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GLOBAL FACTORS, INTERNATIONAL SPILLOVERS, AND THE TERM STRUCTURE OF INTEREST RATES: NEW EVIDENCE FOR ASIAN COUNTRIES

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"Global Factors, International Spillovers, and the Term Structure of Interest Rates: New Evidence for Asian Countries"

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Abstract

This paper provides new evidence about the role of common global factors exploring the existence of structural breaks in the long-run trend of the term structure and analyzes the spillover effects from unconventional monetary policies recently implemented by major industrialized countries. For a panel of four Asian economies (Malaysia, Philippines, Singapore, South Korea), we show that, accounting for the role of global liquidity factors, parameters restrictions associated with the EHTS are not rejected, even after a regime-shift occurring at the end of 2005, hence supporting an extended weak version of the "Liquidity Premium Theory". We also document relevant discrepancies in the short-run dynamics of long-term interest rates, which are strictly related to some structural differences between these Asian countries in terms of the "impossible trinity" between monetary independence, financial openness and exchange rate stability.

Keyword: *Expectation Hypothesis of the Term Structure, Global Interest Rates, Global Liquidity, Asian Emerging Markets, Unconventional Monetary Policy.*

JEL classification: *E43, E52, G12, G15*

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1 INTRODUCTION

Understanding the forces that shape the term structure of interest rates is an important research topic, lying at the intersection of a large amount of macroeconomics and finance literature. The benchmark theoretical model in this area is the Expectations Hypothesis of the Term Structure (EHTS), which relies on an arbitrage condition assuming homogeneity of financial assets in all respects except in the term to maturity, rational expectations of agents, and the absence of relevant transaction costs or taxes. The strong version of the EHTS (sometimes defined as the “Pure Expectations” theory) assumes risk neutrality, and postulates that the return on a long-term financial asset is equal to the average of current and expected short-term interest rates over the corresponding maturity. The weak version of the EHTS (sometimes defined as the “Liquidity Premium” theory) relaxes the risk neutrality assumption, and allows for a constant risk premium in long-term interest rates as a compensation for not holding more liquid financial instruments. This term premium component is assumed to be maturity-specific (and increasing in the time to maturity) but time-invariant.

Assessing the empirical support for the EHTS is important for various reasons. First, if the EHTS holds, the yield curve provides useful information to extract market expectations about future short-term interest rates. A further relevant implication is related to monetary policy. The long-run equilibrium relationship implied by this theory is crucial to evaluate the effectiveness of the transmission mechanism of monetary policy. The standard modern approach to monetary policy relying on inflation targeting assumes in fact that the Central Bank controls a short-term policy rate, and that monetary impulses are transmitted to the real sector through the no arbitrage long-run equilibrium condition implied by the EHTS (Bernanke & Blinder (1992), Clarida , et al. (1999)). Note, moreover, that in a zero-lower bound environment, the EHTS provides a sound rationale to commit to an expansionary monetary policy for an extended time-period, eventually complementing this policy with large-scale asset purchases to lower risk premia at longer maturities. Last but not least, the validity of the EHTS has relevant implications for various financial management issues involving both the private sector (portfolio allocation choices, hedging of interest rate risk) and the public sector (accurate management of public debt through optimal selection of debt instruments at different maturities).

Recent applied research exploring international bond yield structures has identified two macroeconomic channels which apparently display an important role in shaping the term structure of interest rates both in industrial and in emerging market economies:

1. Besides domestic country-specific factors, the dynamics of international term structures is significantly affected by common global factors, related to the pattern of macroeconomic fundamentals;
2. The unconventional monetary policies initiated by the US Fed in 2008, namely forward guidance about future interest rates and large-scale asset purchases, extended their effects well beyond US financial markets, prompting large international spillover effects on long-term interest rates.

The former channel is strictly related to Diebold, et al. (2008) seminal paper. These authors extend the yield curve model of Nelson & Siegel (1987) and Diebold & Li (2006) to a multi-country framework where each country's yield curve reflects both country-specific factors and global level and slope factors. Applying the above framework to a large data set of government bond yields of major industrialized countries, Diebold, et al. (2008) extract global factors, document that they account for a large fraction of the variation in country yields, and detect a close relationship between global factors dynamics and that of some macroeconomic fundamentals (inflation and real output). Quite interestingly in the perspective of the present paper (which explores the validity of the EHTS for a panel of Asian countries), the relevance of common global factors is confirmed in complementary research on emerging markets, documenting that US monetary policy announcements significantly affected the term structure of interest rates in some Asian countries (Valente, 2009).Turning to the latter point, the international effects of US unconventional monetary policy measures on long term interest rates of major industrialized countries are documented in Bauer & Neely (2014) and Neely (2015), applying an event-study approach which shows that these effects are consistent with the decrease in bond yields predicted by a simple portfolio model.

Similar spillover effects have been identified for many emerging market economies, using either event-study methodologies (Morgan, 2011 and Bowman, et al., 2015) or VAR models (Miyajima, et al., 2014 and Tillmann, 2016). More recently, Belke, et al. (2017) have extended the analysis about the international effects of unconventional monetary policies including not only those adopted in the US, but also those implemented in the Eurozone and in Japan. Using a daily data set for eight Asian economies, these authors find that Asian sovereign bond yields respond significantly to unconventional monetary policies carried out in various economic areas, although the intensity of spillover effects exhibits notable cross-country differences and time variations. Overall, these results document that Central Banks of emerging market economies have been significantly constrained, in more recent years, in the management of long-term bond yields; this evidence, therefore, calls for further empirical investigation to assess the validity of the EHTS in these countries.

This paper extends the empirical investigation carried out in Guerello & Tronzano (2016) on a panel of four Asian countries (i.e. Malaysia, Philippines, Singapore, South Korea). They provide robust evidence supporting the EHTS for this sample of Asian countries for the period 2001-2013 and document the influence of an international global factor on the yield curve, while local country-specific factors are not statistically significant. In this paper, we extend our panel data set to more recent years (2001-2016) and contribute to the existing literature on the EHTS in two main respects. First, we provide new evidence about the role of common global factors exploring the existence of structural breaks in the long-run trend of the term structure during the recent Great Recession; second, we explore deeply the spillover effects from unconventional monetary policies implemented by major industrialized countries during this period.

More specifically, we extend the Error Correction Model used in Guerello & Tronzano (2016), incorporating as exogenous variables the term structure of G4 interest rates. Moreover, we extract some stationary global factors from financial and macroeconomic data of major industrial countries (i.e. US, Euro Area, UK, Japan) and analyze the impact of these factors on bond yield structures of Asian economies. Overall, the approach taken in the present paper allows to reassess the empirical support for the EHTS, and to quantify the intensity of spillovers effects arising from the Quantitative Easing policies implemented by various industrial countries.

The outline of the paper is as follows. Section 2 describes our new data set and contains some preliminary unit root tests. In section 3 we perform some standard panel cointegration tests and explore the validity of the EHTS allowing for cross-sectional dependence and multiple structural breaks. Section 4 analyzes the links between global liquidity factors and Asian bond yield structures, reassesses the empirical support for the EHTS, and quantifies the intensity of international spillover effects. Section 5 concludes.

2 PRELIMINARY DATA ANALYSIS

2.1 DATA

The dataset includes three different interest rates measures. We consider Government bonds yields at a 1-year and a 10-year maturity, respectively as a proxy for short and long-term interest rates. Additionally, as a measure of the policy rate, we focus on the interbank rate with 3-months maturity.

The panel of four Asian countries (Malaysia, Singapore, South Korea and Philippines) is chosen on the basis of data homogeneity and of the degree of financial markets liberalization.

