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# Monetary Policy and Financial Spillovers: Losing Traction?

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# Monetary Policy and Financial Spillovers: Losing Traction?*

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**Abstract**

Has financial globalisation compromised central banks' ability to manage domestic financial conditions? This paper tackles this question by studying the dynamics of bond yields encompassing 31 advanced and emerging market economies. To gauge the extent to which external financial conditions complicate the conduct of monetary policy, we isolate a "contagion" component by focusing on comovements in measures of bond return risk premia that are unrelated to economic fundamentals. Our contagion measure is designed to more accurately capture spillovers driven by exogenous global shifts in risk preference or appetite. The analysis reaches several conclusions that run counter to popular presumptions based on comovements in bond yields. In particular, emerging market economies appear to be much less susceptible to global contagion than advanced economies, and the overall sensitivities to contagion have not increased post-crisis.

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*Keywords*: Monetary policy, financial spillovers, contagion, interest rates, trilemma, bond risk premium, capital flows

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# 1 Introduction

Increased financial globalisation and the associated rise in cross-border capital flows have renewed debate on appropriate monetary policy conduct and frameworks in open economies. Heightened susceptibility of domestic credit and asset prices to external influences, in particular, has raised questions about central banks' ability to manage domestic financial conditions. Some even argue that without the imposition of capital controls, monetary autonomy is largely lost.

This paper examines this issue from a broad perspective that encompasses 10 advanced and 21 emerging market economies. We propose an organising principle that delineates external influences on domestic financial conditions along three dimensions. *Monetary autonomy* is the ability of central banks to achieve desired targets with their instruments, abstracting from how those targets are set as well as the factors that may influence them. *Monetary dependence* is the extent to which the actual setting of policy, as well as monetary conditions more generally, are influenced by external financial developments. Finally, *financial contagion* represents changes in domestic financial conditions driven by external shifts in risk appetites or preferences unrelated to domestic fundamentals.

Absent clear distinctions along these dimensions, discussions of how greater financial integration impacts on policy have often become muddled. Some recent renditions of the classic Mundell-Fleming trilemma, for example, conflate the notions of monetary autonomy and monetary dependence. Under this view, "monetary autonomy" has sometimes been associated with the degree to which local interest rates vary with foreign ones. But this makes no distinction between the *ability* to set monetary policy independently and the *willingness* to do so. Observed interest rate comovements do not inform on the ability of central banks to set rates independently so much as on how external developments enter their policy reaction functions, and the extent to which responding to them is deemed appropriate given local mandates.

At the same time, "monetary autonomy" under the trilemma has also been interpreted as the complete insulation of domestic financial conditions from external factors. Rey (2013) prominently argued that even with flexible exchange rates, so that central banks can set interest rates independently, the trilemma breaks down because broader financial conditions are still affected by external influences. We argue that this is again an overly broad interpretation of monetary autonomy under the trilemma.

To shed light on the extent to which central banks' influence over domestic monetary conditions may have been compromised with increased financial globalisation, we add to the literature that examines comovements in global bond yields along two main dimensions. First, in contrast to the bulk of the literature that focuses exclusively on advanced economies, our sample encompasses most emerging market economies where much of the focus on spillovers has been directed. Secondly, we make the critical distinction between *monetary dependence* and *financial contagion* as outlined above.

With trade and financial integration, it is inevitable that external developments will impinge on local economic and financial conditions. In this context, comovements in yields, and asset prices more generally, are part and parcel of monetary dependence. From a policy perspective, however, whether comovement in yields reflects reactions to common fundamentals and uncertainty about those fundamentals, or reactions to exogenous changes in risk appetite and preferences has vastly different implications. In the former, the bond market is acting simply as a messenger about expected future economic developments whereas in the latter case, they are a conduit of exogenous financial shocks unrelated to domestic fundamentals. Such global financial contagion may warrant offsetting policy actions.

The starting point for our measure of global financial contagion is the bond return risk premium, namely the expected excess return from investing in a long-term bond over a short one (throughout the paper, "risk premium" and "term premium" will be used interchangeably in reference to such expected excess return). By looking at bond risk premium, we purge the direct influence of the expected path of monetary policy on bond price movements. Thus any incidental comovement in monetary policy across countries, which could result in correlated bond prices yet be fully consistent with individual monetary autonomy, is removed from our measure of global financial contagion.

Term premia may still be affected by fundamentals, not least monetary policy through the risk-taking channel. We therefore proceed to refine the term premia by controlling for these influences. In the final step, we then extract the common component from these "cleansed" term premia to obtain our measure of global financial contagion. This measure essentially captures comovements in bond returns unrelated to the expected path of monetary policy and economic fundamentals. This is the component that arguably matters most for policy traction as it represents an external shock that interferes with the transmission mechanism. In reacting to it, policy may need to deviate from what would have been justified purely based on domestic fundamentals.

Our analysis yields some novel results. First, our estimate of global financial contagion contains significant information not present in other popular global risk appetite measures such as the VIX. We argue that our measure is a more accurate metric to gauge the extent of policy traction. Second, emerging market economies are much less susceptible to global financial contagion than advanced economies, contrary to popular presumptions. Third, for all country groups, it is far from obvious that the sensitivity to global financial contagion has increased after the global financial crisis, despite oft-cited concerns about the spillover effects of quantitative easing policies. Fourth, the analysis confirms that the simple correlation of bond yields can be misleading, as it could be influenced by correlation in monetary policies and fundamentals. Finally, the results shed some light on the interactions of term premia and exchange rate movements and point to the prevalence of nominal shocks, such as portfolio rebalancing, in emerging economies but not so in advanced countries.

Overall, our analysis suggests that the impact of financial globalisation on domestic policy traction appears to be less severe than sometimes portrayed. In particular, the spillovers that directly impinge on policy are substantially lower than those indicated by statistical comovements in bond yields. In addition to its importance in underpinning expected short rates, monetary policy exerts significant influence on term premia via the risk-taking channel. We conclude that the domestic credit cycle remains very much the domain of central banks and local financial regulators.

The paper is organised as follows. In section 2, we discuss the conceptual distinction between monetary autonomy, monetary independence and financial contagion. Section 3 explains the empirical approach for isolating the influence of financial contagion and sets out the main results. Section 4 takes a step back and discusses the notion of monetary independence more broadly, and in relation to the process of domestic credit creation. The final section concludes.

## 2 Financial globalisation and monetary control

Has financial globalisation compromised central banks' ability to manage domestic financial conditions? In a provocative paper, Rey (2013) argued that the emergence of a global financial cycle has meant that for small open economies "...independent monetary policies are possible if and only if the capital account is managed, directly or indirectly via macroprudential policies."

(Rey (2013), p. 287) This view suggests that the conventional monetary "trilemma" has morphed into a "dilemma" between monetary autonomy on the one hand and capital mobility on the other. This is in stark contrast to Woodford (2010) who argued that central banks' control over inflation has not diminished, and has in some respects been strengthened, by globalisation. Obstfeld (2015) and Kamin (2010) meanwhile take the middle road by acknowledging that spillovers complicates the task of monetary policy but independent monetary policy remains feasible for financially open emerging economies with relatively flexible exchange rates.

At the same time, many studies such as Fratzscher (2012), Miranda-Agrippino and Rey (2014), Bruno and Shin (2013), and Cerutti et al. (2014) highlight the important role for "push factors" such as the VIX in driving financial flows. This is collaborated by a growing literature documenting the presence of a global factor driving comovement in bond yields and other asset prices across countries (e.g. Aizenman et al. (2015), Diebold et al. (2008), Bauer and de los Rios (2012), Abbritti et al. (2013) and Jotikasthira et al. (2015)). Taken at face value, this suggests that the traction that monetary policy has over domestic monetary conditions has diminished.

An important shortcoming of the extant literature, however, is the tendency to conflate different definitions of monetary independence. As a result, interpretations of empirical results and policy implications drawn are often muddled. We therefore begin by establishing a clear distinction between three notions of external linkages.

First, we define *monetary autonomy* as central banks' ability to achieve desired targets of their instruments irrespective of whatever those instruments and targets may be. This is the narrow sense of policy autonomy that focuses only on the technical capability to attain a given target setting of the monetary instrument, abstracting from the reasons behind those targets. Second, *monetary dependence* is the extent to which the actual setting of policy, as well as monetary conditions more broadly, are influenced by external financial developments. Observed monetary conditions embed the trade-offs weighed by policymakers implicitly in their reaction functions in response to foreign shocks, as well as financial market reactions to those shocks. Finally, the third notion is *financial contagion*, identified as changes in domestic financial conditions driven by shifts in global risk appetites or preferences unrelated to domestic fundamentals.

## 2.1 Monetary autonomy versus monetary dependence: revisiting the trilemma

Discussions of monetary policy autonomy in the context of open economies has invariably been framed around the classic Mundell-Fleming trilemma which states that countries can simultaneously attain no more than two objectives out of the possible combinations among capital mobility, a fixed exchange rate, and an independent ability to set interest rates. The last of these has been synonymous with monetary policy autonomy. To assess the degree of autonomy, most existing studies seek to gauge the extent to which domestic interest rates are related to world/base-country interest rates (e.g. Frankel et al. (2004), Obstfeld et al. (2005), Bluedorn and Bowdler (2010), Klein and Shambaugh (2013), Obstfeld (2015), Edwards (2015) and Aizenman et al. (2015)).

When it comes to assessing monetary policy traction, however, a focus on simple correlations of short-term or long-term interest rates may result in misleading inferences. At the most basic level, the approach makes no distinction between the *ability* to set monetary policy independently and the *willingness* to do so given central banks' goals and mandates. Flexible exchange rates do give central banks the technical ability to set short-term interest rates at some arbitrary level. But the actual conduct of policy will be governed by central bank mandates and goals. Hence any inference based on observed *outcomes* of policy setting will embody *both* the technical ability to set short rates independently and the normative choice of a policy setting deemed appropriate for the domestic economy. The approach, in other words, conflates the notions of monetary autonomy and monetary dependence as defined above.

Another way to see the point is to consider that countries with flexible exchange rates might just as easily choose to peg interest rates to another country, entailing no less a degree of dependence on foreign monetary policy as a fixed exchange rate. Conversely, countries that choose to peg exchange rates are able to vary their monetary stance by adjusting the peg or adopt frameworks that send monetary policy signals through future prospective paths of the exchange rate. The Monetary Authority of Singapore is the leading example of this latter approach.

With well-functioning operational frameworks for monetary policies, central banks' ability to achieve the desired setting of their policy instrument can be taken as given: interest rates and exchange rates targets can be achieved. Monetary autonomy obtains. Nonetheless, in globally integrated economies, policymakers naturally have to consider external developments and how they impinge on the domestic economy in calibrating their policy actions. If policy interest rates of particular central banks seem to track those of other countries, we would argue that this reflects the chosen optimal response to changes in foreign financial conditions rather than a loss of monetary autonomy. There is monetary dependence even as there is monetary autonomy. Looking at correlation between policy rates does not inform on the degree of autonomy insomuch as the degree of spillovers and reaction to them. The fact that foreign interest rates help explain variations in local policy rates can primarily be because they contain information about current or future developments that matter for central banks' domestic mandates.

At the same time, the ability to set interest rates autonomously does not imply that domestic financial conditions are impervious to external influences. Rey (2013) rightly argues that with deeper financial integration, external financial developments influence capital flows, credit growth, and bank leverage. But her conclusion that this has led to a break-down of the trilemma rests on an overly broad notion of monetary independence which encompasses not only the ability of central banks to set rates autonomously, but also the independence of domestic financial conditions more generally from external influences. Under this view, the trilemma breaks down because even though flexible exchange rates do allow central banks to set interest rates independently, they "...cannot insulate economies from the global financial cycle" so that monetary autonomy can be maintained only if the capital account is managed (Rey (2013), p.21).

But the trilemma does not imply that flexible exchange rates can fully insulate economies from external financial shocks, only that they enable interest rates to be set autonomously. Indeed, exchange rate fluctuations themselves constitute changes in local financial conditions and are a key transmission channel of external shocks. The emphasis on policy interest rates in discussions of monetary independence can be overdone. Other aspects of global financial conditions can and do spill across borders in the form of incipient or actual capital flows, with potentially large impacts on exchange rates, asset prices, and credit volumes, and so on economic activity, inflation, and financial stability. Nothing can insulate countries from the influence of global financial markets once the capital account is open. If one wants to swim, getting wet is unavoidable. The central issue is the extent of external linkages and degree of spillovers rather than the ability to completely shield the economy from them. Rey's (2013) point is more about the *degree* to which monetary dependence, as we define it, has increased rather than the underlying trade-offs characterised by the trilemma.

At the basic level, the trilemma simply represents alternative ways in which open economies can choose to absorb external shocks, namely through interest rates or exchange rates. In the extreme, a fixed exchange rate implies that the brunt of foreign financial shocks falls on interest rate adjustments. Alternatively, if interest rates are fixed then the burden of adjustment falls on exchange rates. In either case, capital flows may have repercussions for a wider set of asset prices in the domestic economy regardless. Neither can perfectly insulate the economy from global financial shocks. The first-order choice under the trilemma is to open the capital account. The rest is adjustment mechanisms. Traditional portrayals of the trilemma treat exchange rate stability and interest rate autonomy as separate goals (e.g. Goldberg (2013)). But if one views both exchange rate and interest rate adjustments as two tools to achieve domestic goals, then the trade-off is between the form of adjustments rather than policy autonomy.[1] The trilemma says nothing about monetary autonomy, which invariably obtains, and is silent on monetary dependence, which depends on the country's financial structure as well as degree of integration with world capital markets.

The real issue posed by greater financial integration is not so much monetary autonomy but monetary dependence. The question is how much of this dependence arises naturally from common fundamentals among economically and financially integrated economies, and how much of it reflects exposure to unpredictable swings in global risk appetite and preferences. We elaborate on this distinction in the next section.

### 2.2 Monetary dependence versus financial contagion

With trade and financial integration, it is inevitable that external developments will impinge on local economic and financial conditions. In this context, comovements in yields, and asset prices more generally, are part and parcel of monetary dependence. From a policy perspective, however, it is important to ascertain the underlying shocks driving such comovements. These can be divided into two broad categories.

In the first category, comovements in asset prices may result from the normal interdependence among market economies due to real and financial linkages. Such "fundamentals-based comovement" can be due to common global factors, such as a major economic shift in advanced

[1] When viewed in this way, as a description of the choice between channels of transmission, it is not *a priori* clear whether fixed or floating exchange rates entails more insulation of domestic financial conditions, broadly defined, from external influences. A fixed exchange rate may entail more insulation given that it neutralises to a large degree the impact of foreign policy shocks coming through interest rate differentials. On the other hand, if exchange rates are fixed at levels inconsistent with fundamentals, persistent capital flows may be quite destabilising. At the same time, fluctuations in the exchange rate may act to both dampen or exacerbate the impact of external shocks

countries or commodity price shocks, that trigger capital flows and portfolio readjustments. Here, asset price adjustments reflect the natural outcome of markets internalising news about expected fundamentals. *A priori*, there may be no need for policy to counteract such movements as they reflect the normal working of markets. Indeed, a substantial part of the price adjustment already reflects anticipated policy reactions to changing fundamentals.

The second category of asset price comovement is one that cannot necessarily be linked to changes in macroeconomic or other fundamentals but arise as a result of arbitrary changes in the behaviour of investors. Such *financial contagion* is often linked to shifts in investors' risk appetites and preferences and may be characterised by herd behaviour or financial panic. Here, asset prices are acting as conduits of exogenous financial shocks unrelated to domestic fundamentals and, as such, may warrant offsetting policy actions.

