area is used to predict inflation in emerging economies.[18] For example, according to the first result reported for the Czech Republic, beyond a 100 basis point steepening in the slope of the euro area yield curve observed a year and half ago, inflation is expected to accelerate at an annualised rate of around 1.3 percentage points over the next 6 months. Overall, regarding specification (2), it is noteworthy that the slope of the US yield curve is found to contain information for future inflation in a wide array of emerging Asian economies, including Hong Kong, Korea, Malaysia (at long forecast horizons), the Philippines and Taiwan, as well as in Saudi Arabia and South Africa. Moreover, the slope of the euro area yield curve is found to contain information for future inflation in the new EU Member States, including the Czech Republic, Hungary and Poland. Conversely, the slope of the US yield curve contains no significant information for future inflation in Brazil, India, Mexico and Singapore. Turning to industrial production growth, the slope of the US yield curve is found to contain information for almost all economies, while that of the euro area is found to have information for Hungary. Moreover, the estimated coefficients are always positive, in line with expectations, and more stable than for inflation (they never change sign across forecast horizons, in particular). In terms of magnitude, averaging the statistically significant results across the sample suggests that beyond a 100 basis point steepening in the slope of the foreign yield curve observed a year and a half ago, inflation is expected to accelerate by around 60 basis points a year ahead (at annual rates), while industrial production is expected to accelerate by around 200 basis points.

Table 5 also reports the MSFE based on equation (2), with results for inflation in the second column and those for growth in the fifth column. For inflation, the results suggest that for a third of the countries in the sample Czech Republic, Poland, Saudi Arabia, South Africa and Taiwan), adding the slope of the yield curve of the US or euro area to a simple AR process improves the out-of-sample forecasting performance at all horizons. It is noteworthy that this improvement is statistically significant at the 6-month horizon for a number of economies, although the *DM* test is demanding in short samples. This suggests that, for these economies, the US or euro area slope of the yield curve has genuine predictive power for future inflation. In the same vein, the results suggest that for almost half of the countries in the sample (Czech Republic, Hong Kong, India, the Philippines, Singapore and South Africa), adding the slope of the yield curve of the US or euro area to a simple AR process improves the out-of-sample forecasting performance for industrial growth at all horizons. This suggests that, for these economies, the US or euro area slope of the yield curve has genuine predictive power for future growth.

The third and sixth columns of Table 5 give the MSFE, comparing out-of-sample forecasts based on equation (1) relative to those based on equation (2), to assess whether the US or euro area slope of the yield curve is a better predictor of inflation and growth in emerging economies than their own domestic slope. As for inflation, this is the case for six economies (Hong-Kong, Malaysia, and Philippines at the 18-month horizon; Saudi Arabia, South Africa at the 6-month horizon; and Taiwan), against nine for growth (Brazil, Czech Republic, Hong-Kong, India, Philippines, Poland, Singapore, South Africa and Taiwan).Several of these economies tightly peg (or tightly manage) their currency to the US dollar, which makes their monetary policy – and thereby slope of the yield curve as well as inflation and growth trends – follow closely that of the US.

<u>(ii) Yield curve spillovers</u>

To assess whether part of the information on future inflation and growth contained in the slope of the yield curve in emerging economies stems from the slope of the US or euro area yield curve in the first place, I instrument the former with the latter. The fitted series captures the movements in emerging economy yield curves which can be explained by movements in the US or euro area yield curve or by common shocks. The quality of the intrumentation is gauged with the statistical significance of the estimated parameter of the first stage regression, its R^2 and Granger causality tests. When the latter is found as a reasonably good instrument, the fitted series is used in a second stage regression, as specified in equation (3).

Table 7a reports the results of the first stage regression. The estimated coefficients are statistically significant for most countries, with the exception of India, Korea, Singapore and South Africa (and Hungary, except when the euro area yield curve is used as instrument), which I then exclude from subsequent estimations. This may suggest that these

[18] To give an idea of the intensiveness of the computations involved, this adds another 16,000 regressions to the previous estimations.

economies, having deep or closed domestic financial markets, are somewhat insulated from US developments.[19] Moreover, the coefficient is mostly positive and often close to 1, suggesting that the yield curve in emerging economies reacts in tandem with movements in the yield curve in the US or euro area. Exceptions include Hungary and Malaysia, where the correlation is significantly negative. The slope of the US yield curve explains a large share of the variance of the slope of the yield curve in Hong Kong, Mexico, Poland, Saudi Arabia and Taiwan, all of which have an exchange rate regime oriented towards the US dollar – over part of the sample period, at least – and have the US as an important trading partner. Granger causality test results, reported in Table 7b, further suggest that causality runs from the US yield curve to the yield curve in Hong Kong, Poland, Saudi Arabia and Taiwan, and detects significant feedback at some lags for both Brazil and Saudi Arabia.

Table 8 reports the results when the instrumented emerging economy yield curve is used as a predictor for domestic inflation and growth. For example, according to the first result reported for Saudi Arabia, beyond a 100 basis point steepening in the domestic yield curve driven by movements in the US yield curve, and observed a half year ago, inflation is expected to accelerate by about half a percentage point p.a. in the next 6 months. Overall, using specification (3), this is also the case for Hong Kong, Poland and Taiwan, which together account for a quarter of the economies in the sample. The instrumented slope of the yield curve is also found to contain information for future inflation in other economies, including Brazil, Czech Republic, Hungary, Mexico and Philippines, although the direction of causality remains open here, as mentioned above. Likewise, the instrumented slope of the yield curve is found to have information for future industrial production growth in these economies, with the same caveats. The negative response of inflation and growth for Hungary and Malaysia mirrors the negative sign of the estimated coefficient in the first stage regression. In terms of magnitude, averaging the statistically significant results over the sample suggest that, beyond a 100 basis points steepening in the slope of the domestic yield curve driven by movements in the US or euro area yield curve observed a year ago, inflation is expected to accelerate by around 60 basis points, while industrial production growth is expected to accelerate by 1.5 percentage points.

Lastly, I test whether movements in emerging market yield curves that are purely country-specific contain useful information for future information and growth beyond that

[19] For some of these countries, the ability of the US yield curve to predict inflation or growth likely stems from the greater liquidity of US debt security markets, and thereby more efficient information processing in forecasting

already contained in foreign-driven movements. To this end, I add the residual of the first-stage regression (which can be interpreted as a country-specific component) to the specification, as in equation (4). The results are reported in Table 9. The magnitude and significance of the response of inflation or growth to movements of the emerging market yield curve driven by the US or euro area curve (β_1) remain very similar to the results from the previous specification (although it did not control for movements of the emerging market yield curve that are purely country-specific). The movements in the emerging market yield curve that are purely country-specific have no residual forecasting power for future inflation ($\beta_2 = 0$) for close to half of the countries in the sample; for the remaining half, some residual forecasting power remains ($\beta_2 \neq 0$). As for future growth, movements in the emerging market yield curve that are purely country-specific tend to have no residual forecasting power for two-thirds of the countries in the sample while, for the remaining third, some residual information content remains.

5 Robustness checks and interpretation

5.1 Robustness checks

I first check the robustness of the in-sample results by using an alternative specification of the persistence term, since the earlier literature placed particular emphasis on the marginal significance of predictive power.