The sample starts in 1999 and terminates in 2015. Given the monthly frequency, roughly 200 observations are available for each country, yielding a total of more than 750 observations. The sample starts right after the Asian financial crisis, and covers therefore a period of relatively stable monetary policy. However, since this sample includes the so called "Great Moderation" period, the 2007-2008 financial crisis, and the recent wave of Quantitative Easing (Q.E.) monetary policies implemented by major advanced economies, our results are robust to different levels of uncertainty on international financial markets.

To account for the influence of global factors and interest rates spillovers from unconventional monetary policies, our data set includes further analogous nominal interest rates from the group of G4 countries (US, UK, Japan and Germany), and some additional macroeconomic series useful to extract global liquidity factors and risk-aversion indicators.

A complete description of this dataset and of data sources is provided in Annex A.

2.2 PANEL UNIT ROOT TESTS

As a preliminary step, we implement some stationarity tests on the single series. These tests include the standard Phillips & Perron (1988) test for a unit root, and some more recent testing procedures allowing for one or two structural breaks in the trend and in the constant term (see, respectively: Kim & Perron, 2009; Papell & Prodan, 2006 and Lee & Strazicich, 2003). The tests description and their results are reported in Annex B.

Overall, the null hypothesis of unit root in the series is not rejected for all countries in the case of one break and for most of the countries in the case of two breaks. Since unit root tests applied to single series suffer from low power, we complement the above evidence with some panel data techniques which offer enhanced power combining the time-series and the cross-sectional dimensions. The most commonly used panel unit root tests include Im, et al. (2003), Pesaran (2007) and Bai & Ng (2004), which test the joint null hypothesis of a unit root against the alternative of at least one stationary series in the panel. These tests are based on augmented Dickey and Fuller (1979) statistics across the cross-sectional units of the panel. However, the Bai & Ng (2004) test is preferable for this analysis because it is the only one that allows for common factors with different order of integration than the idiosyncratic errors. The Bai & Carrion-i-Silvestre (2009) and the Bai & Ng (2010) extensions of this test, which allows for multiple structural breaks, is also considered because the length of the series suggests that there might be multiple structural breaks both in the constant and in the trend. Table 1 summarizes our results.

Table 1 Panel Unit Root tests

	10-Year Gov. Bonds Yields	**1-year Gov. Bond Yields**	**Money Market Rate**
Bai and Ng (2004) Panel Unit Root test with 2 common factors			
stat	-0.861	-0.649	-0.581
p-value	0.1945	0.2582	0.2807
Bai & Carrion-i-Silvestre (2009) Panel Unit Root test with 2 common factors and 1 structural change			
break date	Apr-03	Jul-08	Oct-08
stat	1.597	0.876	0.736
p-value	0.0559	0.1922	0.2327
Bai & Carrion-i-Silvestre (2009) Panel Unit Root test with 2 common factors and 2 structural changes			
break date	Apr-03	Sep-02	Oct-02
break date	May-11	Jul-08	Oct-08
stat	-1.548	-1.279	-1.561
p-value	0.0618	0.1021	0.0594

The reported statistics are pseudo t-ratio on augmented Dickey-Fuller type regression equations. All the equations include a time trend and a constant. The panel test statistics is, hence, the sum if individual ADF statistics. The hull hypothesis of unit root in the series implies that there is no unit root in all units, against the hypothesis that for some units the series are stationary. Therefore, the rejection of the null hypothesis does not necessarily imply that there is not unit root in all units.

The null hypothesis of unit root in the series is not rejected for most interest rates at all maturities. Few exceptions are recorded only for 10-year government bond yields, where the Bai & Carrion-i-Silvestre (2009) methodologies reject the null at a 10% confidence level. This is in line with the single country analysis in which ten-year government bond yields for Malaysia and Singapore are found to be stationary applying the Kim & Perron (2009) test with two breaks. Therefore, it is plausible to consider the model with two breaks misspecified and to proceed in the analysis looking only at the models with either no-break or one break[1].

[1] As argued by Banerjee & Carrion-i-Silvestre (2015), the rejection of the null hypothesis of unit root in the model with two breaks is often due to model misspecification rather than due to the stationarity of the series. This seems to be the case here because the Kim & Perron (2009) hardly identifies two common breaks across the countries because of the high heterogeneity among the second break dates identified for each country's series. For instance, the long-run yield of Malaysia breaks twice before 2005 whereas the long-run yield of Singapore breaks twice after 2011.

3 EVIDENCE OF EHTS IN ASIAN COUNTRIES

3.1 PANEL COINTEGRATION TESTS

In our previous work Guerello & Tronzano (2016) we found that the spread between the 10-year government bond yield and the 1-year government bond yield is not stationary in these Asian countries; however, if both the policy rate and common factors are included in the model, the evidence supports the EHTS.

We start by replicating this latter result by employing the Westerlund (2007) error-correction based[2] panel cointegration test on the relationship between the 10-year yield, the 1-year yield and the policy rate. Although this test does not explicitly account for common factors, it is robust for cross-sectional dependence.

Moreover, following the procedure proposed by Reese & Westerlund (2015), we extend the analysis by allowing for and by testing the stationarity of multiple unobservable common factors (stationary or integrated). This estimator extracts the common components combining the methodologies outlined in Pesaran, et al. (2013) and in Bai & Ng (2004)[3]. Since unit root tests on single countries provide evidence of multiple structural breaks, we also implement the Banerjee & Carrion-i-Silvestre (2015) cointegration test, which accounts for one common structural break in the Bai & Ng (2004) test.

Table 2 Cointegration Tests

Dependent: 10-year yield; Regressors: 1-year yield, policy rate

Westerlund(2007) cointegration tests with 100 bootstrap rep.		
Mean Group test (G_a)	-25.308	(0.006)
Mean Group t-test (G_t)	-3.598	(0.001)
Pooled test (P_a)	-24.893	(0.000)
Pooled t-test (P_t)	-4.262	(0.000)
Reese & Westerlund (2015) PANICCA tests on the id. residuals		
Mean Group test (P_a)	-5.712	(0.000)
Pooled test (P_b)	-2.8	(0.0026)
MSB test (PMSB)	-1.337*	(0.0906)
Banerjee & Carrion-i-Silvestre (2015) cointegration tests with one common structural break		
Common Break Date	Sep-05	
Z	-2.7518	(<0.05)

For the Westerlund (2007) test, we report four statistics. The Mean Group statistics have as null hypothesis that at least one series is not-cointegrated, while the Pooled test has as null hypothesis that all series are not-cointegrated. All the other tests reported have the null hypothesis of all series not being cointegrated versus the alternative hypothesis of at least one series is cointegrated. The Westerlund (2007) test is based on the error correction while the other tests are based on the order of integration of the residuals. For the PANICCA test, we report the three statistics for the null of all individual series of the residual to be integrated, as in Bai & Ng (2010), in the case of either mean group or pooled ADF tests and the MSB test of Sargan & Bhargava (1983). For the (Banerjee & Carrion-i-Silvestre (2015), the breaks are assumed common but unknown. The tabulated critical values for T=250 are: 1% -2.619; 5% -1.931; 10% -1.506, which are not dependent on the number of breaks.

[2] The (Westerlund, 2007) cointegration tests overcome several problems of previous tests because they are based on the structural (i.e. EC form) rather than the residuals dynamics. This methodology accommodates individual specific dynamics, trends and constants as well as not-strictly exogenous regressors. Furthermore, by bootstrapping the EC estimator, it is robust to cross-sectional dependence.