Our focus in this paper will be on applying this distinction to bond yields, where the role of monetary policy looms large. The strong comovement in government bond yields has been well documented, especially among advanced economies since the late 1980s. An obvious explanation for this stylised fact is that economic activity and inflation co-move across countries, entailing short-term policy rates that move in tandem. Indeed, there is ample evidence in the literature that points to the existence of a world business cycle ( e.g. Kose et al. (2003)) as well as the influence of global factors on inflation (e.g. Borio and Filardo (2007) and Ciccarelli and Mojon (2010)).[2] Clearly, we need to move beyond simple correlation in bond yields to get a handle on the contagion component.

Our underlying premise is that externally driven changes in domestic financial conditions unrelated to domestic economic developments may give rise to adverse policy trade-offs. This is because they may necessitate monetary policy actions that, given the pervasiveness of their impacts, result in undesirable outcomes or side-effects along other dimensions.[3] From this perspective, "policy traction" refers to the degree to which domestic monetary conditions are influenced by global financial factors unrelated to current and expected future fundamentals. The greater the influence, the lower is the degree of traction and the more policy may need to

[2]Henrisksen et al. (2013) show that interest rate comovements are part of a more general pattern of greater synchronisation of nominal variables across countries than fluctuations in real activity, even at medium-term business-cycle frequencies. This can be rationalised as the outcome of expected monetary policy reaction to anticipated comovements in real variables in response to positive productivity shock spillovers.

[3]The analogy with exchange rate movements is useful here (Engel (2011)). As long as nominal exchange rate movements reflect changes in underlying resource costs across countries, there is no case for policy concern. Only when movements are not related to fundamentals and cause international prices to deviate from underlying relative costs do they pose a concern.

offset these movements.

To be clear, we are not saying that fundamental-based changes in financial conditions are always benign. Capital flows linked to fundamental developments can create real challenges. For example, capital flows to emerging markets tend to be procyclical, reinforcing booms and exacerbating downturns. Indeed, we find that term premia in emerging markets are substantially larger and much more volatile than those in advanced economies. This reflects both lower market liquidity as well as the greater prevalence of economic shocks in these countries. By analysing changes in term premia unrelated to fundamentals, we are focussing more narrowly on externally driven variations in financial conditions that are exogenous to the domestic economy.

At the end of the day, properly assessing whether financial contagion has compromised the conduct of monetary policy requires a focus directly on outcomes. Has monetary policy becomes less effective in delivering price stability, leaning against the build-up of financial imbalances, or cushioning the economy from financial instability? If so, monetary policy traction has diminished. We aim to take a first preliminary step in this direction by identifying externally driven variations in term premia that are unrelated to country fundamentals and, as such, likely to pose trade-offs and challenges for monetary policy management.

## 3 Contagion in bond premia

Our starting point for measuring financial contagion is term premia in government bond yields. By abstracting from short-rate expectations, term premia to a large extent already control for variations in bond yields related to anticipated fundamental economic developments. That said, term premia themselves may also be related to fundamentals and hence external developments. To the extent that global macroeconomic risks are correlated with domestic ones, for example, it is natural to expect comovements in risk premia. Indeed, Diebold et al. (2008) and Jotikasthira et al. (2015) document the importance of global factors in driving co-variation in risk compensation for long-term bonds across countries.

Our focus will be on the vagaries of global finance that do not discriminate countries based on perceived fundamentals but affect them simultaneously through arbitrary shifts in risk appetites and preferences. Technically, this more disruptive driver of financial conditions can be interpreted as global fluctuations in the "pricing of risks" in the asset pricing model. The prevalence of such movements indicates the extent to which policy trade-offs may be adversely affected by external financial developments. For each country, we therefore construct measures of term premia that cannot be explained by variations in domestic fundamentals and then ascertain the extent to which they co-move across countries. This is our measure of "global financial contagion".

We propose a 3-step empirical procedure to identify financial contagion. In step 1, we estimate the term premia of long-term government bonds through an excess return regression (thus removing monetary policy expectations). In addition to the standard term structure factors, we show how an "unspanned global factor" related to the level of global yields helps forecast excess returns for all countries. In step 2, given these term premium estimates, we filter out the influence of monetary policy and macroeconomic fundamentals to obtain restricted term premia, which may depend on foreign influences but not through their impact on domestic monetary policy or fundamentals. In the final step, we recover the global financial contagion factor as the common component of the restricted term premia.

The empirical exercise covers 31 countries comprising 10 advanced economies, 10 emerging economies in Asia and 11 other emerging market economies. This rough division into three groups provide a convenient way to organise and interpret the empirical results. Data used are monthly zero-coupon yields from Bloomberg, and consensus forecasts of GDP and inflation obtained from Consensus Economics. Further details regarding the data are given in Appendix A.

## 3.1 Identification strategy

Consider a stylised model for bond pricing with a log-normal discount rate and a linear return specification. The log of the stochastic discount factor for country $c \in C$ is given by:

$$\log(M_{c,t+1}) = -y^1_{c,t} - \frac{1}{2}\sigma^2_c \lambda^2_{c,t} - \lambda_{c,t}\varepsilon_{c,t+1} \tag{3.1}$$

where $y^1_{c,t}$ is the log short-term rate, $\lambda_{c,t}$ is the price of risk, $\varepsilon_{c,t+1}$ is the source of risks, and $\sigma^2_c = E(\varepsilon^2_{c,t+1})$. The excess return of a particular bond (holding period return less risk-free short-term rate) is linear in observed factors $x_{c,t}$:

$$er_{c,t+1} = \beta'_c x_{c,t} + \varepsilon_{c,t+1} \tag{3.2}$$

Using the fundamental asset pricing equation $1 = E_t(M_{c,t+1}R_{c,t+1})$, where $R_{c,t+1}$ is the gross one-period return on the bond, it can be deduced from equations 3.1 and 3.2 that

$$\lambda_{c,t} = \frac{\beta_c' x_{c,t}}{\sigma_c^2} + \frac{1}{2} \tag{3.3}$$

In other words, both the expected excess return $E_t(er_{c,t+1}) = \beta_c' x_{c,t}$ (or term premium in short) and the price of risk are linear in $x_{c,t}$. The (affine) model 3.2 can be estimated by OLS since $x_{c,t}$ is observable. In step 1 of the analysis, we choose a set of factors $x_{c,t}$, estimate the model, and obtain a congruent empirical description of the term premium as well as the price of risk.

Suppose, however, that the latent structural form for $\lambda_{c,t}$ takes another representation

$$\lambda_{c,t} = \phi_1 G_t + \phi_2' z_{c,t} \tag{3.4}$$

where $G_t$ is the "global financial contagion factor" that drives the prices of risks in all countries $c \in C$ and $z_{c,t}$ is a vector of country-specific fundamental factors. $G_t$ may represent the degree of risk appetite of international investors, unrelated to country-specific fundamentals or policies. Domestic fundamentals affect the prices of risks via $z_{c,t}$. For example, to the extent that monetary policy affects $\lambda_{c,t}$ through the risk-taking channel, this would be reflected in $z_{c,t}$. The empirical relationship 3.3 is then simply a linear transformation of the unobserved structural representation 3.4, so that each $x_{c,t}$ is a linear combination of $G_t$ and $z_{c,t}$.

The problem is to identify the structural representation 3.4, and recover the importance of $G_t$ in explaining the comovement of $\lambda_{c,t}$ and risk premia $\beta_c' x_{c,t}$. Step 2 does this by first projecting each factor in $x_{c,t}$ on a set of observed variables belonging to $z_{c,t}$, including monetary policy and expectations of growth and inflation. The residuals can then be used to construct a restricted version of term premia, which are related to $G_t$ (as well as parts of $z_{c,t}$ unaccounted for). In the final refinement, step 3 exploits the fact that all countries are exposed to the global financial contagion, and recovers $G_t$ as the first principal component of restricted term premia.

This empirical procedure emphasises the conceptual importance of differentiating between global financial contagion and other determinants of term premia. There are clearly econometric challenges to bear in mind. Because of endogeneity and the fact that $z_{c,t}$ is not observed in its entirety, step 2 can only imperfectly control for fundamentals. At one extreme, if step 2 is bypassed altogether so that all variations in the term premium is treated as unrelated to fundamentals, then step 3 will mistake any correlation in $z_{c,t}$ as $G_t$. As a result, the importance of $G_t$ may thus be overstated. On the other hand, if observables in $z_{c,t}$ are highly correlated with $G_t$ (for example, because of endogeneity), then step 2 could underestimate the importance $G_t$ by prematurely removing its influence before step 3. In the following, we adopt a conservative approach by considering several alternatives conditioning variables (each containing no more than 3 variables) in step 2, in order to ensure not to underestimate the importance of $G_t$.[4]

### 3.2 The basic factor model of bond returns

Expected excess returns, or equivalently the risk or term premia, are the compensation that investors demand for bearing risks of holding a long-term bond over the risk-free return of a short-term bond. Define the log excess returns of investing in an $n$-year bond in period $t$ and selling in period $t+1$ as $er^n_{t+1} = p^{n-1}_{t+1} - p^n_t + p^1_t$, where $p^n_t$ is the log price of an $n$-period bond at time $t$. The log yield is given by $y^n_t = -p^n_t/n$, while the forward rate is $f^n_t = p^n_t - p^{n+1}_t$.

Consider a linear factor model of risk premium:

$$er^n_{t+1} = \beta^{n\prime} x_t + \varepsilon^n_{t+1} \tag{3.5}$$

Three standard candidates for $x_t$ may be considered:

$$x^{PC}_t = [1, pc^1_t, pc^2_t, pc^3_t, pc^4_t, pc^5_t]' \tag{3.6}$$

$$x^{CP}_t = [1, f^1_t, f^3_t, f^5_t, f^7_t, f^{10}_t]' \tag{3.7}$$

$$x^{FB}_t = [1, f^{10}_t - y^1_t]' \tag{3.8}$$

The first model (PC) is based on the first five principal components $pc^1_t, ..., pc^5_t$ of the yield curves (maturities used are 3-month, 6-month, each annual maturity up to 10-year). The second model (CP) uses five log forward rates $f^n_t$ $(n = 1, 3, 5, 7, 10)$, inspired by Cochrane and Piazzesi (2005). The final model (FB) uses the forward spread as in Fama and Bliss (1987).

Unrestricted estimates of $\beta^n$ under the PC and CP models suggest a common loading pattern on $x_t$ for all bonds. To exploit this commonality and fully utilise information contained in the term structure, we follow Cochrane and Piazzesi (2005) and other subsequent works in fixing the relative loadings of each factor for all maturities of bonds. In this restricted estimation,

[4]The procedure may also overstate the extent of contagion under correlated shifts in the "amount" of risks across countries, which can generate correlated risk premia even if the prices of risks remain constant. In the presence of such heteroskedasticity, our estimate of financial contagion remains conservative in overestimating rather than underestimating its effect.

the average excess return is first regressed on the factors

$$\sum_{n=1}^{10} \frac{(er_{t+1}^n)}{n} = \beta' x_t + \varepsilon_{t+1} \tag{3.9}$$

The common loading structure $\hat{\beta}' x_t$ is then used as a single factor to fit the excess return of the $n$-period bond via the scaling parameter $\beta_s^n$:

$$er_{t+1}^n = \beta_s^n (\hat{\beta}' x_t) + \varepsilon_{t+1}^n \tag{3.10}$$

Our primary focus will be on the term premia of 10-year bonds and the superscript $n$ will be suppressed to simplify notation.

The goodness of fit for the three models are reported in Table 1. In line with the existing literature, there is a clear evidence of excess return predictability, particular under the first two models where $R^2$ are all high for this type of regression. The Fama-Bliss model finds more mixed success across countries, although in the case of the United States the fit is in the same order of magnitude as in previous findings.

Our 5-factor PC model does at least as well as the CP model in forecasting excess returns for nearly all countries, outperforming in a number of cases.[5] Table 2 shows the parameter estimates of the PC model along with t-statistics p-values, confirming that the loadings on the fourth and fifth principal components ($\beta_4$ and $\beta_5$) are significant as a predictor of excess returns for many countries. It is also noteworthy that the loading $\beta_2$ on factor $pc^2$ (inversely related to the slope of the yield curve) is significantly negative for all but one country. This is consistent with the Fama-Bliss insights that yield spreads have predictive power for excess returns. The PC model therefore appears to nest the other two. Furthermore, because principal components are uncorrelated, a multicollinearity problem is not present, a property that will prove useful later on. The superior performance of the PC specification justifies a focus on it for the rest of the paper.

### 3.3 Unspanned pricing factor

A notable feature of the above regression is the positive correlation of unexpected excess returns (the residuals in equation 3.10) across countries. This feature suggests that there may exist a

[5] Cochrane and Piazzesi (2005) found evidence in favour of the CP model over the traditional 3-principal-component models, and conjectured that the forward-rate factors may capture useful information contained in the fourth principal component. Our results, based on 5 factors, are consistent with their hypothesis.

**Table 1:** Excess returns models' goodness of fit

| | 1st-stage | | | | | | 2nd-stage | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Adj. $R^2$ | | | F-statistics | | | Adj. $R^2$ | | | T |
| | PC | CP | FB | PC | CP | FB | PC | CP | FB | |
| US | 0.21 | 0.21 | 0.01 | 0.000 | 0.000 | 0.028 | 0.22 | 0.21 | 0.04 | 291 |
| GE | 0.26 | 0.20 | 0.06 | 0.000 | 0.000 | 0.000 | 0.31 | 0.25 | 0.13 | 232 |
| JP | 0.50 | 0.49 | -0.00 | 0.000 | 0.000 | 0.696 | 0.36 | 0.35 | -0.00 | 291 |
| UK | 0.25 | 0.24 | 0.07 | 0.000 | 0.000 | 0.000 | 0.29 | 0.27 | 0.09 | 232 |
| CA | 0.33 | 0.29 | 0.13 | 0.000 | 0.000 | 0.000 | 0.36 | 0.34 | 0.19 | 232 |
| AU | 0.27 | 0.28 | 0.04 | 0.000 | 0.000 | 0.002 | 0.29 | 0.30 | 0.07 | 232 |
| NZ | 0.26 | 0.24 | 0.06 | 0.000 | 0.000 | 0.000 | 0.30 | 0.28 | 0.08 | 232 |
| CH | 0.24 | 0.21 | 0.01 | 0.000 | 0.000 | 0.053 | 0.24 | 0.17 | 0.04 | 232 |
| SE | 0.38 | 0.37 | 0.07 | 0.000 | 0.000 | 0.000 | 0.40 | 0.40 | 0.12 | 232 |
| NO | 0.27 | 0.27 | 0.17 | 0.000 | 0.000 | 0.000 | 0.35 | 0.36 | 0.25 | 232 |
| HK | 0.15 | 0.14 | 0.05 | 0.000 | 0.000 | 0.001 | 0.18 | 0.18 | 0.07 | 232 |
| KR | 0.19 | 0.19 | 0.11 | 0.000 | 0.000 | 0.000 | 0.19 | 0.18 | 0.13 | 137 |
| SG | 0.40 | 0.39 | 0.13 | 0.000 | 0.000 | 0.000 | 0.40 | 0.39 | 0.19 | 232 |
| TW | 0.46 | 0.48 | 0.03 | 0.000 | 0.000 | 0.010 | 0.47 | 0.49 | 0.08 | 181 |
| ID | 0.32 | 0.29 | -0.01 | 0.000 | 0.000 | 0.583 | 0.31 | 0.27 | -0.01 | 131 |
| MY | 0.68 | 0.68 | 0.34 | 0.000 | 0.000 | 0.000 | 0.59 | 0.60 | 0.36 | 151 |
| PH | 0.18 | 0.14 | 0.09 | 0.000 | 0.000 | 0.000 | 0.23 | 0.19 | 0.15 | 214 |
| TH | 0.45 | 0.46 | 0.12 | 0.000 | 0.000 | 0.000 | 0.40 | 0.41 | 0.18 | 232 |
| CN | 0.71 | 0.66 | -0.00 | 0.000 | 0.000 | 0.453 | 0.74 | 0.68 | 0.02 | 120 |
| IN | 0.48 | 0.40 | 0.09 | 0.000 | 0.000 | 0.000 | 0.51 | 0.41 | 0.15 | 185 |
| CL | 0.22 | 0.21 | -0.01 | 0.000 | 0.000 | 0.506 | 0.18 | 0.16 | -0.01 | 103 |
| CO | 0.45 | 0.40 | 0.14 | 0.000 | 0.000 | 0.000 | 0.45 | 0.41 | 0.18 | 96 |
| MX | 0.20 | 0.39 | 0.09 | 0.000 | 0.000 | 0.000 | 0.25 | 0.44 | 0.14 | 128 |
| PE | 0.53 | 0.54 | -0.01 | 0.000 | 0.000 | 0.566 | 0.56 | 0.54 | -0.01 | 95 |
| CZ | 0.36 | 0.33 | 0.11 | 0.000 | 0.000 | 0.000 | 0.36 | 0.34 | 0.16 | 160 |
| HU | 0.36 | 0.37 | 0.04 | 0.000 | 0.000 | 0.008 | 0.34 | 0.36 | 0.08 | 157 |
| IL | 0.13 | 0.10 | 0.07 | 0.002 | 0.006 | 0.003 | 0.26 | 0.20 | 0.14 | 109 |
| PL | 0.20 | 0.25 | -0.00 | 0.000 | 0.000 | 0.482 | 0.33 | 0.32 | 0.01 | 191 |
| RU | 0.65 | 0.62 | 0.00 | 0.000 | 0.000 | 0.262 | 0.62 | 0.62 | -0.00 | 87 |
| ZA | 0.26 | 0.29 | 0.06 | 0.000 | 0.000 | 0.000 | 0.30 | 0.31 | 0.10 | 231 |
| TR | 0.56 | 0.53 | 0.12 | 0.000 | 0.000 | 0.000 | 0.56 | 0.54 | 0.13 | 108 |