To this end, I replace $\sum_{i=0}^{p} \alpha_i Y_{t-i}$ with lagged terms of the *h*-step ahead forecast itself, i.e. $\sum_{i=1}^{p} \alpha_i Y_{t+h-i}^{h}$ in equations (1), (2) and (3). In this alternative specification

$$\frac{\beta_1}{\sum_{i=1}^{p} \alpha_i}$$

is the steady-state response of Y_{t+h}^{h} to X_{t-k}, i.e. the long-run acceleration in inflation or growth predicted by the slope of the yield curve *k* months ago (in annual percentage rates), and

common shocks.

$$\left|\sum_{i=1}^{p}\alpha_i\right|$$

is a necessary and sufficient condition for all the characteristic roots of the autoregressive part of the process to lie inside the unit circle. Results are similar for this specification, in terms of both sign and significance.[20] The magnitude of the responses of inflation and growth tends to be slightly larger, however, given that they are steady-state (long-run) estimates. Reflecting this, averaging the results across the sample suggests that, beyond a 100 basis point steepening in the slope of the emerging market yield curve, inflation is expected to accelerate by around 50 basis points and growth by 70 basis points. Likewise, beyond a 100 basis point steepening in the slope of the foreign yield curve, domestic inflation is expected to accelerate by around 70 basis points and growth by 3 percentage points. Lastly, beyond a 100 basis point steepening in the slope of the emerging yield curve driven by movements in the foreign yield curve, inflation is expected to accelerate by around 1.3 percentage points and growth by 2.7 percentage points.

Turning to the out-of-sample results, I calculate the modified Diebold-Mariano test statistic (as in Harvey et al. 1997), which has better properties than the standard one for samples of moderate size, such as mine. The results remain largely unaltered.[21] In addition, I use a longer out-of-sample period (3 years versus the previous 2 years) for the countries with data from the mid-1990s (Hong Kong, India, Malaysia, Mexico, Philippines, Saudi Arabia, Singapore and South Africa). The results are reported in Table 10. By and large, and bearing in mind the possible loss of consistency due to the smaller in-sample estimation period, the results are qualitatively similar. MSFEs often remain close in magnitude to those previously obtained. An exception is Singapore, where the ability of the US yield curve to beat an AR process or the local yield curve at forecasting growth deteriorates sharply. In terms of statistical significance (measured by the *DM* statistic), the results are more mixed. The forecasting power of the local yield curve gains in significance for the Philippines and South Africa (inflation), but loses in significance for Hong Kong, Malaysia (inflation) and Mexico (growth). Moreover, the forecasting power of the US yield curve gains in significance for Saudi Arabia (inflation) and South Africa (growth), but loses in significance for Singapore (growth) and South Africa (inflation).

[20] They are not reported here in detail to save space but are available upon request.

[21] The modified *DM*-statistic is equal to the standard one times a scaling factor; it follows a *t*-distribution with *n*-1 degrees of freedom. Results are not reported here to save space but are available upon request.

As a recent paper by Ang et al. (2006) finds evidence in the US that the short term rate predicts growth better than the yield curve, I test whether this is also the case in emerging economies. Table 11 reports the MSFE comparing out-of-sample forecasts of growth at the 6-month horizon based on equation (1) relative to those based on a similar equation where I replace the emerging market yield curve with the 3-month treasury bill rate. The results are mixed. The short term rate is found to be a better predictor indeed than the yield curve in Hong-Kong, Hungary, India and Singapore (as the MSFE above unity suggests). This mirrors the evidence for the US in Ang et al. (2006). By contrast, the yield curve remains a better predictor for Malaysia, Mexico, Philippines, Poland and South Africa (as suggested by the MSFE criterion, which is significantly below unity). This confirms that, at least for some emerging market countries, the yield curve is a relevant leading indicator for growth.

To end with international spillovers, I test as a final robustness check whether country spreads, that is the premia paid by emerging economies to borrow in international capital markets, also help forecast macroeconomic variables in these economies.[22] To this end, I replace the slope of the yield curve in equation (1) by the spread, relative to US treasuries, of international bonds of a similar maturity issued by emerging sovereigns, as available from JP Morgan's EMBIG indices, a standard market benchmark. I have data for seven countries from January 1998 onwards. Table 12 reports in-sample estimations at the 6-month and 12-month horizon. The key result is that country spreads indeed contain information for both future inflation and growth. This underscores their direct impact on future economic conditions and their role as catalyst of US interest rate shocks. In terms of sign, spreads are found to widen ahead of an acceleration in inflation (except for Hungary and Malaysia), which may reflect market expectations of tighter monetary policy going forward. The evidence for growth is mixed, with wider spreads signalling higher growth in Brazil, Malaysia and the Philippines, but lower growth in the remaining countries. The latter result perhaps mirrors the adverse impact of higher borrowing costs on future economic activity, as noted in Uribe and Yue (2006).

[22] Uribe and Yue (2006) find indeed that country spreads drive their business cycles and play a role in propagating US interest rate shocks.

5.2 Interpretation

To measure synthetically the quality of the emerging market yield curve as a predictor of both domestic inflation and growth at various horizons, I define the following index

$$\Theta_{i,j,h} = \begin{cases} 1 | \text{MSFE}^h < 1 \\ 0 \end{cases} \quad \text{and} \quad \Theta_i = \sum_j \sum_h \Theta_{i,j,h}$$

for emerging market i; j = inflation, growth; and horizon h = 6 months, 12 months, 18 months. The index Θ_i can take values between 0 (relative to an AR process, the emerging market slope of the yield curve never adds information content at any horizon in out-of-sample forecasting of both inflation and growth) and 6 (the emerging market yield curve adds information content at all horizons in out-of-sample forecasting of both inflation and growth). Likewise, to measure synthetically whether the US or euro area yield curve is a "better" predictor of both inflation and growth in emerging economies than their own domestic yield curves, I define a similar index using the MSFE that compares out-of-sample forecasts based on equation (1) to those based on equation (2), denoted Θ_i^*.

As can be seen from Figure 2, which plots the values of Θ_i by country, the yield curve of India adds information content at all horizons in out-of-sample forecasting of domestic inflation and growth, which is never the case for Brazil and Taiwan. The remaining countries are intermediate cases. There are signs that differences across emerging economies in terms of forecasting ability of the domestic slope of the yield curve are linked to market liquidity. As can be seen from regression results reported in Table 13 indeed, Θ_i is positively correlated with the share of long-term domestic debt securities in GDP, although not significantly, which may be due to the very small size of my sample (14 country observations).[23] Likewise, as can be seen from Figure 3, which plots the values of Θ_i^* by country, the US or euro area yield curve is always a better predictor of inflation and growth in Hong Kong than its own domestic curve, which is never the case for e.g. Korea, while the remaining countries are intermediate cases. There is evidence that differences across emerging economies in terms of forecasting ability of the foreign yield curve are linked to exchange rate rigidity. Indeed, Θ_i^* is negatively – and significantly – correlated with a de facto index of exchange rate flexibility, notwithstanding the small size of the sample.[24] Moreover, the less liquid domestic debt markets are relative to US debt markets, the better the slope of the US or euro area yield curve is as predictor, although this negative correlation is not significant. Conversely, the role of common shocks, proxied by the average of correlations between (i) domestic and US inflation and (ii) domestic and US industrial production growth, is less certain, as it is neither robust nor significant. All in all, this suggests that international yield curve spillovers are channelled mainly through the short end of the maturity spectrum and policy interest rate pass-through. This echoes recent evidence from Frankel et al. (2004), Shambaugh (2004) and Obstfeld et al. (2005), suggesting that pegs follow base country interest rates more than non-pegs.

6 Conclusions

The role of the yield curve as a predictor has been challenged forcefully of late, particularly in the US context. This paper has found some evidence that the yield curve, including the US one, may still be useful for forecasting purposes and, perhaps more importantly, to understand the ongoing process of international financial integration.

A sample of 14 emerging economies was used to investigate the usefulness of the slope of the domestic yield curve in forecasting inflation and growth over the last decade, following the standard methodology surveyed in Stock and Watson (2003). It has found that the yield curve contains information in almost all countries, even after controlling for inflation and growth persistence, at both short and long forecast horizons. On average, in-sample results suggest that, beyond a 100 basis point steepening observed a year and a half ago, both inflation and growth are expected to accelerate by around 30 basis points a year ahead. Moreover, for around half of the countries in the sample, adding the yield curve to a simple autoregressive process improves out-of-sample forecasting performance for inflation at all horizons. This confirms that, for these economies, the yield curve embodies genuine information for forecasting future inflation in real time. Likewise, for a quarter of

[23] It is worth noting that the overall share of domestic debt securities in GDP is not a good proxy for liquidity, as it includes – in economies which had high and volatile inflation – instruments that are linked to a foreign currency or indexed to prices.