[3] The PANICCA test is developed combining two main strands of literature: the cross-section averages augmentation approach in (Pesaran, et al., 2013), which employs the cross-section averages as a proxy for the common components and has strong small sample properties, and the PANIC approach of (Bai & Ng, 2004), which extracts the common factors by a principal component analysis on the first difference of the variables to allow the common components and the idiosyncratic terms to have different orders of integration.

Table 2 reports our empirical findings. The Westerlund (2007) panel cointegration test and the Reese & Westerlund (2015) PANICCA test reject the null hypothesis of no-cointegration. The Banerjee & Carrion-i-Silvestre (2015) test allowing for one common structural break identifies a regime-shift in the cointegration relationship in September 2015, and supports the existence of panel cointegration at a 5% confidence level. This evidence is therefore closely in line with other panel cointegration tests reported in Table 2.

Almost all the literature exploring the EHTS in the presence of structural breaks focuses on single-country case studies, both in the case of industrial countries and in the case of emerging market economies (see e.g., respectively, Koukouritakis, 2013 and Koukouritakis, 2010). An identical feature emerges focusing on empirical work on Asian economies (see, e.g. Zhu, 2011). To the best of our knowledge, the only contribution addressing the validity of the EHTS inside a panel approach is Holmes, et al. (2011) which considers a large group of Asian countries (including all those examined in the present paper). The main conclusion reached by these authors is that panel stationarity tests allowing for endogenously determined structural breaks and cross-sectional dependence support the stationarity of the spreads between long and short-term yields and thus the validity of the EHTS. In this perspective, the main evidence obtained in the present section, namely the robustness of the EHTS to regime-shifts in the cointegrating relationship is fully in line with the recent applied literature on Asian economies.

3.2 TESTING THE EHTS ALLOWING FOR CROSS-SECTIONAL DEPENDENCE AND STRUCTURAL BREAKS.

This section assesses the robustness of our empirical findings through alternative approaches for dynamic heterogeneous panels with non-stationary regressors. More specifically, we implement the Pooled Mean Group (PMG) estimator developed in Pesaran, et al. (1999) and the extension (Dynamic Common Correlated Effects, DCCE) of Pesaran (2006) and Chudik & Pesaran (2015), which allows for cross-sectional dependence. The PMG combines pooling and averaging, allowing the intercepts and short-run coefficients to differ across countries, while the error correction coefficient and the long-run parameters are constrained to be the same.

These error-correction estimators are applied to the relationship between the 10-year bond yield, the 1-year bond yield and the 3-month money market rate. However, as shown in Figure 1, the average 1-year yield and the average policy rate are highly correlated, mainly after the 2007/2008 crisis. For this reason, we introduce in the long-run equation the first principal component of these rates, which can explain about 97% of the dynamics of these variables, and focus on the quantitative estimates of the associated coefficient. Figure 1 shows that this component approximates well the common dynamics of these two interest rates. These variables enter however separately into the short-run equations to pinpoint significant short-term divergences among the above yields.

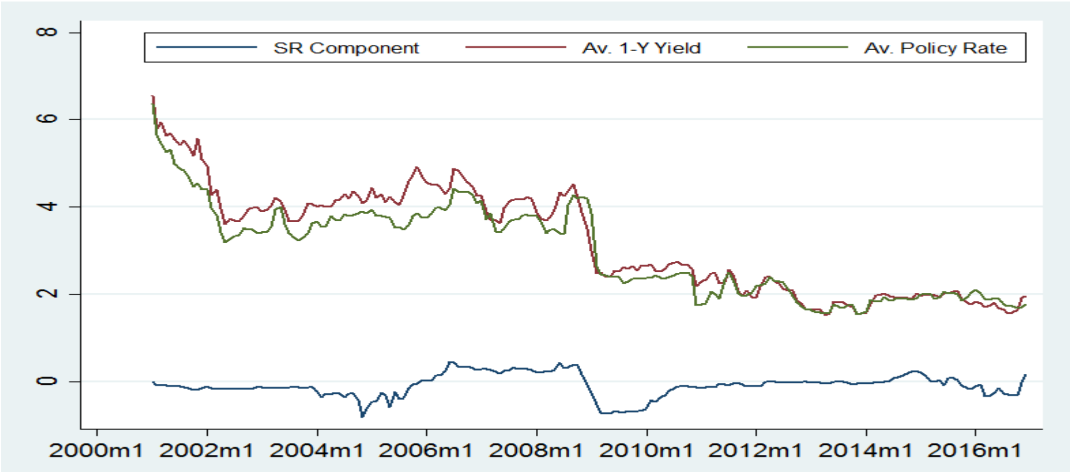


Figure 1 *Short-Run Component: time-line of the first component from the PCA of the 1-year yield and the policy rate and the cross-country average of both 1-year yield and 3-month policy rate.*

Although the Hausman (1978) test[4] for heterogeneous coefficients bias supports the PMG estimator, the Pesaran (2015) test points out residuals strong cross-sectional dependence, probably due to omitted common effects, which makes this estimator inconsistent.

A strand of empirical literature focuses on the role of global latent factors in explaining the decoupling of short and long interest rates observed in many industrial countries in recent years. Byrne, et al. (2012) applying a PANIC estimator to a sample of industrialized countries, report that after 2000 there is evidence supporting the existence of global factors driving the yield curve. They show that short run interest rates are driven by country specific forces, while long run rates are affected by international factors. The increasing financial globalization occurred in recent years has led many other authors to explore the existence of alternative common factors as potential determinants of the long end of the spread emphasizing, respectively, the role of global inflation (e.g. Ciccarelli & Majon, 2010), of global output (e.g. Henriksen, et al., 2009), or of global savings (e.g. Bernanke, 2005). Furthermore, in our cointegration analysis, the PANIC estimator highlights the presence of up to three non-stationary common factors in the long-run relationship of the Asian interest rates.

To overcome the cross-sectional dependence problem and to account for the influence of common factors, we use the Common Correlated Effects estimator proposed by Pesaran (2006), which approximates the unobserved common factors with cross-sectional means of the dependent variable and of the regressors, under the strict exogeneity of the latter. More specifically, we implement the Chudik & Pesaran (2015) correction for the dynamic inconsistency of the CCE estimator, which adds a sufficient number of lags of the cross-sectional means (DCCE). Applying this approach to the PMG estimator, as suggested by Ditzen (2016), we estimated the following model by OLS.

[4] The Hausman (1978) test for heterogenous coefficient bias is investigates the robustness of long-run poolability of the coefficients. It compares the PMG estimator and the Mean Group estimator because if the long-run slopes are heterogeneous across the countries, the PMG model is inconsistent, but if the coefficients heterogeneity hypothesis is rejected pooling increases the efficiency of the dynamic panel estimator.

$$\Delta r_{i,t}^{10Y} = \sum_{k=10Y,1Y,3M} B_{k,i}\Delta r_{i,t-1}^{k} + \lambda\left(r_{i,t-1}^{10Y} - \gamma r_{t-1}^{SR} - \gamma\delta_t r_{t-1}^{SR}\right) + \sum_{j=0}^{p}\left(B_{10Y,i,j}\Delta\bar{r}_{i,t-j}^{10Y} + \sum_{k=1Y,3M} B_{k,i,j}\Delta\bar{r}_{i,t-1-j}^{SR}\right) + a_i t + u_{i,t} \quad \textbf{(1)}$$

$$with\ p = \sqrt[3]{N}\ \ for\ the\ DCCE\ and\ 0\ otherwise\ and\ \delta = 1\ after\ 2005m9\ for\ the\ DCCE\ with\ breaks\ and\ 0\ otherwise$$

A further problem addressed inside this econometric framework is related to the potential occurrence of a structural break. The destabilizing effects associated with the global financial crisis have been widely documented in the literature. Evidence about the adverse effects induced by this crisis is provided, among others, in Choudhry (2016) where GARCH-M estimates for five European markets (Greece, Ireland, Italy, Portugal and Spain) point out a substantial change in the term structure volatility, persistence of volatility, and the risk premium coefficient. Moreover, as documented in the previous section, our cointegration analysis detects the existence of a regime-shift in the common long-run trend of Asian yields. We account for the influence of a structural break by means of a dummy variable (δ_t) in equation 1, allowing the common long-run coefficient to vary at a predetermined date identified by the Bai & Perron (1998) test. This structural break is assumed to happen at a common date but with heterogenous impacts on the term structures of the countries.