**Note:** First six columns show adjusted $R^2$ and F-statistics from regressing average excess returns on three sets of factors, PC, CP and FB (1st-stage regression in equation 3.9). The next three columns report adjusted $R^2$ from regressing 10-year excess returns on the fitted values of the 1st-stage regression corresponding to the three models (2nd-stage regression in equation 3.10). $T$ is the length of available data in months.

residual global influence unspanned by the local term structure factors $x_t$ that is informative about the joint future excess returns of all countries. For example, previous research has highlighted the role of inflation risks in driving the term premia (e.g. Wright (2011), Jotikasthira et al. (2015)), a potential common driver of bond returns given globally correlated inflation. Dahlquist and Hasseltoft (2013) also document evidence that a global factor plays a significant role in explaining risk premia in selected advanced economies. If the local-factor model were to inadequately capture this global driver of the term premia, it may underestimate the degree of financial contagion. It is therefore important to take into account the part of term premia unspanned by local factors.

Three candidates for the unspanned global pricing factor are considered. One choice is the

**Table 2:** PC model estimates

| | $\beta_0$ | $\beta_1$ | $\beta_2$ | $\beta_3$ | $\beta_4$ | $\beta_5$ | Adj. $R^2$ | $\beta_S$ | Adj. $R^2$ (10y) | T |
|---|---|---|---|---|---|---|---|---|---|---|
| US | 0.032 | 0.138 | -1.633 | 0.184 | -8.864 | 16.978 | 0.21 | 1.562 | 0.22 | 291 |
| | (0.000) | (0.001) | (0.000) | (0.910) | (0.010) | (0.000) | | (0.000) | | |
| GE | 0.031 | 0.188 | -1.700 | -3.868 | 12.656 | 19.903 | 0.26 | 1.607 | 0.31 | 232 |
| | (0.000) | (0.000) | (0.000) | (0.008) | (0.005) | (0.000) | | (0.000) | | |
| JP | 0.027 | 0.293 | -1.572 | -5.091 | -4.395 | 0.563 | 0.50 | 1.550 | 0.36 | 291 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.634) | | (0.000) | | |
| UK | 0.025 | 0.073 | -1.902 | -0.859 | -2.317 | -3.558 | 0.25 | 1.636 | 0.29 | 232 |
| | (0.000) | (0.067) | (0.000) | (0.383) | (0.458) | (0.424) | | (0.000) | | |
| CA | 0.030 | 0.196 | -1.810 | 0.543 | 1.279 | -14.815 | 0.33 | 1.606 | 0.36 | 232 |
| | (0.000) | (0.000) | (0.000) | (0.633) | (0.693) | (0.003) | | (0.000) | | |
| AU | 0.022 | 0.488 | -1.583 | -1.206 | 13.492 | 14.272 | 0.27 | 1.694 | 0.29 | 232 |
| | (0.000) | (0.000) | (0.000) | (0.430) | (0.018) | (0.166) | | (0.000) | | |
| NZ | 0.014 | 0.141 | -2.332 | 0.683 | -8.652 | -10.026 | 0.26 | 1.722 | 0.30 | 232 |
| | (0.000) | (0.017) | (0.000) | (0.598) | (0.024) | (0.121) | | (0.000) | | |
| CH | 0.021 | 0.362 | -1.381 | 3.404 | -0.244 | 7.522 | 0.24 | 1.651 | 0.24 | 232 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.908) | (0.030) | | (0.000) | | |
| SE | 0.035 | 0.426 | -1.593 | 0.462 | -13.130 | 11.584 | 0.38 | 1.653 | 0.40 | 232 |
| | (0.000) | (0.000) | (0.000) | (0.692) | (0.007) | (0.204) | | (0.000) | | |
| NO | 0.021 | 0.114 | -1.951 | 1.797 | -1.955 | -5.919 | 0.27 | 1.743 | 0.35 | 232 |
| | (0.000) | (0.016) | (0.000) | (0.092) | (0.554) | (0.310) | | (0.000) | | |
| HK | 0.032 | 0.132 | -1.479 | 0.730 | 12.292 | 4.441 | 0.15 | 1.581 | 0.18 | 232 |
| | (0.000) | (0.003) | (0.000) | (0.617) | (0.000) | (0.533) | | (0.000) | | |
| KR | 0.017 | 0.309 | -2.199 | -0.200 | -7.209 | -4.457 | 0.19 | 1.585 | 0.19 | 137 |
| | (0.000) | (0.006) | (0.000) | (0.871) | (0.045) | (0.340) | | (0.000) | | |
| SG | 0.023 | 0.359 | -2.224 | 3.179 | 4.799 | -9.948 | 0.40 | 1.679 | 0.40 | 232 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) | | (0.000) | | |
| TW | 0.024 | 0.444 | -2.452 | -2.687 | -2.454 | 0.134 | 0.46 | 1.775 | 0.47 | 181 |
| | (0.000) | (0.000) | (0.000) | (0.096) | (0.270) | (0.964) | | (0.000) | | |
| ID | 0.036 | 0.789 | 1.210 | 2.629 | -8.868 | 9.189 | 0.32 | 1.600 | 0.31 | 131 |
| | (0.000) | (0.000) | (0.170) | (0.158) | (0.015) | (0.070) | | (0.000) | | |
| MY | 0.013 | 2.319 | -0.529 | 0.226 | -2.501 | -3.747 | 0.68 | 1.877 | 0.59 | 151 |
| | (0.000) | (0.000) | (0.019) | (0.736) | (0.103) | (0.315) | | (0.000) | | |
| PH | 0.061 | 0.195 | -3.033 | 1.600 | 3.155 | 9.869 | 0.18 | 1.731 | 0.23 | 214 |
| | (0.000) | (0.000) | (0.000) | (0.207) | (0.160) | (0.001) | | (0.000) | | |
| TH | 0.029 | 1.168 | -1.678 | 0.129 | -0.803 | 1.117 | 0.45 | 1.777 | 0.40 | 232 |
| | (0.000) | (0.000) | (0.000) | (0.912) | (0.806) | (0.780) | | (0.000) | | |
| CN | 0.017 | 1.662 | -3.293 | 0.502 | 4.709 | 1.354 | 0.71 | 1.710 | 0.74 | 120 |
| | (0.000) | (0.000) | (0.000) | (0.757) | (0.054) | (0.668) | | (0.000) | | |
| IN | 0.020 | 0.644 | -1.186 | 5.928 | -1.102 | 5.284 | 0.48 | 1.838 | 0.51 | 185 |
| | (0.000) | (0.000) | (0.003) | (0.000) | (0.647) | (0.074) | | (0.000) | | |
| CL | 0.018 | 0.823 | -0.868 | 0.602 | 2.175 | -0.274 | 0.22 | 1.287 | 0.18 | 103 |
| | (0.000) | (0.000) | (0.004) | (0.627) | (0.364) | (0.939) | | (0.000) | | |
| CO | 0.041 | 0.333 | -3.310 | -5.827 | -3.678 | 1.637 | 0.45 | 1.483 | 0.45 | 96 |
| | (0.000) | (0.002) | (0.000) | (0.001) | (0.210) | (0.707) | | (0.000) | | |
| MX | 0.032 | 0.131 | -1.832 | -2.896 | 2.428 | -3.767 | 0.20 | 1.734 | 0.25 | 128 |
| | (0.000) | (0.120) | (0.000) | (0.035) | (0.321) | (0.183) | | (0.000) | | |
| PE | 0.029 | 1.121 | -3.088 | 4.699 | 1.949 | -5.422 | 0.53 | 1.634 | 0.56 | 95 |
| | (0.000) | (0.000) | (0.000) | (0.008) | (0.513) | (0.076) | | (0.000) | | |
| CZ | 0.033 | 0.561 | -4.053 | 2.365 | 7.555 | 6.085 | 0.36 | 1.642 | 0.36 | 160 |
| | (0.000) | (0.000) | (0.000) | (0.099) | (0.013) | (0.196) | | (0.000) | | |
| HU | 0.005 | 0.690 | -3.796 | 5.598 | -1.412 | 15.180 | 0.36 | 1.474 | 0.34 | 157 |
| | (0.392) | (0.000) | (0.000) | (0.010) | (0.761) | (0.075) | | (0.000) | | |
| IL | 0.043 | -0.082 | -0.972 | -0.178 | 9.028 | -6.136 | 0.13 | 1.594 | 0.26 | 109 |
| | (0.000) | (0.422) | (0.072) | (0.902) | (0.000) | (0.129) | | (0.000) | | |
| PL | 0.019 | 0.160 | -3.701 | -1.962 | -1.179 | 0.787 | 0.20 | 1.965 | 0.33 | 191 |
| | (0.000) | (0.004) | (0.000) | (0.160) | (0.686) | (0.874) | | (0.000) | | |
| RU | 0.001 | 1.917 | -2.990 | -4.063 | 0.934 | -7.292 | 0.65 | 1.768 | 0.62 | 87 |
| | (0.931) | (0.000) | (0.002) | (0.056) | (0.798) | (0.248) | | (0.000) | | |
| ZA | 0.026 | 0.179 | -1.832 | -0.731 | -5.281 | 9.046 | 0.26 | 1.742 | 0.30 | 231 |
| | (0.000) | (0.000) | (0.000) | (0.457) | (0.009) | (0.006) | | (0.000) | | |
| TR | 0.020 | 0.554 | -9.298 | 4.699 | -8.153 | 7.676 | 0.56 | 1.727 | 0.56 | 108 |
| | (0.107) | (0.000) | (0.000) | (0.055) | (0.121) | (0.213) | | (0.000) | | |

**Note:** The table shows the estimates of the PC model. $\beta_0$ is the constant term while $\beta_1, \beta_2, ..., \beta_5$ are coefficients of the factors $pc^1, pc^2, ..., pc^5$ in the 1st-stage regression (equation 3.9). $\beta_S$ is the scaling parameter from the 2nd-stage regression (equation 3.10). Corresponding p-values are in parentheses.

first principal component of all global yields, denoted $G_t^y$, which represents the trend of global interest rates (and may ultimately be related to global inflation).[6] For each country $c$, $G_t^y$ is regressed on the local factors $x_{c,t}^{PC}$, to obtain the residual $G_{c,t}^y$, which contains information about the global factor unspanned by the local factors. The set of local factors is then augmented by this unspanned global factor, to make up the complete set of factors $[x_{c,t}^{PC}, G_{c,t}^y]'$ for each country $c$.

The second choice of the unspanned global factor is the first principal component of the residuals from equation 3.10 based on the PC model, denoted $G_t^u$. The idea is that the common driver of unexpected returns across countries may be forecastible using its own lag. As before, the portion of $G_t^u$ unexplained by the local factors $x_{c,t}^{PC}$ (denoted by $G_{c,t}^u \equiv G_t^u \perp x_{c,t}$) is used to construct the new set of factors $[x_{c,t}^{PC}, G_{c,t}^u]'$ for calculating the term premia. Finally, the third candidate is simply the VIX index, whose projection on $x_{c,t}^{PC}$ gives a residual that can be included in the set of factors $[x_{c,t}^{PC}, G_{c,t}^v]'$. As is often asserted, the VIX index is related to global risk appetite, which may help predict excess returns of long-term bonds.

Table 3 provides basic criteria for evaluating the three augmented models. Akaike information criterion confirms that adding a global factor improves the model, and suggests that using the global-yield factor $G_{c,t}^y$ generally increases the likelihood by more than $G_{c,t}^u$ or $G_{c,t}^v$. The coefficients on $G_{c,t}^y$ are statistically significant for 25 countries, slightly better than the second model for which the coefficients are significant in 20 cases, and clearly outperforming the third model which is significant only for 12 countries. From these observations, the final term premia estimates are computed using the PC factor model augmented by the global-yield factor:

$$x_{c,t} = [x_{c,t}^{PC}, G_{c,t}^y]' \tag{3.11}$$

giving the term premia:

$$tp_{c,t} \equiv E_t(er_{c,t+1}) = \hat{\beta}_{c,s}^{10}(\hat{\beta}_c' x_{c,t}) \tag{3.12}$$

Estimates of the selected model are shown in Table 4. By design, adding the unspanned

[6] To preserve time-series observations, only 14 countries are used to compute a global factor at this stage. These consist of all 10 advanced economies, plus HK, SG, TH and ZA. Including other countries does not materially change the resulting principal components, but would curtail available data points. With 14 selected countries, the global factor starts from January 1995, and $G_t^y$ is the first principal component of 14 countries x 10 annual yields =140 series.