[24] The index is constructed from Reinhart and Rogoff (2004)'s de facto classification of exchange rate regimes. Each country is split each year into 3 categories, i.e. peg, intermediate and float, with weights of 0, 1 and 2, respectively. I take the weighted average over the sample period as a proxy of the de facto regime of the corresponding country. The proxy is therefore continuously increasing with exchange rate flexibility.

the countries in the sample, the slope of the yield curve improves out-of-sample forecasting performance for industrial production growth at all horizons. It is noteworthy to observe that this improvement is statistically significant at the 6-month horizon for a number of economies, although the tests are very demanding for small samples. Moreover, there are signs – albeit still tentative – that differences across emerging economies in terms of forecasting ability of the slope of the domestic yield curve are linked to market liquidity.

In examining international financial linkages, my core focus, the paper assessed the ability of the slope of the US or euro area yield curve to help predict inflation and growth in these emerging economies. It has found that the US yield curve contains information for future inflation in half of the countries in the sample, while the slope of the euro area yield curve has information for future inflation in the new EU Member States. Likewise, the US yield curve is found to contain information content for growth in almost all economies. On average, in-sample results suggest that, beyond a 100 basis point steepening observed a year and a half ago, inflation is expected to accelerate by around 60 basis points a year ahead, against 2 percentage points for industrial production growth. Moreover, for around a third of the countries in the sample, adding the US or the euro area yield curve to a simple autoregressive process improves out-of-sample forecasting performance for inflation at all horizons. This confirms that, for these economies, the US or euro area yield curve embodies genuine information for forecasting future inflation in real time. Similarly, for almost half of the countries in the sample, the US curve improves out-of-sample forecasting performance for industrial production growth at all horizons. Again, the improvement is statistically significant at the 6-month horizon for a number of economies, although the tests are very demanding for small samples.

The paper also found that the slope of the US or euro area yield curve is a “better” predictor than emerging economies’ own domestic slopes for around half of the countries in the sample for inflation, against two-thirds for growth. There is evidence that differences across countries are linked to the exchange rate regime, controlling for relative market liquidity and commonalities in economic shocks. Indeed, the more an emerging economy pegs to the US dollar or euro, the greater the superiority of the US or euro area yield curve in terms predictive power. This suggests that international yield curve spillovers are channelled mainly through the short end of the maturity spectrum and policy interest rate pass-through.

In line with this, in investigating the possible spillovers between yield curves, I have found that part of the information content of the slope of the Hong Kong, Polish, Saudi and Taiwanese yield curves stems, in a causal sense, from the US yield curve in the first place. All these countries had a – more or less stringent – peg to the US dollar, at least over part of the sample period. This confirms that US monetary policy changes spill over to the rest of the world and are a key driver of international financial linkages. Moreover, movements in the emerging market yield curves that are purely country-specific are often found not to have residual information content, in particular for future growth. In essence, these results, which are resilient to a number of robustness checks, are in line with, and extend those of, Chinn and Frankel (2005) who – focusing on interest rate *levels* and the *industrialised* world – found that US interest rates drive interest rates elsewhere, at least at the short end of the maturity spectrum.

Looking ahead, more work may be needed to understand cross-country differences in terms of ability of domestic yield curves to predict inflation and growth, an area which has remained under-researched, including for industrial countries. I have tried to provide some interpretation for my results, but it relies on a small sample, and should therefore be considered tentative. Moreover, investigating possible forecasting improvements via adjustments in yield curve movements for variations in risk premia, in line with very recent findings in the literature on the US or euro area, may be worthwhile. Given that this involves markedly different methods, including estimation of affine arbitrage-free term structure models, I will take this up in future research.

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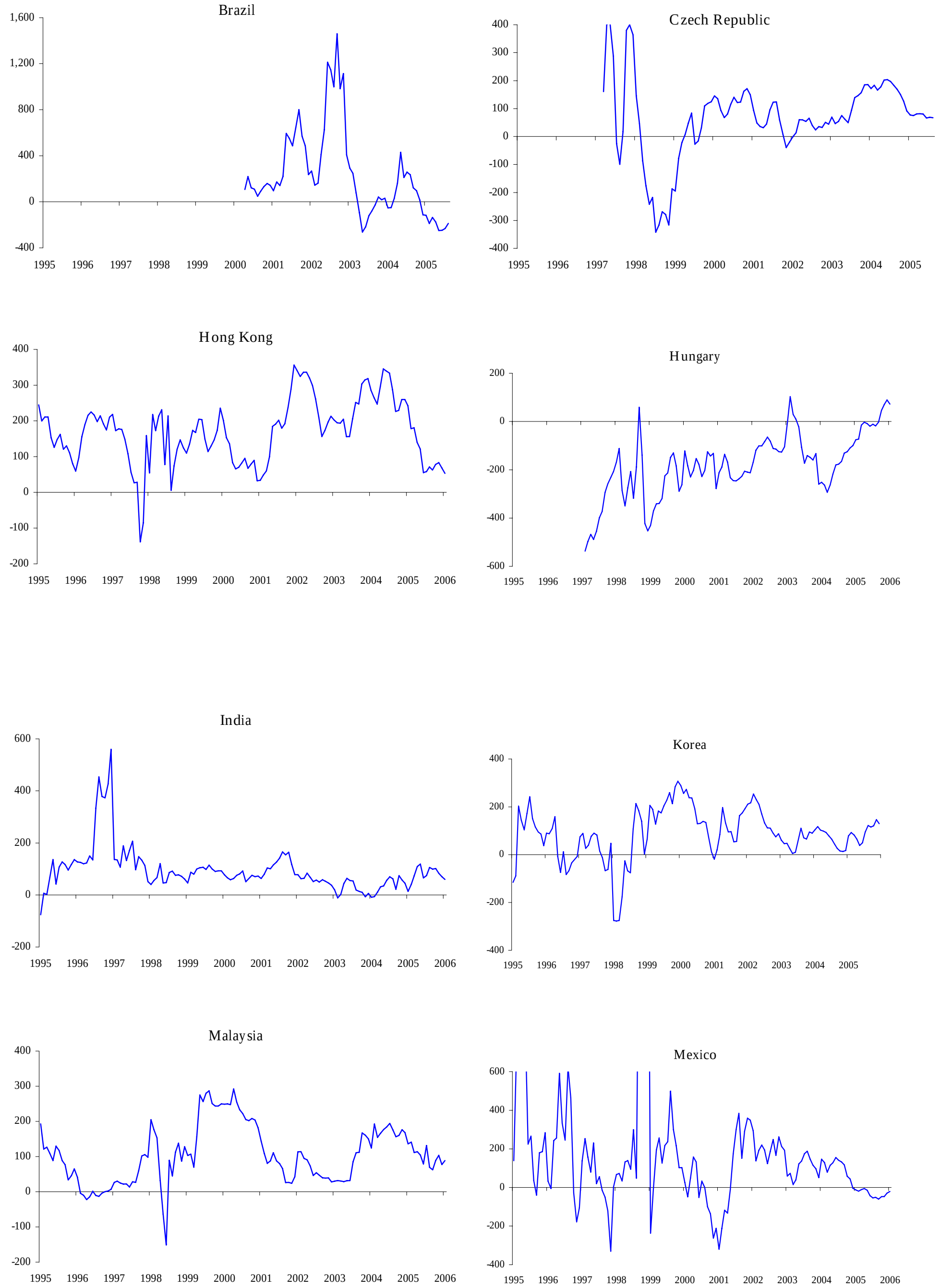
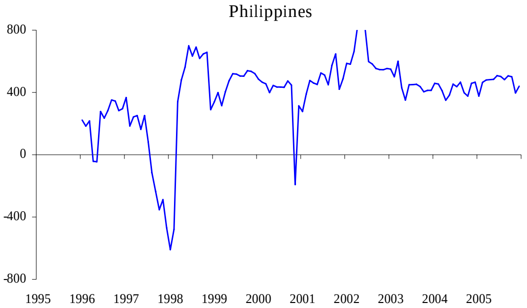
Figure 1: Evolution of the slope of the yield curve in selected emerging economies *(in basis points)*