Table 3, 1st column contains the results from the PMG estimator. The upper part of this table reports the estimate of the long-run equilibrium equation normalized on the long-term rate and displays a significant equilibrium relationship between yields at different maturities. However, the Chi-squared statistic for the hypothesis that the 1-Year Yield long-run coefficient is equal to 1 provides, in this case, uncertain evidence about the validity of the EHTS. The remaining columns of Table 3 report the results for DCCE estimator assuming, respectively, the absence or the existence of a common structural break. In sharp contrast with the results from the PMG estimator, the CD statistics now point out the absence of residuals cross-sectional dependence for both dynamic models. Moreover, the value of the CD statistics turns out to be much lower assuming the existence of a structural break in the cointegration relationship, suggesting that the regime-shift itself is an important source of cross sectional dependence in the residuals.

Focusing on the long-run regressions, both DCCE models exhibit a faster adjustment process of the term structure towards the long-run equilibrium (i.e. a higher estimate of the error correction parameter than that obtained through the PMG estimator). However, DCCE models with or without break provide a rather different picture about the validity of the EHTS. Assuming no break, the LR-test does not reject the null hypothesis that the lagged short-run parameter is equal to 1 at the 5% confidence level. On the other hand, assuming a regime-shift in September 2005, the EHTS is strongly supported before the break date but not thereafter (see parameters estimates and results for the LR-test in Table 3, 3rd column)[5].

Finally, for the short-run dynamics, we observe that almost all the correlation between interest rates in DCCE models is collected by the strong adjustment towards the long-run trend and by the common components.

[5] The coefficient for the interaction term between the break dummy and the short-run component is assumed to be heterogenous across countries but only the average coefficient is reported and tested for EHTS. Regarding the country specific jumps at the break date, we obtain that Singapore and South Korea are not impacted by the break, whereas Malaysia and Philippines are strongly affected and exhibit a large drop in the long-run elasticity.

Table 3 Pool Mean Group Estimates

Dependent Variable: D.10-Year Yield	PMG (1)	DCCE (2)	DCCE with break (9/05) (3)
		Long-Run	
Ec	-0.066***	-0.103***	-0.109***
	(2.86)	(-6.19)	(-7.11)
SR component	1.502***	0.612***	0.707***
	(8.87)	(3.67)	(3.27)
SR component after 2005m9			0.312
			(0.88)
		Malaysia	
L.D. 1-Year Yield	-0.028	-0.091	-0.069
	(-0.24)	(-0.60)	(-0.46)
L.D. Policy Rate	-0.085	-0.144	-0.139
	(-0.89)	(-1.20)	(-1.16)
		South Korea	
D. 1-Year Yield	0.245***	0.055	0.053
	(3.17)	(0.52)	(0.49)
D. Policy Rate	-0.166***	-0.064	-0.077
	(-2.72)	(-0.71)	(-0.84)
		Singapore	
D. 1-Year Yield	-0.189	-0.192	-0.192
	(-0.87)	(-0.80)	(-0.80)
D. Policy Rate	0.137	0.209	0.206
	(0.67)	(0.95)	(0.93)
		Philippines	
D. 1-Year Yield	0.022	-0.034	-0.036
	(0.26)	(-0.078)	(-0.47)
D. Policy Rate	-0.100	-0.064	-0.074
	(-1.15)	(-0.81)	(-0.92)
Individual Trend	Yes	Yes	Yes
L.D.10-Year Yield	Yes	Yes	Yes
Observations	760	736	736
CD test	3.33	-1.85	-1.19
CD p-value	(0.0009)	(0.0641)	(0.2344)
Hausman MG test	1.74	0.17	4.56
Hausman MG p-value	(0.1865)	(0.9999)	(0.1021)
EHTS LR test	8.80	5.43	1.84
EHTS p-value	(0.003)	(0.0201)	(0.1754)
EHTS LR test after 2005m9			2.89
EHTS p-value after 2005m9			(0.0894)

Standard errors in parentheses; * $p < 0.20$, ** $p < 0.1$, *** $p < 0.05$ (for side: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.025$)
PMG: Pool Mean Group estimator proposed by Shin et al. (1999).; DCCE: Dynamic Conditional Correlated Effect estimator proposed in Chudik & Pesaran(2015) with 6 lags and HAC s.e. Recursive mean adjustment used to correct for small sample bias. Pooled Variables: SR component; Heterogenous constant partialled out with the Cross Sectional Averaged Variables: D.10Y-Yield, LD.1Y-Yield and LD.Policy;
PC1: first principal component of 1Y-Yield and Policy Rate; The reported statistics are the Observations (the number of group is constant and equal to 4), CD: Cross-Sectional Dependence test as in Chudik and Pesaran(2015); EHTS: test for the coefficient of L. 1-Year Yield in Long Run equations to be equal to 1. The EHTS test has been performed after the break on the average country specific coefficients.; Hausman MG: Hausman test of Mean Group estimator vs Pool Mean Group estimator.

To sum up, the main result achieved in this section is that the evidence obtained from DCCE models is more reliable since it is never affected by residuals cross-sectional dependence. The DCCE estimator, moreover identifies one significant structural break towards the end of 2005, and shows that the EHTS is no more supported after this regime-shift. This structural break in the EHTS relationship is mostly affected, in our opinion, by the spillover effects on Asian interest rates arising from some important exogenous international factors, namely the strongly expansionary monetary policies pursued in Japan since 2006 and in other major industrialized countries since 2008/2009 as a reaction to the global financial crisis.

These results are aligned with the current literature. For instance, analyzing a sample of five EU countries (France, Germany, Italy, Spain and United Kingdom), and allowing for structural breaks in the data generating process, Koukouritakis (2013) finds substantial evidence against the EHTS for the whole maturity spectrum. According to the author, this result is mainly driven by a time-varying risk premium and the existence of segmented markets, and the influence of these factors was amplified during the European debt crisis.

4 QE IN ADVANCED ECONOMIES AS A GLOBAL SHOCK TO THE EHTS.

In the previous section, we provide evidence of a structural break in the long-run equation around 2006, a period in which Japan started to undertake its quantitative easing monetary policy.

A large swath of literature has stressed the influence of global factors, rather than local forces, in driving the dynamics of the long-run interest rate in EMEs. It is therefore plausible to believe that after 2006 the EHTS is no longer supported in these countries since several advanced economies started to implement unconventional monetary policy (Japan from 2006 and US, UK and EA from 2008/2009).

Several recent studies point out that US yield curve may generate significant spillovers towards EMEs, both at the long end[6] and at the short end[7] of the yield curve. According to Bowman, et al. (2015), these spillovers increased since the Fed's LSAP announcement and, hence, QE had a larger impact than standard monetary policy. However, several other large advanced economies carried on unconventional monetary policy in the last decade, and hence US rates might not collect all the changes in the international interest rates. Belke, et al. (2017), for instance, find that Asian EMEs interest rates respond also to EA and Japan QE policy.