**Table 3:** Model selection criteria with a global factor

| | p-values | | | AIC | | | |
|---|---|---|---|---|---|---|---|
| | $G^y$ | $G^u$ | $G^v$ | PC | PC-$G^y$ | PC-$G^u$ | PC-$G^v$ |
| US | 0.003 | 0.000 | 0.023 | -3.70 | -3.73 | -3.83 | -3.46 |
| GE | 0.000 | 0.021 | 0.440 | -3.95 | -4.08 | -3.96 | -3.93 |
| JP | 0.013 | 0.021 | 0.015 | -5.54 | -5.56 | -5.85 | -4.79 |
| UK | 0.060 | 0.000 | 0.214 | -3.78 | -3.78 | -3.87 | -3.78 |
| CA | 0.090 | 0.000 | 0.003 | -4.26 | -4.27 | -4.47 | -4.28 |
| AU | 0.000 | 0.000 | 0.060 | -3.49 | -3.67 | -3.59 | -3.50 |
| NZ | 0.000 | 0.002 | 0.567 | -3.69 | -3.96 | -3.79 | -3.68 |
| CH | 0.000 | 0.011 | 0.260 | -4.20 | -4.54 | -4.21 | -4.20 |
| SE | 0.000 | 0.000 | 0.016 | -3.67 | -4.01 | -3.73 | -3.68 |
| NO | 0.000 | 0.605 | 0.296 | -3.85 | -4.22 | -3.81 | -3.84 |
| HK | 0.054 | 0.001 | 0.318 | -3.09 | -3.10 | -3.11 | -3.09 |
| KR | 0.000 | 0.712 | 0.175 | -3.94 | -4.35 | -3.92 | -3.94 |
| SG | 0.803 | 0.037 | 0.558 | -4.27 | -4.27 | -4.39 | -4.25 |
| TW | 0.283 | 0.966 | 0.002 | -4.47 | -4.47 | -4.46 | -4.52 |
| ID | 0.000 | 0.398 | 0.002 | -1.76 | -2.01 | -1.75 | -1.82 |
| MY | 0.017 | 0.130 | 0.247 | -5.27 | -5.30 | -5.27 | -5.27 |
| PH | 0.000 | 0.000 | 0.932 | -1.55 | -1.94 | -1.61 | -1.54 |
| TH | 0.000 | 0.067 | 0.362 | -3.23 | -3.54 | -3.20 | -3.23 |
| CN | 0.001 | 0.137 | 0.015 | -4.47 | -4.55 | -4.47 | -4.50 |
| IN | 0.019 | 0.012 | 0.001 | -3.53 | -3.55 | -3.55 | -3.58 |
| CL | 0.000 | 0.377 | 0.695 | -3.67 | -4.11 | -3.66 | -3.65 |
| CO | 0.000 | 0.000 | 0.000 | -2.80 | -3.73 | -3.23 | -2.93 |
| MX | 0.000 | 0.002 | 0.096 | -3.39 | -3.69 | -3.45 | -3.40 |
| PE | 0.000 | 0.000 | 0.047 | -3.23 | -3.84 | -3.58 | -3.25 |
| CZ | 0.000 | 0.700 | 0.141 | -3.73 | -3.94 | -3.72 | -3.74 |
| HU | 0.000 | 0.627 | 0.132 | -2.47 | -2.63 | -2.46 | -2.47 |
| IL | 0.140 | 0.431 | 0.578 | -3.83 | -3.83 | -3.82 | -3.82 |
| PL | 0.000 | 0.017 | 0.266 | -2.37 | -2.62 | -2.39 | -2.36 |
| RU | 0.012 | 0.000 | 0.457 | -1.52 | -1.57 | -1.66 | -1.50 |
| ZA | 0.000 | 0.003 | 0.054 | -2.80 | -2.89 | -2.83 | -2.80 |
| TR | 0.000 | 0.001 | 0.003 | -1.23 | -1.87 | -1.31 | -1.29 |

**Note:** The first three columns show the p-values corresponding to the three alternative unspanned global factors ($G^y$, $G^u$ and $G^v$) that augment the PC model. The last four columns show the Akaike information criterion values for four models; the original PC model, and the PC models augmented by $G^y$, $G^u$ and $G^v$ respectively.

global factor does not result in multicollinearity, and the significance of domestic factors is not affected. The unspanned global factor appears to be helpful for forecasting several large historical moves in the excess returns. Figure 1 compares the average term premia under the selected model with those based on domestic-factor model as well as actual excess returns, sorted by four regional groups (all countries, advanced, emerging Asia, and other EMEs). It shows how some large swings in excess returns, for example in late 90's and early 2010's, are indeed better forecasted with an aid of the unspanned factor.[7]

[7]Our procedure of incorporating the global factor reverses that in Dahlquist and Hasseltoft (2013), where the authors start from a global factor and add orthogonalised local factors. The crucial distinction lies in how we interpret the factors. Dahlquist and Hasseltoft (2013) take their global factor, which is the GDP-weighted average of local CP-based single factors, as representing the true global influence. We emphasise that, in our formulation, there is nothing exclusively global about the unspanned global factor, and the true global influence on risk premium could also be picked up by correlation in the local factors. Likewise, in Dahlquist and Hasseltoft (2013), any incidental correlation in the truly local influences could in fact be picked up by their global factor.

# Table 4: Estimates of the final model

| | $\beta_0$ | $\beta_1$ | $\beta_2$ | $\beta_3$ | $\beta_4$ | $\beta_5$ | $\beta_6$ | Adj. $R^2$ | $\beta_S$ | Adj. $R^2$ (10y) | T |
|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 0.039 | 0.200 | -2.463 | 0.617 | -8.412 | 18.317 | -0.164 | 0.28 | 1.669 | 0.35 | 231 |
| | (0.000) | (0.001) | (0.000) | (0.738) | (0.047) | (0.000) | (0.003) | | (0.000) | | |
| GE | 0.029 | 0.230 | -1.821 | -3.054 | 12.221 | 22.156 | -0.273 | 0.35 | 1.590 | 0.37 | 231 |
| | (0.000) | (0.000) | (0.000) | (0.026) | (0.003) | (0.000) | (0.000) | | (0.000) | | |
| JP | 0.035 | 0.556 | -1.141 | 0.354 | 5.748 | 3.445 | -0.025 | 0.54 | 1.731 | 0.41 | 231 |
| | (0.000) | (0.000) | (0.032) | (0.791) | (0.063) | (0.100) | (0.013) | | (0.000) | | |
| UK | 0.025 | 0.068 | -1.882 | -0.809 | -2.437 | -4.127 | -0.098 | 0.25 | 1.655 | 0.30 | 231 |
| | (0.000) | (0.091) | (0.000) | (0.411) | (0.433) | (0.357) | (0.060) | | (0.000) | | |
| CA | 0.030 | 0.185 | -1.825 | 0.345 | 1.017 | -13.986 | -0.092 | 0.33 | 1.600 | 0.35 | 231 |
| | (0.000) | (0.000) | (0.000) | (0.760) | (0.751) | (0.004) | (0.090) | | (0.000) | | |
| AU | 0.022 | 0.495 | -1.583 | -1.227 | 13.029 | 14.287 | -0.199 | 0.39 | 1.710 | 0.42 | 231 |
| | (0.000) | (0.000) | (0.000) | (0.380) | (0.013) | (0.129) | (0.000) | | (0.000) | | |
| NZ | 0.014 | 0.134 | -2.357 | 0.749 | -9.700 | -10.218 | -0.265 | 0.44 | 1.721 | 0.48 | 231 |
| | (0.000) | (0.010) | (0.000) | (0.506) | (0.005) | (0.070) | (0.000) | | (0.000) | | |
| CH | 0.020 | 0.411 | -1.502 | 3.836 | 0.780 | 6.057 | -0.282 | 0.45 | 1.639 | 0.42 | 231 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.661) | (0.039) | (0.000) | | (0.000) | | |
| SE | 0.034 | 0.434 | -1.592 | 0.218 | -16.062 | 10.526 | -0.320 | 0.56 | 1.622 | 0.53 | 231 |
| | (0.000) | (0.000) | (0.000) | (0.825) | (0.000) | (0.169) | (0.000) | | (0.000) | | |
| NO | 0.021 | 0.125 | -1.961 | 1.910 | -1.293 | -6.596 | -0.308 | 0.49 | 1.667 | 0.52 | 231 |
| | (0.000) | (0.002) | (0.000) | (0.031) | (0.642) | (0.175) | (0.000) | | (0.000) | | |
| HK | 0.033 | 0.117 | -1.460 | 0.738 | 12.231 | 3.875 | -0.139 | 0.16 | 1.590 | 0.19 | 231 |
| | (0.000) | (0.008) | (0.000) | (0.614) | (0.000) | (0.584) | (0.054) | | (0.000) | | |
| KR | 0.016 | 0.391 | -2.250 | -0.291 | -7.677 | -4.684 | -0.372 | 0.47 | 1.632 | 0.44 | 137 |
| | (0.000) | (0.000) | (0.000) | (0.771) | (0.009) | (0.216) | (0.000) | | (0.000) | | |
| SG | 0.022 | 0.346 | -2.205 | 3.270 | 3.897 | -10.918 | 0.006 | 0.39 | 1.687 | 0.40 | 231 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.013) | (0.000) | (0.803) | | (0.000) | | |
| TW | 0.024 | 0.441 | -2.466 | -2.627 | -2.352 | 0.044 | -0.033 | 0.46 | 1.774 | 0.47 | 181 |
| | (0.000) | (0.000) | (0.000) | (0.104) | (0.291) | (0.988) | (0.283) | | (0.000) | | |
| ID | 0.042 | 0.743 | 1.733 | 2.053 | -9.301 | 7.158 | -0.685 | 0.47 | 1.648 | 0.46 | 131 |
| | (0.000) | (0.000) | (0.028) | (0.211) | (0.004) | (0.110) | (0.000) | | (0.000) | | |
| MY | 0.013 | 2.321 | -0.461 | 0.278 | -2.590 | -3.957 | -0.034 | 0.70 | 1.900 | 0.62 | 151 |
| | (0.000) | (0.000) | (0.040) | (0.673) | (0.086) | (0.281) | (0.017) | | (0.000) | | |
| PH | 0.064 | 0.168 | -2.880 | 1.559 | 2.729 | 9.156 | -0.771 | 0.44 | 1.717 | 0.45 | 214 |
| | (0.000) | (0.000) | (0.000) | (0.136) | (0.140) | (0.000) | (0.000) | | (0.000) | | |
| TH | 0.030 | 1.141 | -1.665 | -0.101 | -0.615 | 1.301 | -0.217 | 0.60 | 1.865 | 0.58 | 231 |
| | (0.000) | (0.000) | (0.000) | (0.920) | (0.827) | (0.704) | (0.000) | | (0.000) | | |
| CN | 0.017 | 1.641 | -3.403 | 0.764 | 4.440 | 1.606 | 0.079 | 0.74 | 1.689 | 0.74 | 120 |
| | (0.000) | (0.000) | (0.000) | (0.621) | (0.057) | (0.594) | (0.001) | | (0.000) | | |
| IN | 0.020 | 0.640 | -1.268 | 5.931 | -0.792 | 5.627 | 0.063 | 0.49 | 1.820 | 0.51 | 185 |
| | (0.000) | (0.000) | (0.001) | (0.000) | (0.739) | (0.055) | (0.019) | | (0.000) | | |
| CL | 0.017 | 0.878 | -0.943 | 0.780 | 2.308 | 0.636 | -0.257 | 0.50 | 1.375 | 0.44 | 103 |
| | (0.000) | (0.000) | (0.000) | (0.431) | (0.228) | (0.824) | (0.000) | | (0.000) | | |
| CO | 0.041 | 0.333 | -3.306 | -5.716 | -3.674 | 1.669 | -0.860 | 0.79 | 1.522 | 0.74 | 96 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.046) | (0.539) | (0.000) | | (0.000) | | |
| MX | 0.033 | 0.108 | -1.845 | -3.218 | 1.844 | -3.862 | -0.384 | 0.41 | 1.669 | 0.37 | 128 |
| | (0.000) | (0.137) | (0.000) | (0.007) | (0.380) | (0.112) | (0.000) | | (0.000) | | |
| PE | 0.032 | 1.077 | -3.091 | 5.515 | 0.382 | -4.622 | -0.380 | 0.75 | 1.613 | 0.73 | 95 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.861) | (0.040) | (0.000) | | (0.000) | | |
| CZ | 0.033 | 0.529 | -3.864 | 1.955 | 6.819 | 5.433 | -0.267 | 0.48 | 1.618 | 0.43 | 160 |
| | (0.000) | (0.000) | (0.000) | (0.131) | (0.013) | (0.200) | (0.000) | | (0.000) | | |
| HU | 0.008 | 0.535 | -3.543 | 4.453 | -1.752 | 13.674 | -0.358 | 0.45 | 1.431 | 0.40 | 157 |
| | (0.122) | (0.000) | (0.000) | (0.028) | (0.682) | (0.082) | (0.000) | | (0.000) | | |
| IL | 0.043 | -0.051 | -1.069 | -0.083 | 9.140 | -6.182 | -0.097 | 0.14 | 1.589 | 0.26 | 109 |
| | (0.000) | (0.624) | (0.049) | (0.954) | (0.000) | (0.124) | (0.140) | | (0.000) | | |
| PL | 0.020 | 0.148 | -3.575 | -1.784 | -1.051 | 1.265 | -0.430 | 0.38 | 1.764 | 0.44 | 191 |
| | (0.000) | (0.002) | (0.000) | (0.147) | (0.682) | (0.772) | (0.000) | | (0.000) | | |
| RU | 0.003 | 1.951 | -2.842 | -3.806 | 1.092 | -7.818 | -0.330 | 0.67 | 1.773 | 0.65 | 87 |
| | (0.831) | (0.000) | (0.002) | (0.065) | (0.757) | (0.201) | (0.012) | | (0.000) | | |
| ZA | 0.028 | 0.162 | -1.845 | -0.713 | -5.031 | 8.375 | -0.311 | 0.33 | 1.644 | 0.32 | 231 |
| | (0.000) | (0.000) | (0.000) | (0.445) | (0.009) | (0.007) | (0.000) | | (0.000) | | |
| TR | 0.026 | 0.511 | -9.107 | 4.230 | -10.852 | 8.660 | -1.475 | 0.77 | 1.742 | 0.77 | 108 |
| | (0.004) | (0.000) | (0.000) | (0.017) | (0.005) | (0.053) | (0.000) | | (0.000) | | |

**Note:** The table shows the estimates of the final $G^y$-augmented PC model. $\beta_0, \beta_1, ..., \beta_5$ are the constant term and coefficients of the factors $pc^1, pc^2, ..., pc^5$ in the 1st-stage regression (equation 3.9.). $\beta_6$ is the coefficient of the unspanned global factor. $\beta^{10}$ is the scaling parameter from the 2nd-stage regression (equation 3.10). Corresponding p-values are in parentheses.