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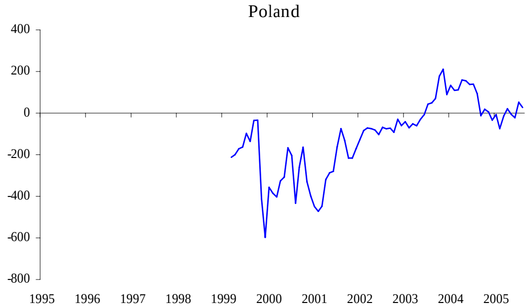
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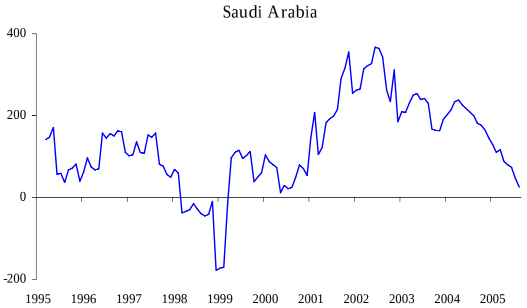
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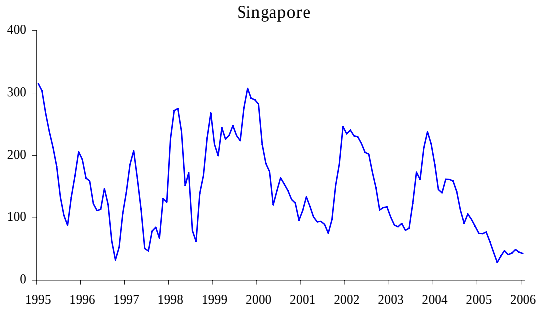
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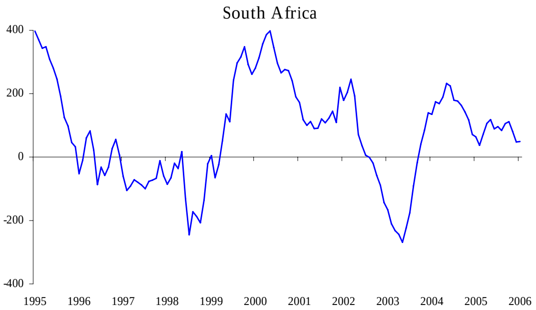
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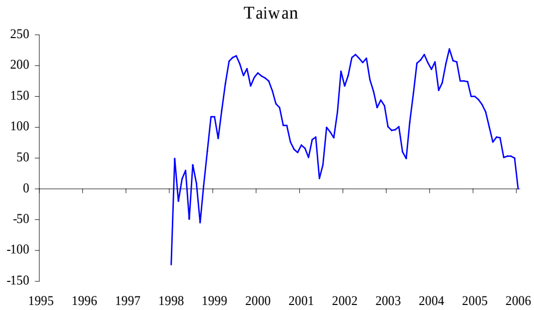
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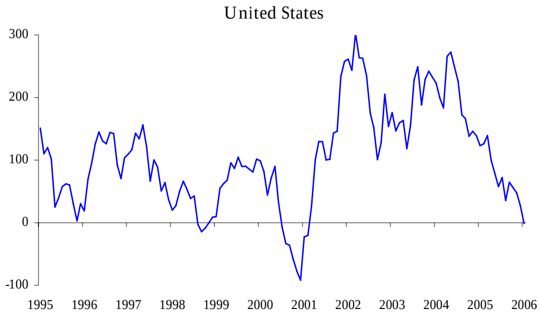


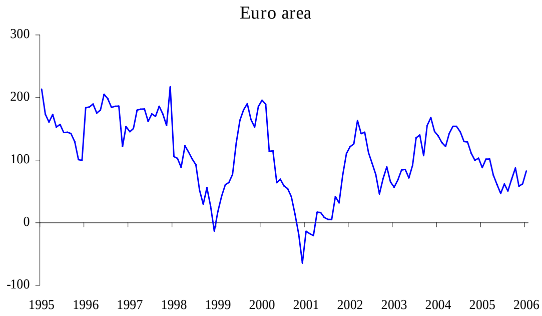
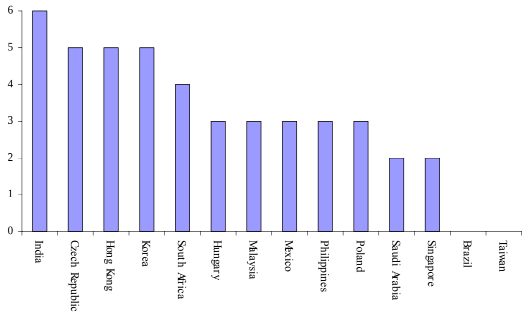


Figure 2: Θ_i

Figure 3: Θ_i^*



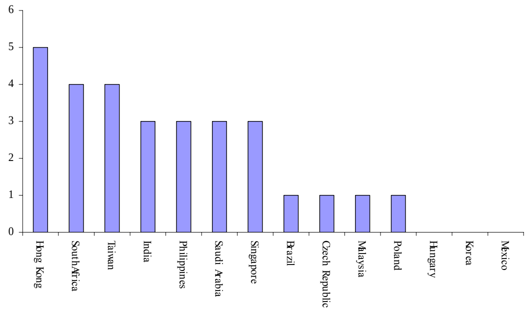


Table 1: Description of the data used to proxy the slope of the yield curve in emerging economies

	Long-term interest rate	Short-term interest rate	Sample	
			(Start)	*(End)*
Euro area (Germany)	5-year government bond yield	3-month treasury bill yield	January 1995	December 2005
United States	5-year government bond yield	3-month treasury bill yield	January 1995	December 2005
Brazil	3-year government bond yield	3-month treasury bill yield	April 2000	August 2005
Czech Republic	5-year government note yield	3-month treasury bill yield	March 1997	August 2005
Hong Kong	5-year government note yield	3-month treasury bill yield	January 1995	December 2005
Hungary	5-year government note yield	3-month treasury bill yield	February 1997	December 2005
India	5-year government bond yield	3-month treasury bill yield	January 1995	December 2005
Korea	5-year government bond yield	3-month time deposit rate	January 1998	December 2005
Malaysia	5-year government note yield	3-month treasury bill discount rate	January 1995	December 2005
Mexico	3-year government bond yield	3-month CETES yield	January 1995	December 2005
Philippines	5-year government bond auction rate	3-month treasury bill yield	January 1996	December 2005
Poland	5-year government bond yield	3-month treasury bill yield	March 1999	August 2005
Saudia Arabia	5-year government note yield	3-month treasury bill yield	March 1995	August 2005
Singapore	5-year government bond yield	3-month treasury bill yield	January 1995	December 2005
South Africa	5-year government note yield	3-month treasury bill yield	January 1995	December 2005
Taiwan	10-year government bond yield	1-month treasury bill yield	January 1998	December 2005

Source: Global Financial Data, with the exception of Brazil, the euro area, the United States and Poland (Bloomberg).

Table 2: Descriptive statisitics for the data

	Inflation (y-o-y, %)		Industrial production (y-o-y, %)		Slope of the yield curve (basis points)	
	(Mean)	*(Standard deviation)*	*(Mean)*	*(Standard deviation)*	*(Mean)*	*(Standard deviation)*
Brazil	7.77	3.91	2.45	5.10	205	384
Czech Republic	4.12	3.33	3.83	5.47	62	142
Hong Kong	0.01	3.77	-4.10	5.13	171	90
Hungary	9.94	5.57	7.58	6.21	-183	132
India	5.56	3.28	5.97	2.55	94	86
Korea	2.78	1.11	7.24	8.82	102	110
Malaysia	2.41	1.28	6.32	8.31	105	83
Mexico	11.15	8.30	3.70	4.92	176	380
Philippines	5.96	2.34	-0.81	6.25	391	248
Poland	6.18	4.52	10.37	7.59	-110	177
Saudia Arabia	-0.11	0.93			128	107
Singapore	0.77	0.97	5.76	12.27	151	71
South Africa	5.70	2.83	1.29	3.78	75	159
Taiwan	1.04	1.38	4.75	7.57	123	72
All countries						
Median	4.84		4.75		114	
Average	4.52		4.18		106	

Source: author's calculations.