In the light of this evidence, we explore the role of global influences extracting some common factors from the term structure of interest rates of the G4 countries (US, UK, Japan and Germany). More specifically, we focus on the 10-year government bond yield, 1-year government bond yield and 3-month money market rate, and rely on the principal analysis of these detrended variables to extract stationary common factors which enter as exogenous variables in the long-run equation of the model. As regards the short-run dynamics, we consider

[6] Miyajima, et al. (2014) find significant spillovers to EMEs long-term rates from US monetary policy before and after the global financial crisis due to the financial market integration. Hofmann & Takats (2015) point out that these spillovers come from both short- and log- run US interst rates and Bowman, et al. (2015) show that they are consistent we the effect observed around the announcement of the LSAP in the US.

[7] Edwards (2012) and Caceres, et al. (2016) find a large pass-through from US yield curve towards EMEs to both short- and long-term bond yield due to business cycles syncronization.

instead the average G4 countries' term structure because it better approximates the business-cycles and financial-cycles synchronization between advances economies and EMEs.[8]

Two global factors have been identified to drive the joint dynamics of G4 interest rates. These factors can explain about 98% of the global interest rates volatility. Table 4 (left-hand side) illustrates the correlation matrix of government bond yields at different maturities and of the policy rates of advanced economies with these two global factors.

The former factor is positively correlated with all interest rates and can therefore be interpreted as a global interest rate shock to the term structure of interest rates. A visual inspection of the evolution of this factor over time (Table 4, upper-left section) strongly corroborates this interpretation, as witnessed by the sharp downward trend of this variable during the financial crisis period (2008-2009), and by its persistence on negative values up to the beginning of 2015.

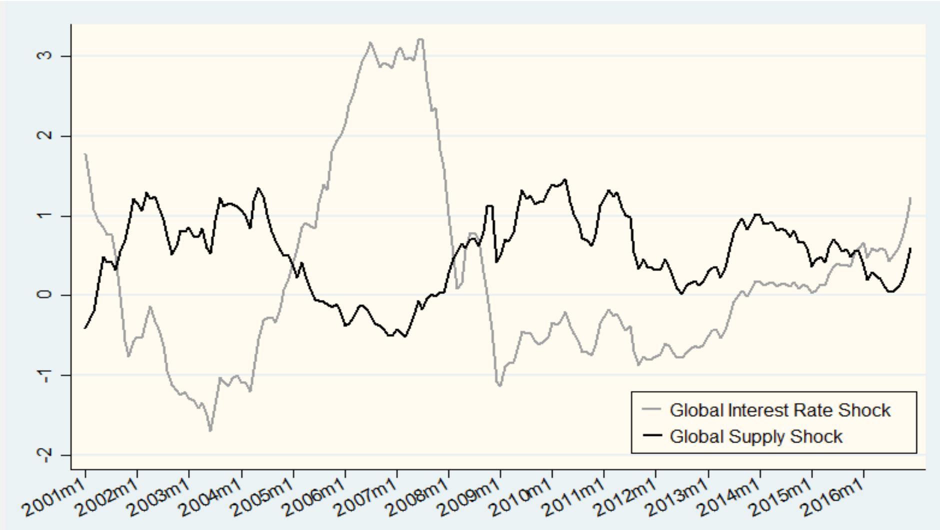
The latter factor is instead negatively correlated with the policy rate and positively correlated with the long end of the term structure, and appears therefore more strictly related to the overall macroeconomic outlook To better characterize the nature of this global factor, we computed its correlation with some key macroeconomic indicators and found a positive correlation with the Composite Leading Indicator (CLI) (+ 0.229) and a negative correlation with the Producer Price Index (PPI) (- 0.153). On the whole, our empirical evidence allows therefore to interpret this factor as a positive global supply shock, namely as a downward shift to the aggregate supply curve leading to a decrease in inflation and to an increase in real output. In this perspective, the negative correlation reported in Table 4 with the policy rate reflects an expansionary monetary policy reaction to stabilize the declining inflation rate; moreover, the positive correlation recorded with the 10-year rate reflects an expectations effect related to higher financial markets confidence, shifting capital from safer financial assets to the stock market and thus boosting the nominal rate on longer term bonds.

The visual inspection of this factor strongly corroborates this interpretation (Table 4, upper-left section). This factor actually displays a remarkable similarity with the trend of Total Factor Productivity (TFP) for advanced economies reported in (Foda, 2016). Closely in line with our estimates, TFP for advanced economies exhibits an increasing trend from 2001 to 2003, a sharp downturn from 2004 up to the first years of the financial crisis (2008-2009) and a partial recovery thereafter.

[8] As Miyajima, et al. (2014) show, it is important to consider both the short and the long-end of the US term structure because, previous to 2008, the innovations to the long-term bond yield stem from either the Fed funds rate and the US term premium. The former mainly affect the exchange rate and the outflows of capital towards EMEs, while the latter might trigger severe repricing in EMEs' assets markets. After 2008, innovations to the long-term interest rate in US originate directly from Fed's QE policies and this channel is similar to the term premium one. Note, moreover, that, although US term structure explains 60% of international spillovers from AEs to EMEs in the last decade, the bond yield structure of Euro Area and Japan explains respectively 30% and 10% of them and, hence, are relevant too (Belke, et al., 2017).

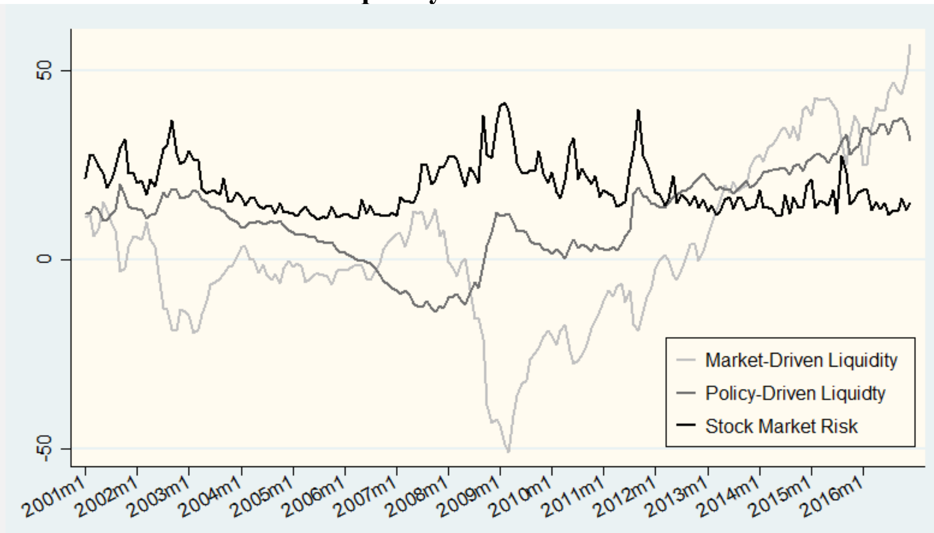
Table 4 Global Factors

Global Interest Rate Factors – timeline



2 stationary common factors extracted with the Principal Analysis on detrended data from 10-year bond yield, 1-year bond yield and 3-month money market rate of the G4 countries. Font: Datastream®

Global Liquidity Momenta – timeline



3 stationary common factors extracted with the Principal Analysis on detrended data from 10-year bond yield, 1-year bond yield, 3-month money market rate, narrow money, stock market index growth, volatility index, commercial loans growth, prime lending spread and PPI of the G4 countries. Font: Datastream® and authors' computation.