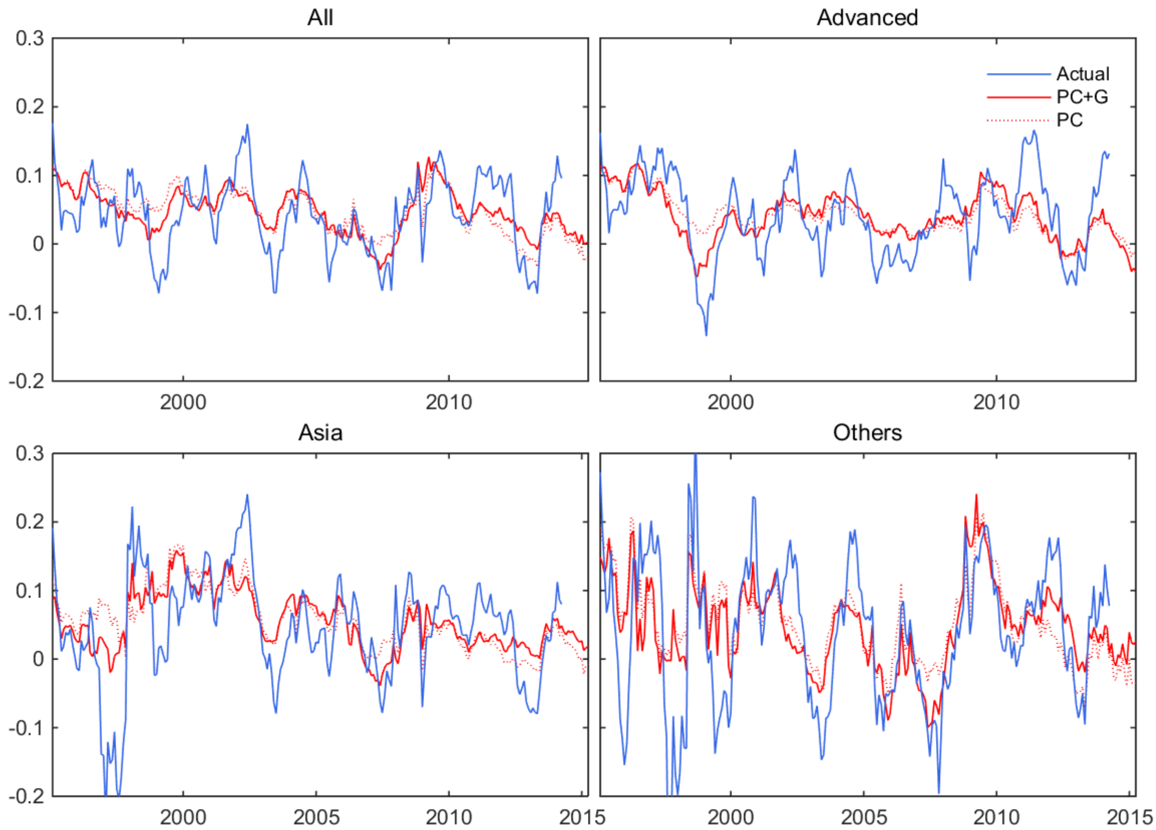



**Figure 1:** Average term premia with and without unspanned global factor

### 3.4 Term premia behaviour

The time-series of all individual term premia are shown in Figure 2, sorted by four regional groups, together with corresponding averages (thick red line) and cross-sectional one standard deviation bands (dotted lines). All panels share the same scales to allow direct comparison. There are clear regional differences in term premia behaviour. Term premia in advanced economies are tightly correlated and are very similar in levels. By contrast, term premia in emerging markets are substantially more volatile and exhibit greater cross-country dispersion. The results may be partly influenced by greater depth and liquidity in advanced markets. They nonetheless suggest that term premia correlation is much stronger among the advanced economies.

With this cross-country heterogeneity in mind, consider the time evolution of average

Similar difficulties arise in Hellerstein (2011) who also examines the interplay between global and local factors. The orthogonalise-then-augment step simply aggregates information from the global and local influences, but does not help segregate the two. Our procedure tackles this segregation problem by progressively cleaning out the local influences using another set of observed fundamentals, before recovering the global contagion effect in the final step.

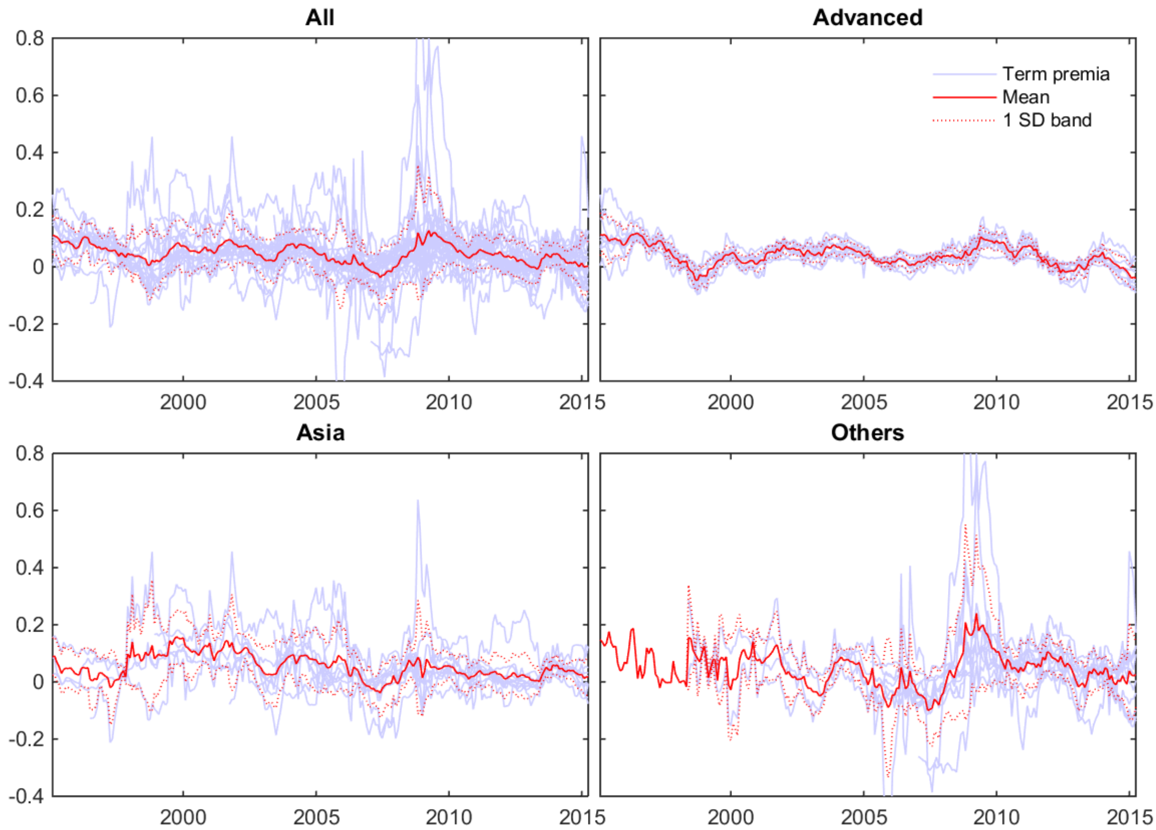



**Figure 2:** Term premia: all regions

term premia for different groups in Figure 3. The cross-regional correlation of term premia appears to be more event-specific rather than systematic. For example, there is a reasonably strong correlation between the term premia among all three groups post-2008, particularly the synchronised decline during 2009-2010 and again in 2014. There is also a correlated pick-up in average term premia in 2013. This occasional synchronicity might be associated with quantitative easing policies, forward guidance, taper tantrum and so on. But on the whole, the correlation appears to be more tenuous at first sight.

How do underlying factors account for the term premium variations? Figure 4 shows the average contributions from each factor on the term premia (ignoring the constant term). The breakdown suggests both similarities and differences about the relative importance of drivers of term premia across regions. Contributions from $pc^1$ and $pc^2$ consistently explain a large part of overall term premium variations, and show some similarities across regions. As argued below, much of this can be explained by correlation in fundamentals working through monetary policy, and should not be necessarily interpreted as financial contagion at work. On the other

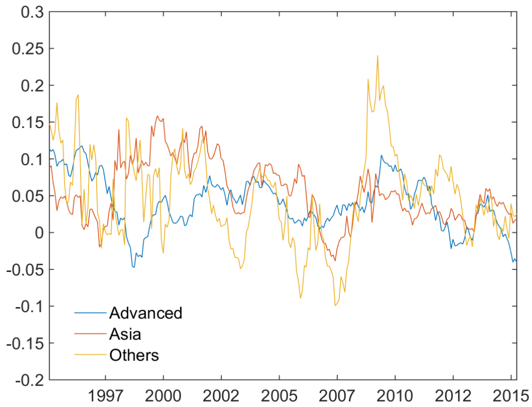



**Figure 3:** Average term premia across regions

hand, contribution from the unspanned global pricing factor appears to be more varied. For emerging market economies, much of term premium fluctuations is explained by the unspanned global factor, especially over the last decade. In advanced economies, the contribution of the unspanned global factor in explaining recent term premium variations is significantly smaller.

### 3.5 Controlling for monetary policy and fundamentals

We now describe step 2 of the procedure. It has become increasingly recognised that monetary policy can influence term premia via the risk-taking channel (see Borio and Zhu (2012)).[8] Domestic fundamentals, such as macroeconomic outlook, may also affect how investors price risks. Variations in term premia arising from these two sources are not related to global financial contagion, and will now be filtered out.

The first principal component of the yield curve is often associated with the level of interest rates. This level factor is thus clearly correlated with the stance of monetary policy, and given its significance, suggests a non-negligible risk-taking channel. Monetary policy also influences the slope of the yield curve, both directly at the short end of the curve and at the long end through expectations of future policy. This points towards a risk-taking channel via $pc^2$. As Figure 5 shows, the first two principal components indeed compete in capturing the effects of monetary policy, though the first component is typically more highly correlated with the short-term interest rate. Other factors have a more tenuous logical link to the risk-taking

[8] Here we equate monetary policy stance with the short-term interest rate. For countries that use exchange rates as the policy instruments, the consequences for term premia are still felt through their implied short-term rates. Thus we interpret these central banks as exercising their policy autonomy by volunteering to fix their exchange rates, and choosing to set their short-term rates similarly to others.

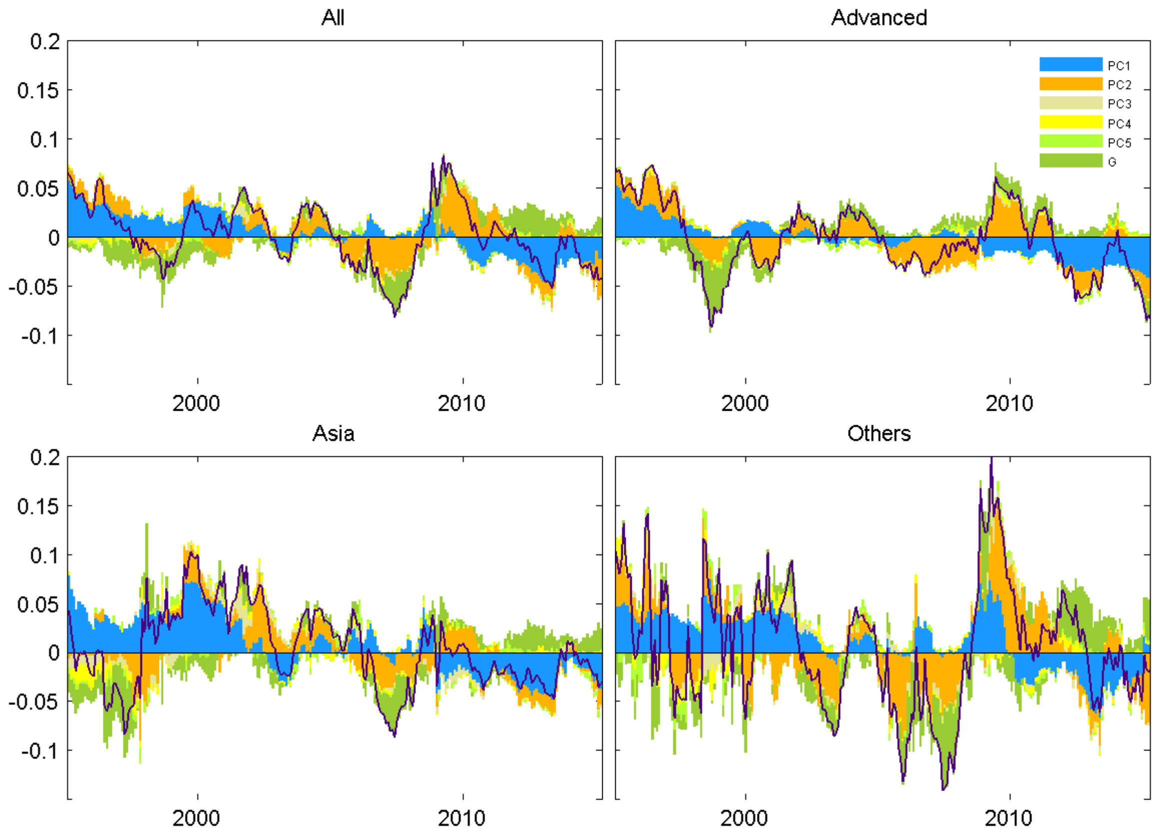



**Figure 4:** Contributions to term premia

channel. One would also expect a progressively lower correlation with the short-term interest rate, as each of these factors is orthogonal to the preceding ones.

We proceed to filter out the influence of monetary policy from each determinant of the term premium, factor by factor. For each country, we regress each factor $pc^1_{c,t}, pc^2_{c,t}, ..., pc^5_{c,t}$ as well as $G^y_{c,t}$ on a constant and the monetary policy variable, the one-year yield $y^1_{c,t}$. The residual from the regression constitutes the "restricted" factor cleansed from the monetary policy influence:

$$\widetilde{pc}^{i,M}_{c,t} \equiv pc^i_{c,t} - \widehat{pc}^{i,M}_{c,t} \qquad (3.13)$$

for $i = 1, 2, ..., 5$, where $\widehat{pc}^{i,M}_{c,t}$ is the fitted value of the regression $pc^i_{c,t}$ on $M_{c,t} = [1, y^1_{c,t}]$, taking into account only coefficients that are significant at the 5 percent level. Insignificant coefficients

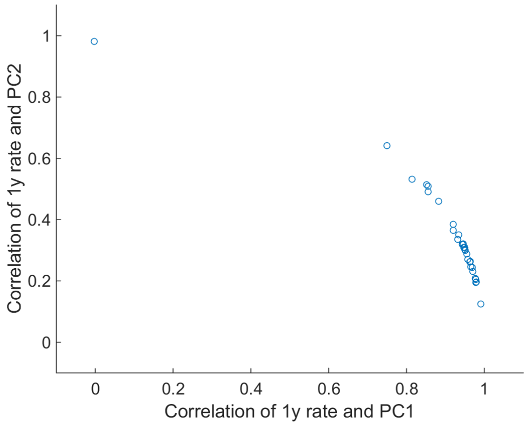



**Figure 5:** Correlation between first two factors and monetary policy

are restricted to zero. A similar procedure is followed for $G^y_{c,t}$, resulting in a restricted version

$$\widetilde{G}^{y,M}_{c,t} \equiv G^y_{c,t} - \widehat{G}^{y,M}_{c,t} \tag{3.14}$$

of the unspanned global factor.

The set of control variables may be expanded to include macro fundamentals, specifically expected growth and inflation. In this alternative procedure, we regress each of $pc^1_{c,t}, pc^2_{c,t}, ..., pc^5_{c,t}$ and $G^y_{c,t}$ on a vector $F_{c,t} = [1, y^1_{c,t}, GDP^{con}_{c,t}, CPI^{con}_{c,t}]$, where $GDP^{con}_{c,t}$ and $CPI^{con}_{c,t}$ are the consensus forecasts of GDP growth and CPI inflation over the next 12 months. These regressions give fitted values $\widehat{pc}^{i,F}_{c,t}$ and $\widehat{G}^{y,F}_{c,t}$, which can be used to construct the restricted factors cleansed of fundamentals (again, keeping only significant variables):

$$\widetilde{pc}^{i,F}_{c,t} \equiv pc^i_{c,t} - \widehat{pc}^{i,F}_{c,t} \tag{3.15}$$

$$\widetilde{G}^{y,F}_{c,t} \equiv G^y_{c,t} - \widehat{G}^{y,F}_{c,t} \tag{3.16}$$

The restricted term premia thus controls for domestic fundamentals, comprising both the risk-taking channel and the influence of the domestic macroeconomic outlook.