Unit root and double unit root tests

Unit root test specification:

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \lambda t + \text{dummies for outliers and seasonal effects} + \varepsilon_t$$

Table 3a: Test results for a unit root in prices

	β	p	$Q(1)$	$Q(6)$	$Q(12)$
Brazil	-2.26	3	0.59	0.59	0.79
Czech Republic	-2.02	8	0.86	0.92	0.92
Hong Kong	-2.95	3	0.96	0.30	0.22
Hungary	-4.13 ***	6	0.70	0.83	0.97
India	-1.48	4	0.72	0.81	0.13
Korea	-3.16 *	4	0.93	0.75	0.38
Malaysia	-2.08	7	0.99	0.99	0.67
Mexico	-2.71	11	0.25	0.56	0.72
Philippines	-2.37	4	0.65	0.36	0.18
Poland	-2.37	2	0.97	0.26	0.62
Saudia Arabia	-0.65	5	0.66	0.93	0.43
Singapore	-2.56	5	0.73	0.99	0.74
South Africa	-2.06	5	0.90	0.95	0.40
Taiwan	-3.20 *	1	0.65	0.42	0.25

Source: author's estimates.
Note: $Q(k)$ is the p- value of the Ljung-Box statistics for absence of autocorrelation up to order k.
(***), (**), (*): statistical significance at the 1%, 5% and 10% level of confidence.

Table 3b: Test results for a unit root in industrial production

	β	p	$Q(1)$	$Q(6)$	$Q(12)$
Brazil	-1.60	8	0.88	0.99	0.99
Czech Republic	-1.25	8	0.98	0.99	0.82
Hong Kong	-2.19	12	0.98	0.99	0.97
Hungary	-1.70	6	0.64	0.95	0.38
India	-2.47	4	0.90	0.98	0.61
Korea	-3.18	4	0.71	0.78	0.52
Malaysia	-3.39 *	10	0.96	0.99	0.95
Mexico	-2.51	5	0.62	0.79	0.28
Philippines	-2.26	2	0.95	0.86	0.97
Poland	-2.67	3	0.86	0.96	0.46
Saudia Arabia					
Singapore	-1.78	11	0.45	0.98	0.23
South Africa	-1.47	2	0.43	0.98	0.61
Taiwan	-2.17	12	0.87	0.97	0.11

Source: author's estimates.
Note: $Q(k)$ is the p- value of the Ljung-Box statistics for absence of autocorrelation up to order k.
(***), (**), (*): statistical significance at the 1%, 5% and 10% level of confidence.

Double unit root test specification:

$$\Delta^2 y_t = \alpha + \beta \Delta y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta^2 y_{t-i} + \lambda t + \text{dummies for outliers and seasonal effects} + \varepsilon_t$$

Table 3c: Test results for a double unit root in prices

	β	p	$Q(1)$	$Q(6)$	$Q(12)$
Brazil	-3.80 **	3	0.85	0.87	0.93
Czech Republic	-2.60	8	0.83	0.96	0.98
Hong Kong	-3.60 **	3	0.60	0.66	0.35
Hungary					
India	-5.69 ***	4	0.78	0.97	0.28
Korea					
Malaysia	-4.19 ***	7	0.97	0.99	0.67
Mexico	-3.55 **	11	0.56	0.98	0.97
Philippines	-3.17 *	4	0.99	0.99	0.39
Poland	-4.92 ***	2	0.91	0.35	0.66
Saudia Arabia	-3.36 *	5	0.93	0.95	0.59
Singapore	-3.84 **	5	0.97	0.99	0.50
South Africa	-3.74 **	5	0.81	0.99	0.52
Taiwan					

Source: author's estimates.
Note: $Q(k)$ is the p- value of the Ljung-Box statistics for absence of autocorrelation up to order k.
(***), (**), (*): statistical significance at the 1%, 5% and 10% level of confidence.

Table 3d: Test results for a double unit root in industrial production

	β	p	$Q(1)$	$Q(6)$	$Q(12)$
Brazil	-4.88 ***	8	0.99	0.99	0.99
Czech Republic	-3.59 **	8	0.96	0.98	0.75
Hong Kong	-2.02	12	0.94	0.99	0.96
Hungary	-3.25 *	5	0.76	0.96	0.43
India	-5.06 ***	4	0.93	0.88	0.38
Korea	-4.89 ***	4	0.93	0.98	0.66
Malaysia	-3.16 *	10	0.85	0.99	0.97
Mexico	-5.82 ***	5	0.90	0.97	0.39
Philippines	-7.02 ***	2	0.73	0.83	0.90
Poland	-5.34 ***	3	0.85	0.97	0.50
Saudia Arabia					
Singapore	-3.60 **	11	0.48	0.96	0.97
South Africa	-7.82 ***	2	0.90	0.98	0.61
Taiwan	-4.01 **	12	0.22	0.61	0.42

Source: author's estimates.
Note: $Q(k)$ is the p- value of the Ljung-Box statistics for absence of autocorrelation up to order k.
(***), (**), (*): statistical significance at the 1%, 5% and 10% level of confidence.

Table 4: The slope of the yield curve in emerging economies as a predictor of their domestic inflation and growth

			Specification as in Eq. (1)					
		Horizon		Longest significant lag	Inflation's response		Longest significant lag	Growth's response
US	*h* =	6 months	*k* =	24	0.37		24	2.17
		1 year		24	0.46		24	2.02
		1.5 years		24	0.44		21	1.87
		2 years		24	0.30		20	1.60
Brazil	*h* =	6 months	*k* =	5	0.88	*k* =	24	0.85
		1 year		24	-0.73		24	0.27
		1.5 years		24	-0.72		22	0.27
		2 years		24	-0.79		23	0.29
Czech Republic	*h* =	6 months	*k* =	19	-0.40	*k* =	24	-0.74
		1 year		19	-0.50		18	-0.74
		1.5 years		18	-0.46		24	0.60
		2 years		17	-0.37		24	0.60
Hong Kong	*h* =	6 months	*k* =	17	0.93	*k* =	20	2.83
		1 year		12	0.83		23	2.33
		1.5 years		17	0.78		21	1.77
		2 years		17	0.76		19	1.52
Hungary	*h* =	6 months	*k* =	20	0.46	*k* =	13	-2.36
		1 year		22	0.44		12	-1.50
		1.5 years		21	0.39		24	-1.95
		2 years		19	0.23		24	-1.58
India	*h* =	6 months	*k* =	21	1.70	*k* =	19	-0.97
		1 year		18	1.35		15	-0.62
		1.5 years		16	0.94		8	-0.68
		2 years		13	0.83			Not significant
Korea	*h* =	6 months	*k* =	23	0.34	*k* =	23	-2.60
		1 year		20	0.21		18	-2.19
		1.5 years		15	0.15		15	-1.88
		2 years		13	0.11		16	-1.27

Malaysia	*h* =	6 months	*k* =	23	-0.56	*k* =	Not significant
		1 year		17	-0.66		Not significant
		1.5 years		17	-0.50		Not significant
		2 years		23	-0.31	20	-0.77
Mexico	*h* =	6 months	*k* =	11	-0.18	*k* = 13	0.26
		1 year		12	-0.13	11	0.16
		1.5 years		11	-0.15	5	0.30
		2 years		13	-0.10	23	-0.16
Philippines	*h* =	6 months	*k* =	8	-0.31	*k* = 1	2.17
		1 year		8	-0.19	0	1.47
		1.5 years		7	-0.27		Not significant
		2 years		5	-0.24	1	1.10
Poland	*h* =	6 months	*k* =	24	0.70	*k* = 13	1.83
		1 year		24	0.54	18	2.90
		1.5 years		24	0.35	13	2.74
		2 years		23	0.13	13	0.97
Saudi Arabia	*h* =	6 months	*k* =	24	0.30		
		1 year		22	0.24		
		1.5 years		20	0.24		
		2 years		17	0.20		
Singapore	*h* =	6 months	*k* =	14	0.62	*k* = 21	-10.59
		1 year		12	0.57	22	-5.98
		1.5 years		9	0.44	19	-3.87
		2 years		5	0.32	24	-3.66
South Africa	*h* =	6 months	*k* =	4	0.66	*k* = 3	1.37
		1 year		16	0.65	2	0.86
		1.5 years		15	0.56	3	0.83
		2 years		15	0.34	24	-0.68
Taiwan	*h* =	6 months	*k* =	5	0.72	*k* = 9	4.00
		1 year		0	0.58		Not significant
		1.5 years			Not significant	24	4.47
		2 years			Not significant	24	4.01

Source: author's estimates. Results significant at least at the 5% level of confidence, unless otherwise indicated.