CORRELATION MATRIX WITH THE GENERATING VARIABLES

	Global Interest Rate Shock (1)	Global Supply Shock (2)
10-Year Yield	0.694	0.344
1-Year Yield	0.814	-0.087
Money Market Rate	0.789	-0.262

The correlation of the 1st factor with the PPI and CLI is respectively 0.302 and -0.199; while the correlation of the 2nd factor with PPI and CLI respectively are -0.153 and 0.229. Whereas, the correlation with Narrow and Broad Money are respectively -0.179 and -0.338 for the 1st factor and less than 0.06 for the 2nd factor.

	Market-Driven Liq. (1)	Policy-Driven Liq. (2)	Stock Mkt. Risk (3)
10Y rate	-0.273	-0.086	-0.193
1Y rate	-0.214	-0.294	-0.198
MM rate	-0.190	-0.301	-0.123
M1	0.279	0.329	-0.171
Stock Index	0.855	-0.122	-0.054
Volatility Index	-0.274	0.134	0.952
Loans Growth	0.122	-0.019	-0.147
Lending R. Spread	0.444	0.127	0.199

CROSS-FACTORS CORRELATION MATRIX

	Market-Driven Liquidity	Policy-Driven Liquidity	Financial Market Risk
Global Interest Rate Shock	-0.292	-0.305	-0.355
Global Supply Shock	-0.189	0.324	-0.178

To further explore the role of common global factors, we follow the approach of Choi, et al. (2014) and extract additional stationary common factors from a larger set of financial indicators including, beside the three interest rates, narrow money (M1), stock market growth and volatility indexes, commercial loans growth and the bank lending spread. These additional financial series are processed in three steps. First, we replace the outliers[11] with the decile median because they weight excessively during the components' extraction. Second, we employ detrended variables to extract stationary factors. Finally, as suggested in Choi, et al. (2014), we purge macroeconomic elements in the financial data to single out those unwarranted[12]. The Bai & Ng (2004) procedure points out three stationary common factors to be relevant and the extracted first three components by the principal components analysis can explain 85% of the overall volatility.

Correlation results in Table 4 (right-hand side) reveal that the first two factors comove in the same direction with narrow money and are negatively correlated with interest rates at all maturities. These two factors may therefore be easily interpreted as liquidity momenta.

The first factor, moreover, is positively correlated with the growth of bank loans and exerts a favorable effect on the stock market, both in terms of stock price increase (correlation coefficient: + 0.855) and in terms of volatility decrease (correlation coefficient: - 0.274). Overall, this evidence suggests that this first factor may be interpreted as "Market-Driven Liquidity", namely as the increase in liquidity originating from the endogenous liquidity creation by the banking system (deposits multiplier).[13]

The second factor is closely connected with the injection of liquidity which follows an expansionary monetary policy since it generates a downward shift in the term structure of interest rates without affecting the amount of loans. We therefore label this factor as "Policy-Driven Liquidity". In line with a priori expectations, this liquidity component is weakly correlated with stock market variables and the lending standards. The positive effect of the monetary shock on the lending spread advocated in Choi, et al. (2014) is weak, in our case, since our sample covers a large period of unconventional monetary policy.

Turning to the third factor, the most relevant feature is the very strong positive correlation with the stock market volatility index (+ 0.952). This naturally leads to interpret this factor as a "Financial Risk" component, capturing the increase in stock market risk due to increasing uncertainty. This financial risk momentum is negatively correlated with the whole term structure of interest rates. These negative correlations may be interpreted in terms of a fly-to-quality effect: as the risk in the stock market increases, investors move capitals towards safer investments, thus lowering bond yields at all maturities.

[11] The outliers have been identified as the values that are larger in absolute value than twice the distance between the decile median and the sample median for each countries and for the overall sample. They have been replaced with the country 's decile median.

[12] We regress both stock market price inflation and commercial loans growth on PPI and CLI by means of a panel FE estimator and we take the residuals.

[13] This first factor exhibits also a strong positive correlation with the bank lending spread (+ 0.444). This positive correlation is well justified in the case of a loans demand shock. However, a positive correlation with the lending spread can also originate from a loans supply shock, because an easing of the lending standards implies a deterioration of the average creditworthiness of the borrowers and hence an increase in the average lending spread.

Table 4 (upper right section) shows the dynamics of these stationary common factors. It is interesting to observe that the evolution of all these global factors is always broadly consistent with the main events characterizing the macroeconomic and financial outlook during our sample period.

The financial risk indicator displays two highly volatile phases. The former, at the beginning of the sample, corresponds to the burst of the dot-com bubble and the September 2002 stock market crash as a consequence of the terrorist attack; the latter (2007-2012) covers the whole period of the recent financial crisis, which originated from the US and subsequently produced huge contagion effects around the globe. As regards liquidity indicators, market-driven liquidity exhibits a dramatic downturn in 2007/2008 in concomitance with the unfolding of the US financial crisis and displays a progressive recovery since early 2009. Policy-driven liquidity, on the other hand, exhibits a strong rise since early 2008, mainly as a consequence of the first round of QE policies implemented by major industrial countries. However, as documented in Table 4, these liquidity indicators display a specular pattern for a prolonged period, due to the freeze of interbank money markets and the increase in counterparty risk (e.g. Afonso, et al., 2011).

The above factors have been inserted as exogenous variables the long-run equation of the model, while short-run global influences have been modelled through the average dynamics of G4 interest rates. The estimator is the DCCE with one common break at 2005m9, the cross-sectional average of the first difference of the 10-year yield, the 1-year yield and policy rate of the EMEs partialled out with 6 lags and pooled long-run coefficients for the EMEs' short-run components and for the global factors. The estimated model has the form:

$$\Delta r_{i,t}^{10Y} = \sum_{k=10Y,1Y,3M} B_{k,i} \Delta r_{i,t-1}^{k} + \sum_{k=10Y,1Y,3M} B_{k,i} \Delta r_{US,t-1}^{k} + \lambda \big(r_{i,t-1}^{10Y} - \gamma_1 r_{i,t-1}^{SR} - \gamma_1 r_{i,t-1}^{SR} \delta_t - \sum_{j=1}^{m} \gamma_2^i \Gamma_{i,t}^{j} - \gamma_2^i \delta_t \sum_{j=1}^{m} \gamma_2^i \Gamma_{i,t}^{j} \big) + \sum_{j=0}^{12} \big(B_{10Y,i,j} \Delta \bar{r}_{i,t-j}^{10Y} + \sum_{k=1Y,3} B_{k,i,j} \Delta \bar{r}_{i,t-1-j}^{k} \big) + a_i t + u_{i,t} \quad \textbf{(2)}$$

$$with\ p = \sqrt[3]{N};\ \delta = 1\ after\ 2005m9\ and\ \Gamma\ the\ global\ factors.$$

To improve readability and comparability, the results are split in two tables, respectively for the long-run regression (Table 5) and the short-run dynamic (Table 6).

Table 5 reports three distinct set of results: (1) the baseline specification; (2) the model with two global factors extracted from the term structure of G4 interest rates; (3) the model with three global factors extracted from a larger set of macroeconomic and financial variables.

Table 5 reports the Wald test statistics for the null hypothesis that the coefficient of the lagged 1-year yield is equal to 1. On the one hand, the Wald test for the baseline specification directly assesses the weak version of the EHTS, namely the stationarity of the term spread conditional on the existence of an unobservable time-varying risk premium. On the other hand, the Wald tests for the models including global factors (columns 2 and 3) actually assess an extended weak version of the EHTS, which makes the stationarity of the term spread contingent upon the existence of an unobservable time-varying risk premium (or liquidity premium) and international spillovers from AEs.