**Table 5:** Influence of monetary policy and fundamentals on term premia factors

| | Monetary policy | | | | | | Fundamentals | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $pc^1$ | $pc^2$ | $pc^3$ | $pc^4$ | $pc^5$ | $G^y$ | $pc^1$ | | | $pc^2$ | | | $pc^3$ | | | $pc^4$ | | | $pc^5$ | | | $G^y$ | | |
| | | | | | | | $y^1$ | GDP | CPI | $y^1$ | GDP | CPI | $y^1$ | GDP | CPI | $y^1$ | GDP | CPI | $y^1$ | GDP | CPI | $y^1$ | GDP | CPI |
| US | 0.027 | 0.001 | | | | | 0.025 | -0.003 | 0.009 | 0.003 | 0.002 | -0.006 | -0.000 | -0.000 | 0.001 | | | 0.000 | | -0.000 | -0.000 | | -0.012 | |
| GE | 0.030 | 0.002 | | | | | 0.030 | -0.003 | -0.007 | 0.002 | 0.001 | 0.002 | -0.000 | 0.000 | 0.001 | -0.000 | | | 0.000 | -0.000 | 0.000 | -0.007 | 0.026 | -0.057 |
| JP | 0.029 | 0.001 | | | | | 0.030 | | -0.002 | | | 0.002 | 0.000 | | -0.000 | | 0.000 | -0.000 | | -0.000 | | | -0.012 | -0.022 |
| UK | 0.025 | 0.001 | | | | | 0.023 | -0.003 | | 0.003 | 0.001 | | | | 0.002 | 0.000 | -0.001 | | | | | | -0.009 | -0.012 |
| CA | 0.028 | 0.002 | | | | | 0.029 | | | 0.001 | | | | | 0.001 | 0.000 | -0.000 | | -0.000 | 0.000 | | | 0.009 | -0.040 |
| AU | 0.030 | 0.001 | | | | | 0.033 | -0.006 | -0.004 | | 0.003 | 0.001 | -0.000 | 0.000 | 0.001 | -0.000 | 0.000 | 0.000 | | | | | 0.033 | -0.026 |
| NZ | 0.022 | 0.002 | | | | | 0.022 | | | 0.001 | | | | | | | 0.000 | 0.000 | | | | | | -0.051 |
| CH | 0.029 | 0.002 | 0.000 | | | | 0.022 | -0.007 | 0.021 | 0.005 | 0.005 | -0.011 | | -0.001 | 0.001 | | 0.000 | | | | | | 0.015 | |
| SE | 0.031 | 0.001 | | | | | 0.033 | -0.004 | -0.009 | | 0.002 | 0.004 | | -0.001 | | 0.000 | | -0.000 | | -0.000 | | 0.017 | 0.023 | -0.076 |
| NO | 0.025 | 0.002 | | | | | 0.026 | 0.005 | | 0.002 | -0.002 | | -0.000 | -0.000 | 0.001 | | 0.000 | | | | | -0.008 | 0.021 | 0.054 |
| HK | 0.028 | 0.001 | | | | | 0.029 | | -0.003 | 0.001 | -0.001 | 0.001 | | 0.000 | -0.000 | | | -0.000 | | | 0.000 | | 0.011 | |
| KR | 0.025 | 0.003 | | | | | 0.026 | -0.004 | 0.010 | 0.003 | 0.002 | -0.004 | | | | | | | | | | | 0.015 | -0.023 |
| SG | 0.028 | 0.004 | 0.000 | | | | 0.025 | | -0.006 | 0.005 | | 0.002 | 0.001 | -0.000 | 0.001 | | -0.000 | 0.000 | | | | | 0.017 | 0.012 |
| TW | 0.030 | 0.001 | | | | | 0.030 | 0.003 | -0.009 | 0.001 | -0.001 | 0.006 | 0.000 | -0.000 | | | 0.000 | | -0.000 | 0.000 | -0.000 | | | -0.032 |
| ID | 0.032 | 0.001 | | | | | 0.033 | -0.014 | -0.006 | | 0.006 | 0.002 | | | | | | | 0.000 | | -0.000 | | 0.042 | 0.018 |
| MY | | 0.014 | -0.001 | | | | -0.006 | 0.003 | | 0.013 | | | | | | -0.001 | 0.000 | 0.000 | 0.000 | -0.000 | | 0.110 | | -0.108 |
| PH | 0.032 | 0.001 | | | | | 0.031 | -0.013 | -0.004 | 0.001 | 0.007 | | | 0.001 | | | | | -0.000 | | 0.001 | | 0.020 | |
| TH | 0.025 | 0.007 | 0.000 | | | | 0.024 | 0.003 | | 0.008 | -0.001 | | 0.001 | | -0.000 | | | | | | | -0.041 | | 0.038 |
| CN | 0.022 | 0.004 | | | | | 0.021 | | | 0.004 | | | | | | | -0.001 | | | | | 0.027 | 0.066 | |
| IN | 0.027 | 0.001 | | | | | 0.025 | | 0.003 | 0.002 | 0.001 | -0.001 | 0.001 | -0.001 | -0.001 | | 0.000 | -0.000 | | | -0.000 | 0.015 | 0.016 | -0.029 |
| CL | 0.015 | 0.004 | | | | | 0.010 | 0.005 | 0.010 | 0.008 | -0.003 | -0.007 | 0.001 | -0.001 | | | 0.000 | | 0.000 | -0.000 | -0.000 | | | |
| CO | 0.025 | 0.002 | | | | | 0.010 | | 0.050 | 0.009 | | -0.024 | -0.002 | 0.002 | 0.004 | 0.001 | -0.001 | -0.002 | 0.000 | | -0.001 | | | |
| MX | 0.024 | 0.002 | | | | | 0.024 | -0.002 | 0.016 | 0.002 | 0.001 | -0.010 | | | | | 0.000 | | | | -0.001 | | | -0.032 |
| PE | 0.024 | 0.002 | | | | | 0.023 | | 0.005 | 0.002 | 0.002 | -0.005 | | -0.001 | 0.001 | | 0.001 | | | 0.001 | | | 0.023 | -0.087 |
| CZ | 0.028 | 0.002 | | | | | 0.034 | -0.005 | -0.004 | -0.001 | 0.003 | 0.002 | | -0.000 | | -0.000 | | 0.000 | | | | | 0.026 | -0.038 |
| HU | 0.021 | 0.002 | | | | | 0.023 | -0.005 | -0.003 | | 0.004 | | -0.001 | -0.000 | 0.001 | | | | | | | | 0.014 | |
| IL | 0.026 | 0.001 | | | | | 0.028 | -0.008 | 0.006 | | 0.005 | -0.003 | | | | -0.000 | 0.001 | 0.001 | | | | | | -0.033 |
| PL | 0.023 | | | | | | 0.021 | | 0.003 | 0.003 | | -0.005 | -0.001 | | 0.003 | | 0.000 | | | | | | 0.034 | -0.014 |
| RU | 0.029 | 0.005 | 0.001 | | | | 0.005 | -0.019 | 0.012 | 0.013 | 0.007 | -0.003 | 0.002 | 0.001 | -0.001 | | | -0.001 | | | | | 0.014 | 0.018 |
| ZA | 0.026 | 0.001 | | | | | 0.025 | | 0.004 | 0.002 | 0.003 | | | -0.001 | | | -0.001 | | | -0.001 | | 0.003 | 0.034 | -0.010 |
| TR | 0.028 | 0.001 | | | | | 0.029 | -0.008 | | | 0.003 | | | -0.001 | | | 0.000 | -0.001 | | -0.000 | | | 0.009 | -0.025 |

**Note:** The table shows estimates of regressing each pricing factor $pc_1, pc_2, ..., pc_5, G^y$ on the short-term interest rate $y^1$ (columns 1 to 6) and on a broader set of fundamentals including short-term rate and consensus forecasts of GDP and CPI 1-year ahead (columns 7-24). Statistically insignificant estimates are not shown.

Table 5 reports the estimates obtained from these regressions, suppressing statistically insignificant coefficients. For the conditioning set $M_{c,t}$, the statistical significance vanishes almost uniformly for the third factor onwards, consistent with the priors that much of the policy effects should already be picked up by the first two factors. Even with a broader control $F_{c,t}$, the effect of monetary policy continues to be felt mainly through $pc^1$ and $pc^2$. On the other hand, the two macro variables are significantly related to almost all factors. Notably, there is a significant and sizeable relationship between the fundamental variables and the unspanned global factor.

The restricted factors constitute two new sets of pricing factors $\widetilde{x}_{c,t}^M \equiv [\widetilde{pc}_{c,t}^{1,M}, ..., \widetilde{pc}_{c,t}^{5,M}, \widetilde{G}_{c,t}^{y,M}]'$ and $\widetilde{x}_{c,t}^F \equiv [\widetilde{pc}_{c,t}^{1,F}, ..., \widetilde{pc}_{c,t}^{5,F}, \widetilde{G}_{c,t}^{y,F}]'$. For each of these, a restricted term premium can be derived using the same pricing coefficients as in equation 3.12, to get:

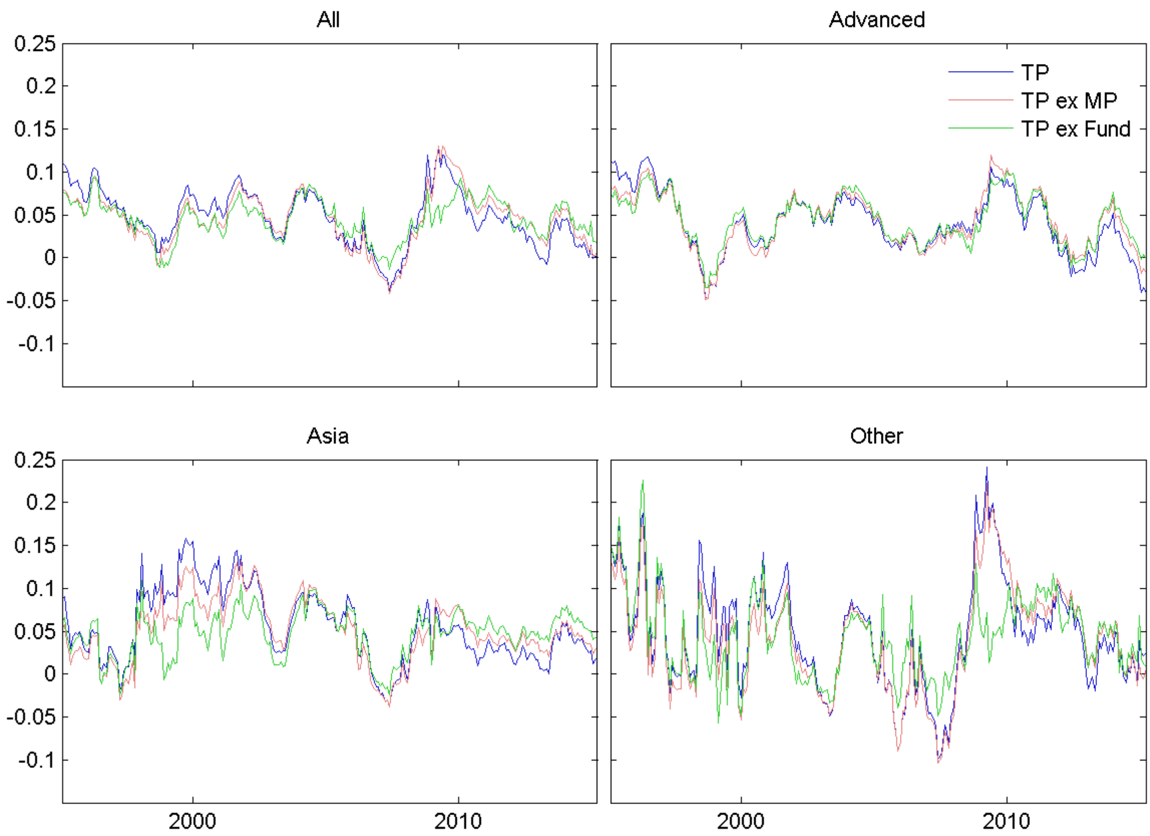
$$\widetilde{tp}_{c,t}^M = \hat{\beta}_{c,s}^{10}(\hat{\beta}_c' \widetilde{x}_{c,t}^M) \tag{3.17}$$

$$\widetilde{tp}_{c,t}^F = \hat{\beta}_{c,s}^{10}(\hat{\beta}_c' \widetilde{x}_{c,t}^F) \tag{3.18}$$

These restricted term premia are counterfactual series after controlling for potentially correlated monetary policies and fundamentals. They are depicted in Figure 6 along with the original term premia, in terms of regional averages. The average cyclical pattern of term premia appears to be relatively little affected by the step-2 conditioning, though the differences are more noticeable with a broader set of controls $F_{c,t}$ and for emerging market economies. Figure 7 shows that contributions to the differences come primarily through the first principal component followed by the second, but any differences in contributions become negligible for the last three local factors (only contributions from the third factor are shown). Contributions from the unspanned global factor also change materially after controlling for macro fundamentals, even if controlling for monetary policy alone does not. These average effects, of course, are silent on the dispersion and within-group synchronicity of term premia, which we will come back to.

### 3.6 Financial contagion

In this final step, we derive the global financial contagion index as the first principal component of the (normalised) term premia $tp_{c,t}$ and, separately, two more indices corresponding to the two restricted versions $\widetilde{tp}_{c,t}^M$ and $\widetilde{tp}_{c,t}^F$. The global financial contagion indices are common factors positively correlated with the underlying term premia. Thus, a higher financial contagion index



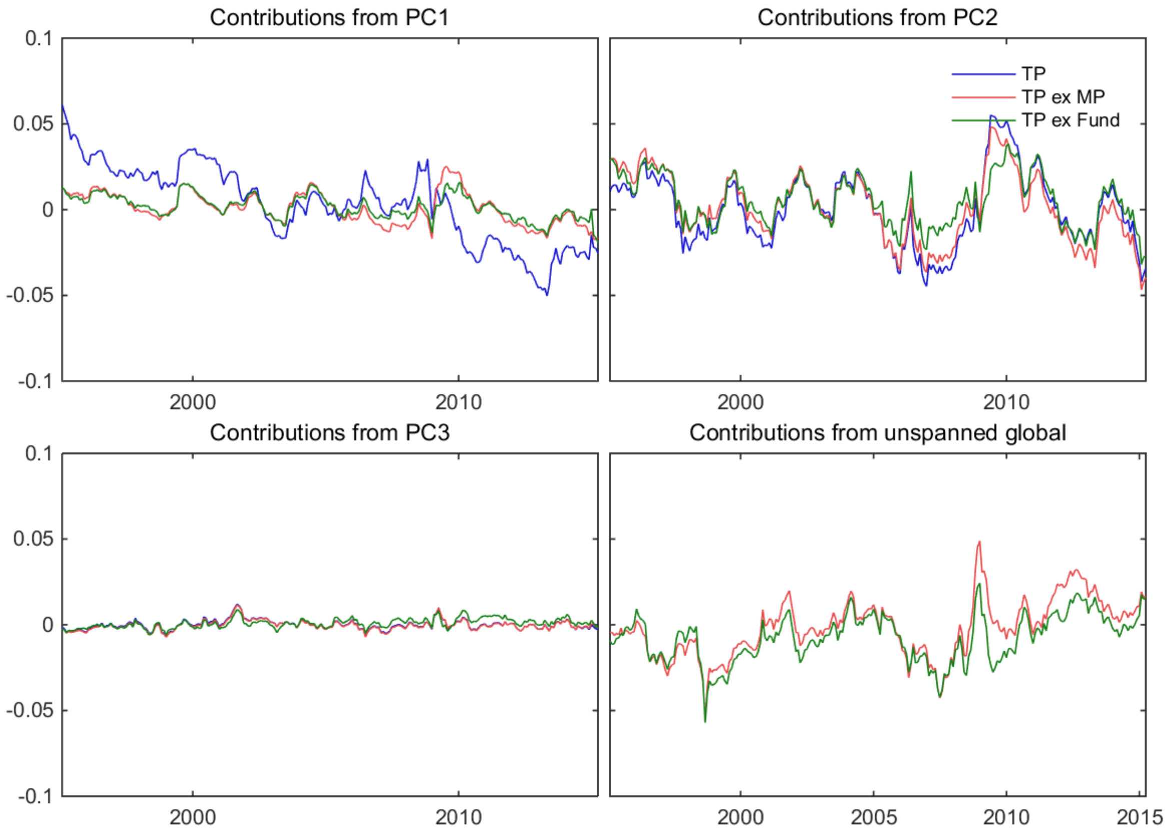

Note: The series "TP", "TP ex MP" and "TP ex Fund" are cross-country averages of, respectively, term premia ($tp_{c,t}$), term premia orthogonal to monetary policy ($\widetilde{tp}^M_{c,t}$) and term premia orthogonal to fundamentals ($\widetilde{tp}^F_{c,t}$).