Table 5: Pseudo out-of-sample mean squared forecast errors

		Inflation forecasts			Growth forecasts		
		EME / AR(*p*)	US / AR(*p*)	US / EME	EME / AR(*p*)	US / AR(*p*)	US / EME
	h =						
Brazil	6 months	1.94	…	…	18.71	1.04	0.06 ***
	(DM's p-value)	(0.93)			(1.00)	(0.46)	(0.00)
	12 months						
	18 months						
Czech Republic	6 months	0.65	0.74	1.14	1.08	0.87 **	0.80 **
	(DM's p-value)	(0.28)	(n/a)	(0.56)	(0.48)	(0.02)	(0.05)
	12 months	0.35	0.77	2.22	0.79	0.65	0.81
	18 months	0.15	0.50	3.20	0.63	0.76	1.20
Hong Kong	6 months	0.87 ***	…	…	0.99	0.78	0.79
	(DM's p-value)	(0.01)			(0.55)	(0.50)	(0.50)
	12 months	0.84	0.77	0.92	0.87	0.50	0.57
	18 months	1.06	0.64	0.60	0.79	0.60	0.76
Hungary	6 months	0.57 ***	0.79 ***	1.38	…	…	…
	(DM's p-value)	(0.00)	(0.00)	(1.00)			
	12 months	0.78	1.03	1.32	…	…	…
	18 months	0.84	1.11	1.32	…	…	…
India	6 months	0.47 ***	…	…	0.81 ***	0.73 ***	0.90
	(DM's p-value)	(0.00)			(0.00)	(0.01)	(0.14)
	12 months	0.36	…	…	0.89	0.55	0.62
	18 months	0.51	…	…	0.78	0.46	0.59
Korea	6 months	0.70 **	2.62	3.75	0.82 ***	3.27	4.00
	(DM's p-value)	(0.05)	(0.71)	(0.78)	(0.01)	(0.93)	(0.96)
	12 months	0.87	2.03	2.34	0.99	2.10	2.13
	18 months	0.54	2.95	5.47	1.04	2.12	2.05
Malaysia	6 months	0.96 *	…	…	…	1.43	…
	(DM's p-value)	(0.11)				(0.85)	
	12 months	0.30	…	…	…	1.27	…
	18 months	0.56	0.42	0.75	…	1.17	…

Mexico	6 months	1.04	…	…	0.77	1.50	1.95
	(DM's p-value)	(0.45)			(n/a)	(0.91)	(0.99)
	12 months	1.06	…	…	0.71	2.22	3.14
	18 months	1.19	…	…	0.70	2.54	3.61
Philippines	6 months	0.80 *	0.88	1.10	1.10	0.90	0.82 **
	(DM's p-value)	(0.07)	(0.20)	(0.22)	(0.50)	(0.20)	(0.05)
	12 months	0.99	…	…	1.32	0.45	0.34
	18 months	0.91	0.31	0.35	…	0.19	…
Poland	6 months	0.24 ***	0.67 ***	2.77	2.96	…	…
	(DM's p-value)	(0.00)	(0.00)	(1.00)	(0.98)		
	12 months	0.10	0.58	6.04	3.30	…	0.44
	18 months	0.10	0.96	9.15	…	1.02	…
Saudi Arabia	6 months	1.04	0.76 **	0.73 **			
	(DM's p-value)	(0.36)	(0.01)	(0.03)			
	12 months	0.61	0.30	0.49			
	18 months	0.55	0.43	0.78			
Singapore	6 months	1.04	…	…	1.11	0.68 ***	0.61
	(DM's p-value)	(0.31)			(0.44)	(0.00)	(0.15)
	12 months	0.43	…	…	1.00	0.71	0.71
	18 months	2.22	…	…	1.02	0.69	0.68
South Africa	6 months	1.20	0.65 ***	0.54 ***	0.88 **	0.80	0.91
	(DM's p-value)	(0.48)	(0.00)	(0.00)	(0.05)	(0.22)	(0.33)
	12 months	0.50	0.57	1.16	0.96	0.86	0.89
	18 months	0.44	0.50	1.14	1.27	0.31	0.24
Taiwan	6 months	1.42	0.83 **	0.58 ***	1.80	1.12	0.62 **
	(DM's p-value)	(1.00)	(0.03)	(0.00)	(0.98)	(0.89)	(0.02)
	12 months	1.27	0.69	0.55	…	0.83	…
	18 months	…	0.51	…	6.22	1.96	0.32

Source: author's estimates.

Notes: (…) indicates that the MSFE was not calculated due to insignificant in-sample predictor.

The *p*-value of the statistic *DM* is that of a one-sided test.

(n/a) indicates that the *p*-value could not be calculated due to a negative estimated asymptotic variance.

(***), (**), (*): statistical significance at the 1%, 5% and 10% level of confidence.

Table 6: The US (or euro area*) slope of the yield curve as a predictor of inflation and growth in emerging economies

	Horizon		Specification as in Eq. (2)				
		Longest significant lag		Inflation's response	Longest significant lag		Growth's response
Brazil	*h* = 6 months	*k* =		Not significant	*k* =	24	3.01
	1 year			Not significant		24	1.79
	1.5 years			Not significant		23	1.29
	2 years		24	-0.88			
Czech Republic*	*h* = 6 months	*k* =	18	1.28	*k* =	13	2.07
	1 year		16	1.48		12	1.97
	1.5 years		12	1.62		9	2.02
	2 years		10	1.30		9	1.52
Hong Kong	*h* = 6 months	*k* =		Not significant	*k* =	24	3.98
	1 year		0	0.99		24	3.74
	1.5 years		0	0.98		24	2.52
	2 years		1	0.84		23	1.51
Hungary*	*h* = 6 months	*k* =	8	1.30	*k* =	0	4.06
	1 year		24	-1.13		0	3.80
	1.5 years		22	-0.76		0	1.83
	2 years		0	0.80		0	1.41
India	*h* = 6 months	*k* =		Not significant	*k* =	24	1.88
	1 year			Not significant		24	1.35
	1.5 years			Not significant		22	1.19
	2 years			Not significant		12	0.96
Korea	*h* = 6 months	*k* =	8	0.51	*k* =	22	4.45
	1 year		12	0.31		18	3.51
	1.5 years		9	0.21		15	1.75
	2 years		10	0.11			Not significant