The former set of results (column 2) points out that all global factors extracted from the G4 term structure are relevant for the long-run trend of 10-year Asian bond yields. However, after the break of September 2005, both factors exert a highly reduced influence. More specifically, the coefficient relative to the global interest rate shock is no more statistically significant, while that relative to the global supply shock is much smaller. Overall, this empirical evidence is closely in line with that obtained from the baseline specification, and suggests that, even if we condition on global factors, the weak version of EHTS for these Asian countries held only before the September 2005 structural break but not thereafter (see the values of the EHTS LR test at the bottom of Table 5). Indeed, although the two global interest rate factors can explain the long-run dynamics of the bond yield spread before September 2005, the same factors are not able to explain this gap afterwards.

Table 5 Global Factors and the Term Structure of Interest Rates in Asian EMEs - Long-Run Equation

Dependent Variable:	**Baseline**		**Global Interest Rate**		**Global Liquidity**	
	Pre-2005m9	**Post-2005m9**	**Pre-2005m9**	**Post-2005m9**	**Pre-2005m9**	**Post-2005m9**
D.10-Year Yield	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Ec	-0.109^{***}		-0.137^{***}		-0.139^{***}	
	(-7.11)		(-8.51)		(-8.60)	
SR component	0.707^{***}	0.342	0.779^{***}	0.406^{*}	0.862^{***}	0.863^{***}
	(3.27)	(0.88)	(4.17)	(1.55)	(4.91)	(4.88)
Global Interest Rate shock			0.324^{**}	-0.021		
(1st Factor)			(1.79)	(0.20)		
Global Supply shock			1.121^{***}	0.421^{**}		
(2nd Factor)			(2.67)	(1.73)		
Market-Driven Liquidity					0.001	0.092^{***}
(1st Factor)					(0.06)	(2.95)
Policy-Driven Liquidity					-0.082^{***}	-0.137^{***}
(2nd Factor)					(-3.08)	(-3.43)
Stock Market Risk					0.068^{***}	-0.501^{*}
(3rd Factor)					(3.48)	(-1.64)
CD test	-1.19		0.01		-1.34	
CD p-value	(0.2344)		(0.9912)		(0.1809)	
EHTS LR test	0.184	2.89	1.39	5.17	0.61	0.59
EHTS p-value	(0.1754)	(0.0894)	(0.2384)	(0.0234)	(0.4337)	(0.4337)

Standard errors in parentheses; * $p < 0.25$, ** $p < 0.1$, *** $p < 0.05$ (for side: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.025$)
Dynamic Conditional Correlated Effect estimator proposed in Chudik & Pesaran(2015) with 6 lags and HAC s.e. Recursive mean adjustment used to correct for small sample bias. Pooled Variables: SR component; Heterogenous constant partialled out with the Cross Sectional Averaged Variables: D.10Y-Yield, LD.1Y-Yield and LD.Policy; PC1: first principal component of 1Y-Yield and Policy Rate; The reported statistics are the Cross-Sectional Dependence test as in Chudik and Pesaran(2015); EHTS: test for the coefficient of L. 1-Year Yield in Long Run equations to be equal to 1. The EHTS test has been performed after the break on the average country specific coefficients.

To better explore the role of global factors and interest rate spillovers from advanced economies, we now focus on the latter set of results, emphasizing the decomposition of global liquidity between market-driven liquidity, policy-driven liquidity and a financial risk component. These results are summarized in the last two columns of Table 5.

Accounting for the influence of global liquidity factors provides a much better picture of the conditions under which the EHTS is supported in Asian countries. As shown in the last row of this table, the EHTS LR test does not reject the null hypothesis that the coefficient of the lagged 1-year yield is equal to one, neither before nor after the 2005 structural break. Therefore, differently from previous results which did not explicitly account for the role of global liquidity factors, long-run parameters restrictions associated with the EHTS are not rejected even after the occurrence of a regime-shift. It follows that under wider conditions (the existence of an unobservable time-varying risk premium and of international spillovers from AEs), an extended version of the EHTS is supported and, hence, the dynamics of the liquidity momenta can explain the volatility of the EMEs interest rate spread for the whole period considered.

Parameters estimates show that both market-driven liquidity and policy-driven liquidity play an important role in driving the long-run trend of Asian interest rates. The former component becomes significant only after the 2005 structural break, while the latter is strongly significant along the whole sample. Note, however, that the downward pressure on Asian long-run interest rates exerted by policy-driven global liquidity is quantitatively higher after the structural break (as witnessed by the estimated coefficient increasing from -0.082 to – 0.137). This means that since the G4 central banks started to undertake quantitative easing as a reaction to the global financial crisis, this expansionary monetary stance produced relevant spillovers effects on the long end of Asian term structures. However, since the G4 central banks implemented also long-run refinancing operations[14] for the banking system, the international effects of policy-driven global liquidity were smoothed by the opposite effect exerted by market-driven liquidity[15].

Overall, as fund in Miyajima, et al. (2014) for the US, before 2006 international interest rates spillovers were mainly originated from AEs monetary policy and global uncertainty and were typically offset by capital and exchange rate control measures. On the contrary, after 2006 there have been larger spillovers from QE measures and long-run refinancing operations for banks, which have not been offset by the tightening of capital controls. Consistently with the above interpretation, our estimates show that the stock market risk factor is statistically significant only during the earlier part of the sample, when an increase in uncertainty in advanced economies financial markets generates an increase in the maturity spread of Asian term structures. After 2006, however, this channel was muted by more stringent capital controls in Asian emerging markets and the fly-to-quality effect (investments' flows from stock markets to safer financial markets) dominated the spillovers from any other financial risk.

Table 6 summarizes the empirical evidence relative to the short-run dynamics of the Asian term structure. The results in column (1) refer to the baseline specification without common factors, while estimates in columns (2) and (3) include, respectively, the effect of global interest rates and that of global liquidity momenta.

It is apparent from this table that 10-Year yields in most Asian countries are mainly driven by global short-run interest rates rather than by domestic factors. This result, moreover, is highly robust to the inclusion of different global factors (compare, at this purpose, the estimates in column (2) with those of column (3)). Actually, as shown in Table 6, the lagged G4 1-Year yield is the only variable which turns out to be statistically significant in affecting long-run interest rates in three out of four Asian countries (namely in Malaysia, Singapore and the Philippines, although in this last country with a sign opposite to expectations). The most salient result from Table 6, hence, is that the influence of global interest rates spillovers has been highly pervasive: namely, this influence did not involve only the long-run dynamics but also short-run fluctuations of Asian interest rates [16].

[14]In 2008 the Fed bought a large amount of agency debt (LSAP1). In 2012, the Funding for Lending Scheme (FLS) of the Bank of England reduced the funding cost of banks. In 2014, ECB has started long-term refinancing operations with a 3-year maturity for banks (LTRO). In 2008, the Bank of Japan undertook the Special Fund-Supplying Operations to Facilitate Corporate Finance and in 2010 started the Comprehensive Monetary Easing program.

[15] the long-run refinancing operations contemporaneously boost the AEs market-driven liquidity and decrease the long-run interest rate on bank bonds and, hence, on AEs government bonds. However, these conditions trigger severe repricing in EMEs and, hence, growing government bond yields, leading to the estimated positive correlation (0.092) between market-driven liquidity and long-run yield after 2005.