**Figure 6:** Average term premia and restricted term premia

suggests generally higher term premia, and vice versa.

Principal component analysis requires a balanced panel of data, constraining the time-series of contagion index to the lowest common denominator of available data. Narrowing the set of countries would extend the global financial contagion series, but at the cost of less cross-sectional information to exploit. We experiment with three choices of country sets, including 14 countries (available data from Jan 1995 onwards), 21 countries (from Sep 2001), and all countries (from Jan 2007). It turns out that the resulting financial contagion indices behave very similarly over alternative country samples for all three models (Figure 8). Thus, the cost of using the narrower set of countries appears to be limited, and we will focus on the global financial contagion index based on 14 countries, unless stated otherwise.

The global financial contagion indices are quite robust to the choice of models. As Figure 9 (left panel) shows, the three models based on $tp_{c,t}$, $\widetilde{tp}^M_{c,t}$ and $\widetilde{tp}^F_{c,t}$ produce very similar contagion series. The result supports the notion that the core common driver of international term premia

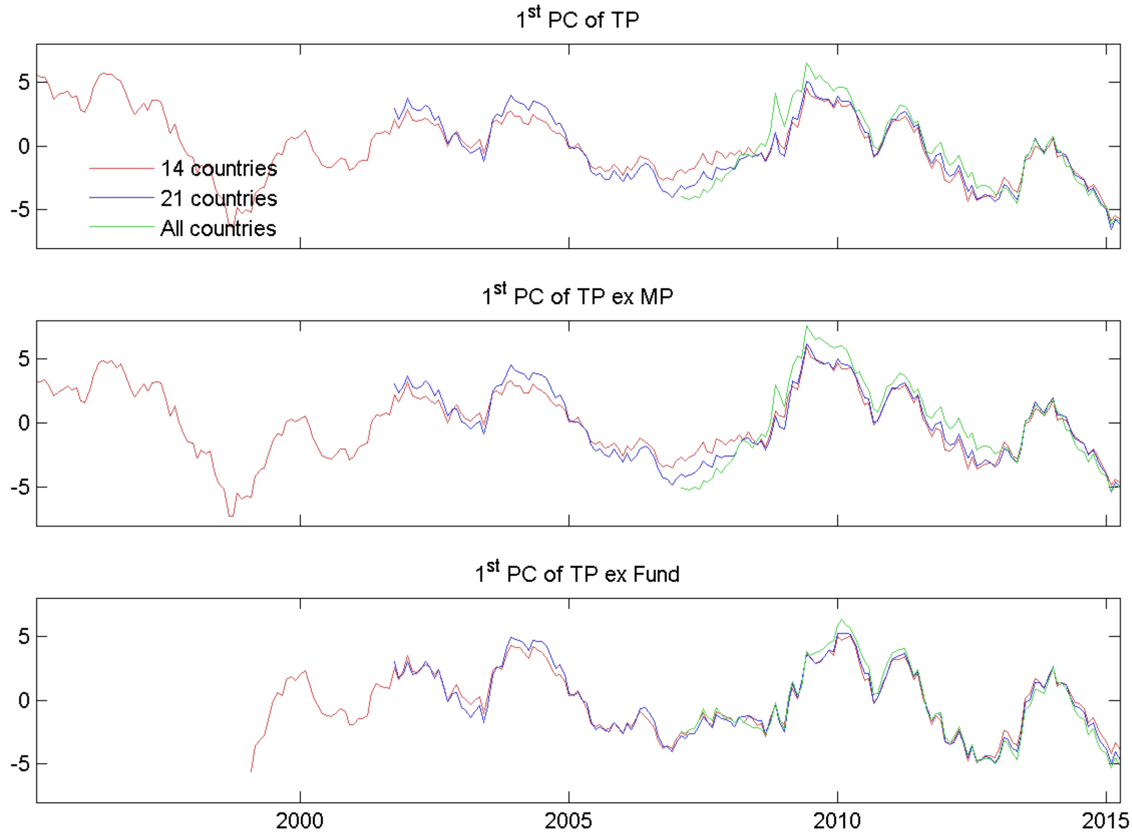



Note: Figures show contributions from selected factors to term premia (labeled “TP”), the term premia orthogonal to monetary policy (“TP ex MP”) and term premia orthogonal to fundamentals (“TP ex Fund”).

**Figure 7:** Contributions to term premia from factors under unrestricted and restricted models

is not due to correlated fundamentals and may be more related to financial contagion. The result may also be indicative of limited endogeneity problems during step 2, so that conditioning on different domestic variables does not appear to materially affect the identification of the financial contagion factor.

It is interesting to compare our financial contagion index with other measures of global risk appetite and other risky asset returns. In Figure 9 (right panel), we plot our contagion index based on model $\widetilde{tp}^{M}_{c,t}$ against the VIX and the global common factor in Miranda-Agrippino and Rey (2014) (MAR index, in short), which is calculated from a broad range of risky asset returns. The correlation between our contagion index and the MAR index is 0.38, suggesting some relations between the global driver of the bond term premia and global risk appetite. But one could argue that this is not a strong correlation. On the other hand, our contagion factor is almost uncorrelated with the VIX (correlation = 0.01). Our index therefore seems to contain additional information about the nature of financial spillovers not captured by other



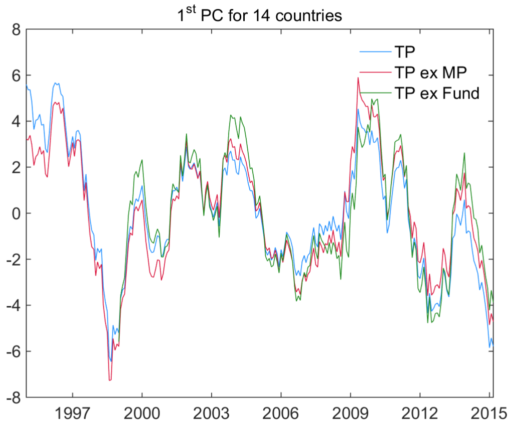

Note: Figures show, from top to bottom, the first principal component of countries' term premia ("1$^{st}$ PC of TP"), the first principal component of term premia orthogonal to monetary policy ("1$^{st}$ PC of TP ex MP") and the first principal component of term premia orthogonal to fundamentals ("1$^{st}$ PC of TP ex Fund").

**Figure 8:** Global contagion indices by sample groups

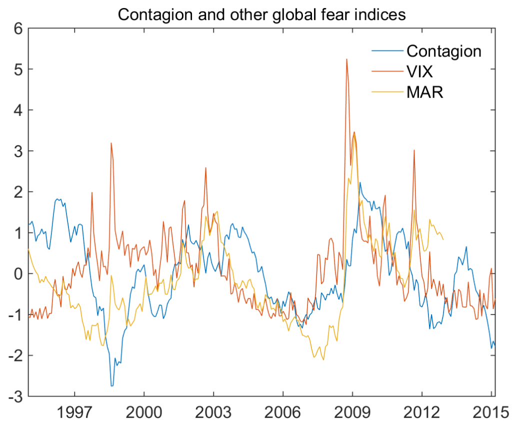
measures. In particular, since government bonds are under greater influence from monetary policy compared to other risky assets, our global financial contagion index may be a more relevant metric to gauge policy traction in the context of financial globalisation.

### 3.7 Reassessing the implications of global financial contagion

Armed with this new estimate of financial contagion, we can now reassess various issues regarding financial contagion. How much policy traction do countries have? Or equivalently, how sensitive are economies to swings in the financial contagion factor? How to compare/contrast our results with a high correlation in long-term yields? Has financial contagion become stronger in recent years, because of extraordinary monetary policies in advanced economies? How do term premia move with exchange rate changes? We now take up these questions in turn.




**(a)** Contagion by models




**(b)** Contagion and global risk appetite indices

**Figure 9:** Global financial contagion indices

### 3.7.1 How sensitive are countries to financial contagion?

The sensitivity to contagion can be measured as the proportion of term premium variation that can be explained by financial contagion. This variance decomposition is straightforward in principal component analysis. In a sample with $T$ periods and $N$ countries, let $F$ be the $T \times N$ matrix of $N-$principal components computed from $tp_{c,t}$. Denote the first column of $F$, which corresponds to the contagion factor, by $F_1$. Then there is an $N \times 1$ country-specific loading vector $\lambda_c$ such that $tp_c \equiv \{tp_{c,t}\}_{t=1}^{T}$ is given by

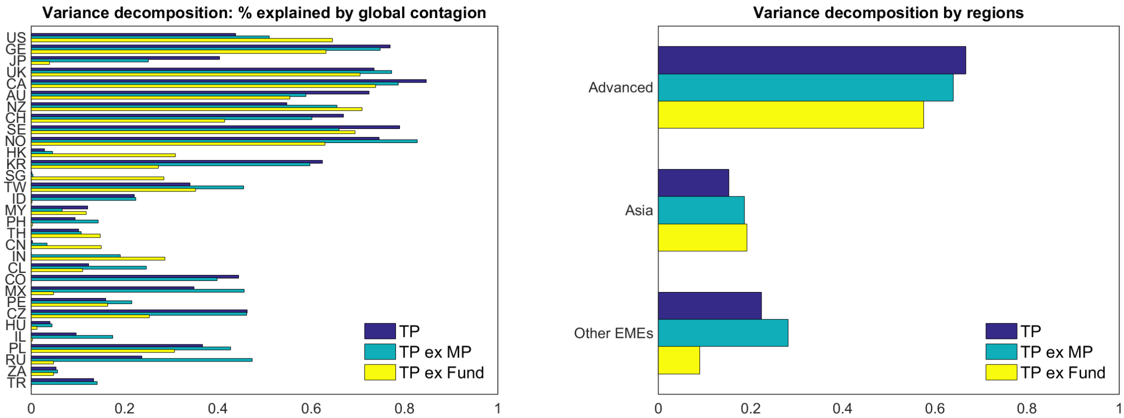
$$tp_c = F\lambda_c \tag{3.19}$$

where $\lambda_c$ is appropriately scaled by the standard deviation of $tp_{c,t}$. Let $\lambda_{1,c}$ be the first element of $\lambda_c$, namely the loading on the first principal component. The variance of $tp_{c,t}$ explained by the contagion factor is then given by

$$\frac{\mathrm{var}(F_1\lambda_{1,c})}{\mathrm{var}(F_1\lambda_{1,c}) + \mathrm{var}(tp_c - F_1\lambda_{1,c})} \tag{3.20}$$

The same decomposition can be applied to contagion factors based on the two restricted models $\widetilde{tp}_{c,t}^{M}$ and $\widetilde{tp}_{c,t}^{F}$.

Variance decomposition from all three models is shown in Figure 10 in detailed country breakdown, and in terms of regional averages. There is a striking differentiation across regions. In particular, the sensitivity to contagion is notably higher for advanced countries than emerg-




**(a)** By country **(b)** Regional averages

**Figure 10:** Variation of term premia explained by global contagion

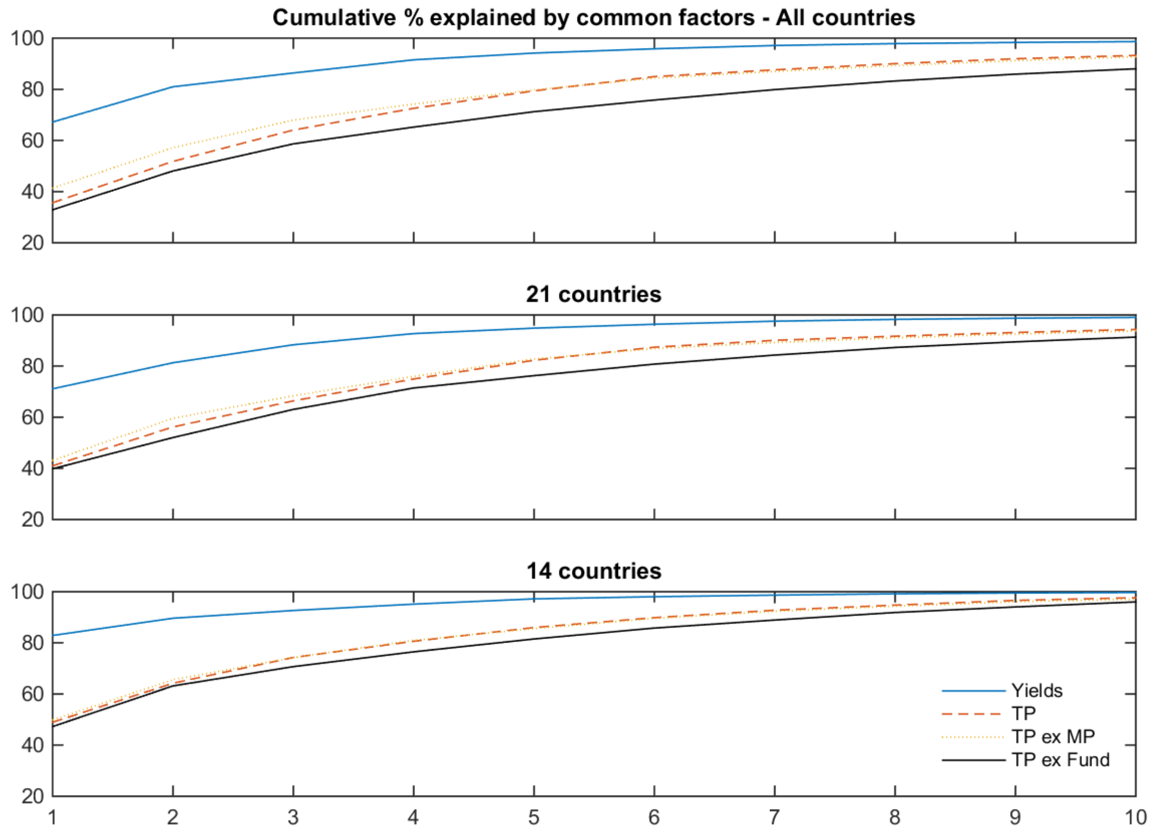
ing markets. Without step-2 conditioning, the contagion factor explains nearly 70 percent of variations in advanced economies' term premia on average, but only 15 percent and 22 percent in emerging Asia and other emerging market economies respectively. The order of magnitude is relatively robust to filtering out monetary policy and macro fundamentals. Controlling for fundamentals indicates a much lower sensitivity to contagion in other emerging economies and only a moderate decline for the advanced economies. Controlling for monetary policy alone suggests a slight increase in exposure to financial contagion for both emerging Asia and other emerging groups. The inter-regional differences remain large whichever model is considered.

Note that this does *not* imply that emerging markets are subject to less external shocks, simply that these shocks are more idiosyncratic. Part of this may be due to greater liquidity shocks, given less developed bond markets in these countries. Moreover, as we discuss below, even as emerging markets are less subject to common shocks, the type of external shocks that they face may pose more challenges for policy. Another possible explanation for greater susceptibility to common movements in term premia among advanced economies is the generally higher degree of financial openness and integration in these countries.[9]

### 3.7.2 How misleading are yield correlations?

High correlation in long-term yields is often associated with strong contagion (see Turner (2014) for example). The degree of such correlation can be seen in Figure 11, which plots cumulative

[9]In principles, greater financial integration can entail both costs and benefits, the latter of which include higher growth and better international risk sharing. See Rungcharoenkitkul (2012) for a discussion of the tradeoff and a measure of risk-sharing in the context of an affine term structure models.