Malaysia	*h* =	6 months	*k* =	Not significant	*k* =	21	2.85
		1 year		Not significant		18	1.81
		1.5 years	24	0.44		17	1.69
		2 years	17	0.34		16	0.99
Mexico	*h* =	6 months	*k* =	Not significant	*k* =	20	1.90
		1 year		Not significant		20	1.69
		1.5 years		Not significant		19	1.56
		2 years	5	0.74		11	0.98
Philippines	*h* =	6 months	*k* = 11	0.82	*k* =	9	2.80
		1 year		Not significant		24	3.02
		1.5 years	23	0.77		24	2.80
		2 years	21	0.60		20	1.87
Poland*	*h* =	6 months	*k* = 21	1.91	*k* =		Not significant
		1 year	21	1.86			Not significant
		1.5 years	18	1.62		7	2.37
		2 years	16	1.64		11	1.62
Saudi Arabia	*h* =	6 months	*k* = 7	0.45			
		1 year	6	0.37			
		1.5 years	3	0.38			
		2 years	0	0.37			
Singapore	*h* =	6 months	*k* =	Not significant	*k* =	24	5.54
		1 year		Not significant		24	5.02
		1.5 years		Not significant		18	3.38
		2 years		Not significant		20	2.46
South Africa	*h* =	6 months	*k* = 24	-1.46	*k* =	24	3.48
		1 year	24	-1.41		24	1.89
		1.5 years	23	-1.03		23	1.42
		2 years	19	-0.97		21	1.14
Taiwan	*h* =	6 months	*k* = 24	1.15	*k* =	20	3.02
		1 year	24	0.75		12	3.23
		1.5 years	24	0.68		13	3.00
		2 years	23	0.47		14	2.63

Source: author's estimates. Results significant at least at the 5% level of confidence, unless otherwise indicated.
Note: (*) The slope of the euro area yield curve is used to forecast emerging market inflation.

Table 7a: First-stage regressions for the instrumentation

	Instrument	Estimated coefficient	Significance level	R^2 of the regression
Brazil	US	0.83	0.09	0.03
Czech Republic	US	0.45	0.00	0.07
Czech Republic	Euro area	0.88	0.00	0.12
Hong Kong	US	0.89	0.00	0.64
Hungary	US	0.13	0.37	0.00
Hungary	Euro area	-0.42	0.05	0.03
India	US	-0.14	0.14	0.01
Korea	US	0.07	0.45	0.44
Malaysia	US	-0.15	0.09	0.11
Mexico	US	0.86	0.00	0.75
Philippines	US	0.71	0.00	0.09
Poland	US	1.25	0.00	0.39
Poland	Euro area	1.21	0.00	0.14
Saudi Arabia	US	0.95	0.00	0.53
Singapore	US	0.12	0.13	0.01
South Africa	US	-0.03	0.87	0.00
Taiwan	US	0.49	0.00	0.37

Source: author's estimates.

Table 7b: Granger causality tests between the slope of the yield curve in the US and the slope of the yield curve in emerging economies

	H_0: The US slope of the yield curve is not Granger causal				H_0: The corresponding country's slope of the yield curve is not Granger causal			
Lags	2	6	12	18	2	6	12	18
Brazil	0.78	0.29	0.73	0.05 **	0.28	0.05 **	0.08 *	0.08 *
Czech	0.12	0.62	0.88	0.95	0.79	0.76	0.96	0.91
Hong Kong	0.00 ***	0.00 ***	0.01 ***	0.02 ***	0.59	0.97	0.97	0.93
Hungary	0.52	0.78	0.59	0.83	0.48	0.40	0.47	0.56
India	0.89	0.32	0.53	0.59	0.86	0.86	0.90	0.90
Korea	0.58	0.34	0.64	0.76	0.48	0.82	0.96	0.98
Malaysia	0.43	0.82	0.82	0.90	0.29	0.70	0.83	0.81
Mexico	0.95	0.82	0.97	0.97	0.97	0.96	0.98	0.99
Philippines	0.29	0.62	0.82	0.81	0.44	0.39	0.62	0.13
Poland	0.03 **	0.44	0.56	0.38	0.70	0.35	0.20	0.66
Saudi	0.10 *	0.16	0.17	0.27	0.02 **	0.12	0.41	0.52
Singapore	0.90	0.93	0.43	0.70	0.22	0.52	0.60	0.71
South Africa	0.65	0.87	0.90	0.45	0.46	0.66	0.87	0.86
Taiwan	0.00 ***	0.04 **	0.03 **	0.01 ***	0.61	0.48	0.25	0.56
Euro area	*0.03 ***	*0.09 **	*0.28*	*0.38*	*0.09 **	*0.35*	*0.73*	*0.35*
	H_0: The euro area slope of the yield curve is not Granger causal				H_0: The corresponding country's slope of the yield curve is not Granger causal			
Lags	2	6	12	18	2	6	12	18
Czech republic	0.51	0.68	0.68	0.19	0.95	0.30	0.73	0.47
Hungary	0.91	0.62	0.17	0.10	0.15	0.18	0.64	0.26
Poland	0.50	0.60	0.10 *	0.30	0.39	0.04 **	0.09 *	0.14

Source: author's estimates.

Note: (***), (**), (*): statistical significance at the 1%, 5% and 10% level of confidence.

Table 8: The instrumented emerging market slope of the yield curve as a predictor of inflation and growth in emerging economies

			Specification as in Eq. (3)					
	Horizon		Longest significant lag		Inflation's response	Longest significant lag		Growth's response
Brazil	*h* =	6 months	*k* =	24	-5.63	*k* =	24	4.77
		1 year		24	-4.47		24	1.89
		1.5 years		24	-3.03		24	0.65
		2 years		24	-2.73		22	0.56
Czech Republic	*h* =	6 months	*k* =	18	1.35	*k* =	12	5.30
		1 year		14	1.37		13	3.82
		1.5 years		17	1.17		12	3.45
		2 years		8	0.99		14	2.57
Hong Kong	*h* =	6 months	*k* =		Not significant	*k* =	24	4.50
		1 year		0	1.12		24	4.22
		1.5 years		0	1.11		24	2.85
		2 years		1	0.95		23	1.71
Hungary	*h* =	6 months	*k* =	8	-2.44	*k* =	0	-8.55
		1 year		8	-2.27		0	-9.03
		1.5 years		4	-2.09		0	-4.35
		2 years		3	-1.50		0	-3.35
Malaysia	*h* =	6 months	*k* =	20	1.14	*k* =	19	-10.81
		1 year			Not significant		19	-8.32
		1.5 years			Not significant		18	-3.98
		2 years			Not significant		17	-2.74

Mexico	*h* =	6 months	*k* =	11	-0.13	*k* =	14	0.17
		1 year		12	-0.09		4	0.21
		1.5 years		11	-0.14		3	0.17
		2 years		11	-0.14		24	-0.23
Philippines	*h* =	6 months	*k* =	11	0.73	*k* =	9	3.44
		1 year		23	0.89		24	2.74
		1.5 years		23	0.80		18	1.39
		2 years		19	0.59		13	1.11
Poland	*h* =	6 months	*k* =	22	1.05	*k* =	20	4.17
		1 year		18	1.00		19	3.43
		1.5 years		15	0.63		18	2.68
		2 years		14	0.28		15	0.92
Saudi Arabia	*h* =	6 months	*k* =	7	0.45			
		1 year		6	0.38			
		1.5 years		3	0.40			
		2 years		0	0.40			
Taiwan	*h* =	6 months	*k* =	24	2.62	*k* =	20	6.51
		1 year		24	1.95		17	6.81
		1.5 years		24	1.63		14	6.65
		2 years		22	1.26		15	5.69

Source: author's estimates. Results significant at least at the 5% level of confidence, unless otherwise indicated.