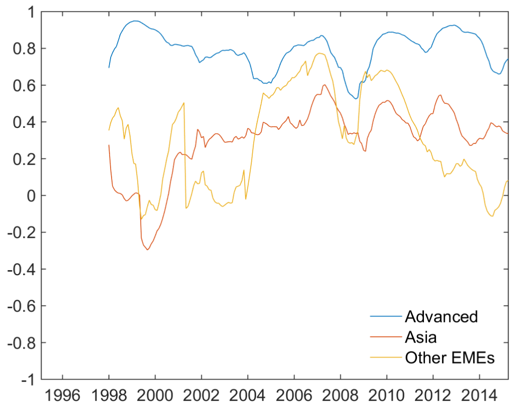



Note: Figure shows the percentage variations in 10-year yields and three definitions of term premia as a function of the top $n$ principal components used, where $n$ is on the horizontal axis.

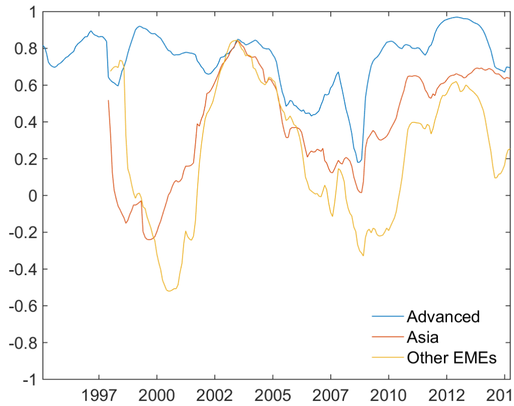
**Figure 11:** Percentage of term premium variations explained by principal components

percentage of cross-country variations in 10-year yields that can be explained by their principal components. The first factor alone can account for 70-80 percent of the total yield variations, depending on the set of countries included. Adding the second principal component lifts the percentage explained to 80-90 percent. It is tempting to conclude from this that financial contagion is the dominant single driver of international long-term yields.

Our results help quantify how misleading a high correlation of yields is. In Figure 11, we also plot the variations in $tp_{c,t}$, $\widetilde{tp}^{M}_{c,t}$ and $\widetilde{tp}^{F}_{c,t}$ that can be explained by their common factors. The first principal component, namely our global contagion factor, explains only 30-50 percent of the total variations in term premia. To explain 80 percent of all term premia variations, five or more principal components are required. The relevance of a single contagion factor in driving term premia is thus much weaker than suggested by yield correlation. Once fundamentals are accounted for, the influence of contagion weakens even further.




**(a)** Rolling correlation of TP ex MP with contagion




**(b)** Rolling correlation of 10-year yields with US Treasuries

**Figure 12:** Traction indices

### 3.7.3 Is financial contagion growing in strength?

Another widely held view is that extraordinary monetary policies adopted by key central banks have brought about more volatile capital flows and stronger financial spillovers. More powerful spillovers may be equated with stronger sensitivities of countries' term premia to global contagion factor, a hypothesis that we now test.

For each country, we construct a "traction index" as 3-year rolling correlation of its $\widetilde{tp}_{c,t}^{M}$ and the contagion factor. An increase in correlation would indicate growing sensitivities and lower policy traction. The result is shown in the left-hand panel of Figure 12, in terms of regional averages. It is evident that the sensitivities to contagion are consistently higher for advanced economies throughout the past two decades. Notwithstanding some variations over time, the traction indices are relatively stable in the sample. In fact, if anything, the sensitivities to global contagion have declined for non-Asian emerging markets over the past five years.

This represents another instance where simple correlations of bond yields could be misleading. The right-hand panel of Figure 12 shows the 3-year rolling correlation between individual countries' 10-year yields and US treasury 10-year yield. The marked and synchronised pickup in correlation over the last five years may be invoked as an evidence increased spillovers. But when considered in conjunction with results on the left panel, it becomes clear that much of the apparent correlation in yields may be due to correlated policy expectations rather than financial contagion.

### 3.7.4 How do term premia and exchange rates comove?

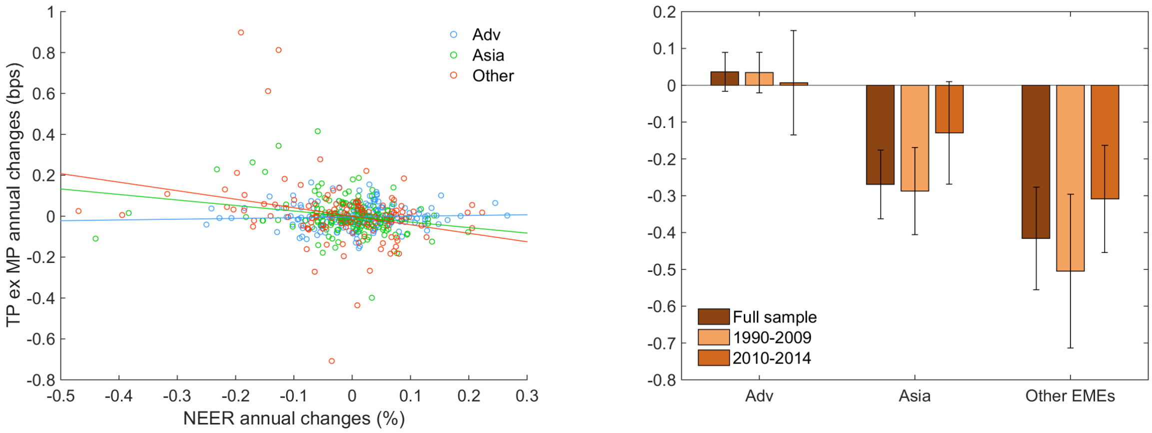
Exchange rates play a prominent role in the dilemma/trilemma debate. The interest rate parity condition offers one way to understand the interactions of interest rates and exchange rates in an integrated framework. Unfortunately, several difficulties arise when long-term interest rates are considered in this framework (for example as in Obstfeld (2015)). Because both long-term interest rates and exchange rates are endogenous, the condition alone is insufficient to pin down either variable. In contrast, in the conventional interest parity condition pertaining to short-term interest rates, rate differentials can be taken as exogenous given policy autonomy. The condition then becomes a theory of short-run exchange rate determination. The same assumption is no longer tenable in the case of long-term interest rates. It is also unclear that the parity constitutes a unique no-arbitrage condition: should expected exchange rate movements over the next 5 years be anchored against the 5-year bond yield differential or the difference in expected 5-year holding period returns on longer bonds?

In this paper, we avert these difficulties as we have relied on an independent method for describing the term premia dynamics. This allows us to investigate how term premia comove with exchange rates, and helps us shed light on the likely sources of nominal external shocks underlying the observed comovements.

The relationship between annual changes in nominal effective exchange rates and $\widetilde{tp}_{c,t}^{M}$ over the full panel sample is shown in a scatter plot in Figure 13 (left panel). In emerging Asia and other emerging markets, there is a significant negative relationship between the two: as exchange rates depreciate, the term premia tend to increase. This result is consistent with the portfolio balance view, and points to joint external nominal shocks as an important driver of both bond premia and exchange rates in emerging economies. For example, portfolio balancing shocks that prompt outflows from an emerging economy would tend to simultaneously widen term premia and cause a currency depreciation.

Meanwhile, for advanced economies there is basically no relationship between term premia and exchange rates. An implication is that the financial contagion factor, on which advanced economies' term premia load heavily, is little correlated with the underlying shocks driving exchange rates. For advanced economies, term premia shocks are common but exchange rate shocks are varied.

Thus while emerging market countries are less influenced by financial contagion, the nature of idiosyncratic shocks that they are subject to may be more challenging. For example, portfolio



**(a)** Scatter plot of annual changes **(b)** Correlation

**Figure 13:** Term premia and exchange rates

inflows that simultaneously push down term premia and cause the currency to appreciate may exacerbate financial stability concerns as well as constrain the export sector's contribution to growth. For countries at an adanced stage of the financial cycle facing a growth slowdown, such shocks pose difficult trade-offs for policy.

Has the nature of nominal shocks changed over the past five years? In particular, have quantitative easing policies accentuated the portfolio balance shocks? Figure 13 (right panel) suggests that this is not the case. In fact, the subsample estimates point to lower correlation between term premia and exchange rates over the last five years. Again our results paint a more nuanced picture than often presumed about the impact of external influence on domestic financial conditions in emerging markets.

# 4 Broader considerations

While the focus of this paper has been on bond yields, the traction of monetary policy obviously depends also on the broader workings of financial and credit markets. Even if bond yields are subject to sizeable financial contagion, for example, the implications for the real economy depends on how important long-term bond yields are for domestic credit and activity. In many emerging markets, there are at least two features that potentially limit the economic repercussions of spillovers in bond yields. First, fixed-rate loans are much less prevalent than floating-rate ones. This implies that the direct impact of changes in long-term bond yields is somewhat muted. Second, firms and households are often more reliant on banks than on capital markets for their funding needs. Again, the pass-through from changes in bond yields to bank loan rates is more tenuous.

At the same time, there is a basic mechanism underlying capital flows that naturally limits their influence on domestic credit. In an economy where payments are settled in bank deposits (money), capital flows are underpinned by the transfer of ownership of bank deposits. Non-residents wishing to acquire local currency claims need first to obtain local purchasing power (bank deposits) from somebody else. Non-residents extinguishing their claims on a country will be selling local purchasing power to somebody else. Contrary to popular belief, capital inflows and outflows generally do not involve “money” coming in and going out of a country. The money (deposits) never leaves the country, ownership simply changes hands.

A key implication is that capital inflows in and of themselves do not create new purchasing power but only reshuffle its ownership. New purchasing power can only be created through domestic banks’ extension of new loans. More generally, gross domestic balance sheets can expand only through the issuance of more domestic assets. Capital inflows affect domestic financial conditions not through “(new) money flowing into the country” that ease some quantitative constraint but through the pricing of credit and asset prices. At the end of the day, the terms and conditions with which agents obtain credit domestically will be subject to the direct influence of local supverisory agencies.

That said, one area where the traction of domestic policy has clearly been compromised is in the increasing use of foreign currency funding. The prevalence internationally of US dollar credit, for one, creates a direct link between movements in US interest rates and financial conditions abroad. Here it is striking that more than a third of global dollar lending by banks to non-banks now takes place outside US borders (McCauley et al. (2015)). The rapid rise in offshore foreign currency bond issuance by emerging market firms and banks is the latest manifestation of this channel of direct exposure to foreign financing conditions (Shin (2013)). As the experience of the US dollar liquidity shortage during the global financial crisis vividly illustrated, one outcome of the heavy reliance on foreign currency funding is that central banks’ ability to backstop their financial systems can be severely compromised. In such situations, monetary policy traction is clearly diminished.

## 5 Conclusion

Has monetary policy lost traction in an era of increased financial globalisation? Our short answer is no. Central banks, by and large, do retain substantial influence over local financial conditions. In addition to their impact on the path of expected short rates, monetary policy appears to also have a significant influence on term premia. This conclusion does not preclude the possibility that the degree of *monetary dependence* may be large. Increased economic and financial linkages across economies do imply greater comovement in asset prices and more rapid transmission of shocks. But a sizeable component of such comovements reflect common fundamentals. We have argued that stripping these out yields a measure of spillovers that is more relevant for the assessment of how policy trade-offs are affected. At the end of the day though, what matters is how financial globalisation has altered such trade-offs, and hence, the set of attainable outcomes. Going forward, research that focus directly on the link between financial globalisation and outcomes of goal variables such as inflation, output, and financial stability, is needed to provide a basis for evaluating the appropriateness of policy regimes and to investigate possible adjustments.

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# Appendix A Data

## A.1 Zero-coupon yields

The end-of-month zero-coupon yields of local-currency government bonds are obtained from Bloomberg for 31 countries, including 10 advanced and 21 emerging market economies (10 of which in Asia). Maturities of 3-month, 6-month, and all annual yields up to 10-year are collected. The coverage extends to March 2015 for all countries, while starting points vary; see details in Table 6. For advanced economies, the yield data are available at least from December 1994.

Bloomberg calculates zero-coupon curves by performing linear interpolations to put the par coupon curve into a canonical form, consisting of 60-equally spaced 6-month intervals, going to 30-year maturity. The canonical coupon yields are then converted to bond-equivalent yields, and stripped into a canonical spot curve, specified in terms of bond-equivalent yields. Linear interpolations are performed to produce bond-equivalent spot yields at the desired maturity points (3-month, 6-month, yearly up to 10-year, 15-year, 20-year, 25-year and 30-year).

## A.2 Consensus forecasts

We collect consensus forecasts of GDP and CPI inflation from Consensus Economics. We ideally want, for each month, expected growth and inflation over the next 12 months. However, Consensus Economics conducts surveys on annual growth and inflation for current and next calendar years. A proxy is calculated from a simple linear interpolation between the two numbers, e.g. for January full weight is attached to current-year forecasts, for February a weight of 11/12 is applied to current-year forecasts and 1/12 is applied to next-year forecasts and so on.

For some countries in the "other EMEs" set and early on in the sample, consensus forecasts are available only bimonthly. We fill the gaps by computing averages of the numbers in the preceding and subsequent months. For the United Kingdom, consensus forecasts of CPI inflation are not available before 2004 (expectations of retailed price index were surveyed instead). For 1999-2003, we compute a proxy based on the euro area survey numbers, mean-adjusted to match the difference in means observed in subsequent period.

**Table 6:** Zero-coupon yields data

| Country | Country code | Country group | Available from |
|---|---|---|---|
| United States | US | Advanced | Jan 1990 |
| Germany | GE | Advanced | Dec 1994 |
| Japan | JP | Advanced | Jan 1990 |
| United Kingdom | UK | Advanced | Dec 1994 |
| Canada | CA | Advanced | Dec 1994 |
| Australia | AU | Advanced | Dec 1994 |
| New Zealand | NZ | Advanced | Dec 1994 |
| Switzerland | CH | Advanced | Dec 1994 |
| Sweden | SE | Advanced | Dec 1994 |
| Norway | NO | Advanced | Dec 1994 |
| Hong Kong | HK | Emerging Asia | Dec 1994 |
| Korea | KR | Emerging Asia | Nov 2002 |
| Singapore | SG | Emerging Asia | Dec 1994 |
| Taiwan | TW | Emerging Asia | Mar 1999 |
| Indonesia | ID | Emerging Asia | May 2003 |
| Malaysia | MY | Emerging Asia | Sep 2001 |
| Philippines | PH | Emerging Asia | Jun 1996 |
| Thailand | TH | Emerging Asia | Dec 1994 |
| China | CN | Emerging Asia | Apr 2004 |
| India | IN | Emerging Asia | Nov 1998 |
| Chile | CL | Other EMEs | Sep 2005 |
| Colombia | CO | Other EMEs | Apr 2006 |
| Mexico | MX | Other EMEs | Aug 2003 |
| Peru | PE | Other EMEs | May 2006 |
| Czech Republic | CZ | Other EMEs | Dec 2000 |
| Hungary | HU | Other EMEs | Mar 2001 |
| Israel | IL | Other EMEs | Mar 2005 |
| Poland | PL | Other EMEs | Mar 1998 |
| Russia | RU | Other EMEs | Jan 2007 |
| South Africa | ZA | Other EMEs | Jan 1995 |
| Turkey | TR | Other EMEs | Apr 2005 |