Table 9: Predictive content of foreign-driven vs. country-specific yield curve movements

			Specification as in Eq. (4)				
			Inflation's response			Growth's response	
Origin of emerging market yield curve movements:			Foreign	Country-specific		Foreign	Country-specific
	Horizon	Lag	β_1	β_2	Lag	β_1	β_2
Brazil	h = 6 months	21	-4.84 **	0.07	24	4.35 ***	0.30
	1 year	24	-3.48 ***	-0.27 ***	22	2.64 ***	0.01
	1.5 years	20	-2.15 ***	-0.26 ***	20	1.91 ***	-0.28
	2 years	19	-1.83 ***	-0.32 ***	18	0.56 ***	0.10 *
Czech Republic	h = 6 months	20	1.15 **	-0.68 ***	12	5.17 ***	-1.11 ***
	1 year	14	1.03 ***	-0.82 ***	13	3.46 ***	-1.11 ***
	1.5 years	10	0.65 ***	-0.76 ***	14	2.75 **	-0.72 **
	2 years	8	0.52 **	-0.72 ***	14	2.57 **	-0.37 **
Hong Kong	h = 6 months	0	0.89 **	-0.85 *	24	4.45 ***	-0.44
	1 year	0	1.10 **	-0.40	24	4.16 ***	-0.77
	1.5 years	0	1.08 **	-0.06	24	2.89 ***	-0.70
	2 years	1	0.97 **	0.30	23	1.70 ***	-0.07
Hungary	h = 6 months	5	-3.14 **	-0.10	0	-9.36 **	-1.54
	1 year	6	-1.97 **	0.33	0	-10.14 ***	-1.57
	1.5 years	4	-2.11 **	0.11	0	-5.01 ***	-1.96
	2 years	3	-1.53 ***	-0.02	0	-3.92 ***	-1.36
Malaysia	h = 6 months	21	0.99 **	-0.76 **	19	-10.92 ***	0.83
	1 year		Not significant		19	-8.38 ***	0.32
	1.5 years	21	0.45 **	-0.77 **	18	-3.79 **	-0.77
	2 years	8	0.45 **	-0.68 ***	17	-3.30 ***	-0.84
Mexico	h = 6 months	11	-0.19 ***	-0.39	14	0.16 **	0.69
	1 year	10	-0.12 ***	-0.40	4	0.20 **	0.98 ***
	1.5 years	11	-0.14 ***	-0.23	3	0.16 **	0.77 **
	2 years	11	-0.14 ***	-0.14	20	-0.24 ***	0.26 *
Philippines	h = 6 months	13	0.69 **	0.05	8	2.32 ***	-1.00 ***
	1 year	23	0.89 **	0.00	24	2.81 ***	-0.89 ***
	1.5 years	23	0.80 **	-0.07	9	1.11 **	-0.13
	2 years	19	0.60 ***	-0.09	4	1.19 ***	-0.17
Poland	h = 6 months	22	1.32 ***	0.42	12	2.65 ***	-0.68
	1 year	17	1.35 ***	0.47 ***	11	3.12 **	-0.96
	1.5 years	11	1.17 ***	0.46 ***	9	4.13 ***	0.67
	2 years	14	0.45 ***	0.41 ***	9	2.53 ***	0.10
Saudi Arabia	h = 6 months	7	0.49 ***	0.44 ***			
	1 year	6	0.41 ***	0.39 ***			
	1.5 years	3	0.41 ***	0.46 ***			
	2 years	0	0.34 ***	0.49 ***			
Taiwan	h = 6 months	24	2.52 ***	-1.20 ***	19	5.78 **	-7.83 ***
	1 year	24	1.92 ***	-0.72 **	17	7.54 ***	-7.93 ***
	1.5 years	24	1.61 ***	-0.46 **	14	7.57 **	-4.41 ***
	2 years	21	1.21 ***	-0.49 ***	16	4.18 **	0.38

Source: author's estimates

Note: (***), (**), (*): statistical significance at the 1%, 5% and 10% level of confidence.

Table 10: Robustness check - Pseudo out-of-sample MSFEs (using a 3-year out-of-sample period)

	Inflation forecasts (h = 6 months)			Growth forecasts (h = 6 months)		
	EME / AR(p)	US / AR(p)	US / EME	EME / AR(p)	US / AR(p)	US / EME
Hong Kong	0.95	…	…	1.27	0.88	0.69
	(0.14)			(0.95)	(0.50)	(0.50)
India	0.59 ***	…	…	0.82 ***	0.46 **	0.56 *
	(0.00)			(0.00)	(0.02)	(0.06)
Malaysia	1.28	…	…	…	0.95	…
	(0.75)				(0.20)	
Mexico	1.06	…	…	1.59	1.74	1.09
	(0.48)			(0.93)	(0.99)	(0.80)
Philippines	0.79 ***	1.17	1.48	1.08	0.60	0.56
	(0.01)	(0.73)	(0.65)	(0.99)	(0.50)	(0.30)
Saudi Arabia	1.31	0.83 ***	0.63 ***			
	(0.98)	(0.00)	(0.00)			
Singapore	0.97	…	…	2.06	7.55	3.67
	(0.16)			(0.96)	(0.97)	(0.93)
South Africa	0.87 *	0.81 ***	0.93	0.94 *	0.67 **	0.72 *
	(0.10)	(0.00)	(0.46)	(0.09)	(0.03)	(0.08)

Source: author's estimates.

Notes: (...) indicates that the MSFE was not calculated due to insignificant in-sample predictor.

The p -value of the statistic DM, reported in parenthesis, is that of a one-sided test.

(***), (**), (*): statistical significance at the 1%, 5% and 10% level of confidence.

Table 11: Robustness check - Pseudo out-of-sample MSFEs (yield curve vs. T-bill rate)

Growth forecasts (h = 6 months)					
Brazil	0.42	Korea	0.69	Singapore	1.22
	(0.15)		(n/a)		(0.91)
Czech Republic	0.95	Malaysia	0.84 **	South Africa	0.78 ***
	(n/a)		(0.05)		(0.00)
Hong-Kong	1.11	Mexico	0.78 ***	Taiwan	0.90
	(n/a)		(0.01)		(n/a)
Hungary	1.01	Philippines	0.54 ***		
	(0.60)		(0.00)		
India	1.11	Poland	0.86 *		
	(0.59)		(0.08)		

Source: author's estimates.

Notes: The p-value of the statistic DM, reported in parenthesis, is that of a one-sided test.

(***), (**), (*): statistical significance at the 1%, 5% and 10% level of confidence.

Table 12: Robustness check - The spread of emerging sovereign bonds vis-à -vis US Treasuries as a predictor of emerging market inflation and growth

	Horizon		Specification as in Eq. (1) [using the EMBIG spread] Lag	Inflation's response	Lag	Growth's response
Brazil	h =	6 months	k = 5	0.31	k = 12	0.63
		1 year	4	0.25	12	0.47
Hungary	h =	6 months	k = 12	-2.07	k = 14	-4.27
		1 year	14	-2.03	12	-3.40
Malaysia	h =	6 months	k = 17	-0.25	k = 12	2.73
		1 year	24	-0.18	12	1.77
Mexico	h =	6 months	k = 12	0.47	k = 17	-1.13
		1 year	11	0.19	14	-1.09
Philippines	h =	6 months	k = 9	2.80	k = 9	2.80
		1 year	5	2.33	5	2.33
Poland	h =	6 months	k = 10	1.62	k = 19	-3.58
		1 year	10	1.48	14	-3.13
South Africa	h =	6 months	k = 12	0.99	k = 24	-1.44
		1 year	12	1.11	20	-0.64

Note: Results significant at least at the 5% level of confidence, unless otherwise indicated.

Table 13: Interpretation of the results[1]

Explanatory variables	*Dependant variable* Θ_i	Θ^*_i	Θ^*_i	Θ^*_i	Θ^*_i
Exchange rate flexibility		-1.13 **			-1.39 *
		(0.06)			(0.08)
Relative market liquidity			-1.85		-3.92
			(0.67)		(0.38)
Average inflation and growth correlation with the US				0.26	-0.67
				(0.91)	(0.78)
Long-term domestic debt securities/GDP	1.24				
	(0.59)				
Constant	2.83 ***	3.44 ***	2.50 ***	2.02 ***	5.01 ***
	(0.00)	(0.00)	(0.07)	(0.00)	(0.03)
R^2	0.02	0.26	0.01	0.00	0.31
Obs.	14	14	14	14	14

Source: author's estimates.

[1] Estimation by OLS. (**) and (*) denote statistical significance at the 5% and 10% level of confidence, respectively.
(***), (**), (*): statistical significance at the 1%, 5% and 10% level of confidence; p-values are reported in parenthesis.

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