[16] In most cases, the dependence of the long-run yield on international spillovers in much larger in the short-run than in the long-run equations, because, abstracting from the long-run adjustments, the local short-run yield and policy rate do not significantly influence the long end of the term structure.

Table 6 Global Factors and the Term Structure of Interest Rates in Asian EMEs – Short-Run Equation

Dependent Variable: D.10-Year Yield	**Baseline (1)**	**Gl. Int. Rate (2)**	**Gl. Liquidity M. (3)**
Long-Run			
Ec	-0.109***	-0.137***	-0.139***
	(-7.11)	(-8.51)	(-8.60)
SR component	Yes	Yes	Yes
2 Global Int. Rate Factors	No	Yes	No
3 Global Liquidity Momenta	No	No	Yes
Malaysia			
L.D. 1-Year Yield	-0.069	-0.079	-0.085
	(-0.46)	(-0.55)	(-0.58)
L.D. Policy Rate	-0.139*	-0.139	-0.154*
	(-1.16)	(-1.18)	(-1.31)
L.D. G4 10-Year Yield		-0.065	-0.04
		(-0.36)	(-0.24)
L.D. G4 1-Year Yield		0.652***	0.672***
		(2.87)	(2.92)
L.D. G4 Policy Rate		-0.159	-0.131
		(-0.79)	(-0.64)
South Korea			
L.D. 1-Year Yield	0.053	0.123	0.137
	(0.49)	(1.05)	(1.17)
L.D. Policy Rate	-0.077	-0.081	-0.068
	(-0.84)	(-0.88)	(-0.74)
L.D. G4 10-Year Yield		0.258*	0.263*
		(1.39)	(1.41)
L.D. G4 1-Year Yield		-0.018	0.068
		(-0.08)	(0.29)
L.D. G4 Policy Rate		-0.251	-0.191
		(-1.15)	(-0.86)
Singapore			
L.D. 1-Year Yield	-0.191	0.223	-0.231
	(-0.80)	(-0.97)	(-1.00)
L.D. Policy Rate	0.206	0.194	0.242
	(0.93)	(0.91)	(1.13)
L.D. G4 10-Year Yield		-0.092	-0.06
		(-0.48)	(-0.30)
L.D. G4 1-Year Yield		0.433**	0.543***
		(1.87)	(2.31)
L.D. G4 Policy Rate		-0.275*	-0.218
		(-1.36)	(-1.07)
Philippines			
L.D. 1-Year Yield	-0.036	0.014	0.004
	(-0.47)	(0.18)	(0.05)
L.D. Policy Rate	-0.074	-0.170***	-0.188***
	(-0.92)	(-2.16)	(-2.36)
L.D. G4 10-Year Yield		-0.061	-0.022
		(-0.31)	(-0.11)
L.D. G4 1-Year Yield		-1.204***	-1.113***
		(-5.25)	(-4.77)
L.D. G4 Policy Rate		0.521***	0.544***
		(2.42)	(-2.52)
Individual Trend	Yes	Yes	Yes
AR(1)	Yes	Yes	Yes
CD test	-1.19	0.01	1.34
CD p-value	(0.2344)	(0.9912)	(0.1809)

Standard errors in parentheses; * $p < 0.20$, ** $p < 0.1$, *** $p < 0.05$ (for side: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.025$)

Dynamic Conditional Correlated Effect estimator proposed in Chudik & Pesaran(2015) with 6 lags and HAC s.e. Recursive mean adjustment used to correct for small sample bias. Pooled Variables: SR component; Heterogenous constant partialled out with the Cross Sectional Averaged Variables: D.10Y-Yield, LD.1Y-Yield and LD.Policy; The reported statistic is the Cross-Sectional Dependence test as in Chudik and Pesaran(2015). Since the short run dynamic is assumed uniform over the sample, the table reports the coefficients without break at September 2005.

Beyond this general feature, we observe however some notable differences in the estimated short-run coefficients of various countries which can be interpreted on the basis of the "impossible trinity" argument put forward in in Aizenman, et al. (2010). The four countries included in our panel are in fact highly heterogeneous across the elements of this theory (see **Errore. L'autoriferimento non è valido per un segnalibro.**), and these structural differences strongly affect the interest rate pass-through from AEs conventional and unconventional monetary policies.

Figure 2 Impossible Trinity in Asian EMEs for 2007 (Font: (Aizenman, et al., 2010))

Consider first the case of South Korea which, according to our results, is the only country where short-run fluctuations in the 10-year yield are not significantly affected by global interest rates. As shown in Beyond this general feature, we observe however some notable differences in the estimated short-run coefficients of various countries which can be interpreted on the basis of the "impossible trinity" argument put forward in in Aizenman, et al. (2010). The four countries included in our panel are in fact highly heterogeneous across the elements of this theory (see **Errore. L'autoriferimento non è valido per un segnalibro.**), and these structural differences strongly affect the interest rate pass-through from AEs conventional and unconventional monetary policies.

Figure 2, this higher degree of monetary independence of South Korea was possible given its lower degree of capital mobility and the existence of a more flexible exchange rate regime with respect to other Asian countries.[17] In line with Edwards (2012) and Caceres, et al. (2016), the above factors explain why South Korea experienced a negligible degree of interest rate pass-through, with a dynamics of the 10-year yield almost

[17] Ilzetzki, et al. (2009) reports that in 2010 Malaysia, Singapore and Philippines have de facto an exchange rate regime of a moving/ crawling band around US dollar, while South Korea follows a managed floating exchange rate regime.

exclusively affected by adjustments to the long-run trend. Monetary policy independence, moreover, became higher in the last decade because this country tightened capital controls as a response to QE policies in advanced countries.

The absence of significant interest rates spillovers documented for South Korea stands in sharp contrast with our empirical short-run estimates for Singapore and Malaysia, where the coefficients relative to the effects of the lagged G4 1-year yield are always highly significant and sizable. Moreover, the domestic policy rate and the domestic short-run term interest rate did not exert any effect on the 10-year yield in these countries.

As regards Singapore, the existence of short-run spillovers effects from advanced countries is mostly explained by its very high degree of capital mobility (see Beyond this general feature, we observe however some notable differences in the estimated short-run coefficients of various countries which can be interpreted on the basis of the "impossible trinity" argument put forward in in Aizenman, et al. (2010). The four countries included in our panel are in fact highly heterogeneous across the elements of this theory (see **Errore. L'autoriferimento non è valido per un segnalibro.**), and these structural differences strongly affect the interest rate pass-through from AEs conventional and unconventional monetary policies.

Figure 2) which, besides the significant influence of the global 1-year yield, explains also the lower influence stemming from the global policy rate (see Table 6). Turning to Malaysia, the estimated impact of the global 1-year yield is even slightly higher than for Singapore (an increase in 100 b.p. in the G4 1-year yield induce an increase in the 10-year yield for Malaysia and Singapore of respectively about 65 b.p. and about 45 b.p.) although, given the existence of some mild capital controls, we do not observe any significant effect stemming from the global policy rate in this case.

Philippines, finally, represent a very special case because of the short-run negative effect of the domestic policy rate on the 10-year yield. Moreover, the short-run coefficient of the international 1-year yield is strongly significant but with sign opposite to the expectations and to the estimates obtained for other Asian countries. Since the error correction term is assumed to be equal across the countries, this result suggests that the long-run adjustments to the global factors are much larger in the Philippines (so that the error correction term is larger) and, hence, part of this adjustment is collected by the large and negative short-run elasticity with respect to the G4 1-year interest rate.

Moreover, in the short run, international spillovers mainly stem from the global policy rate, rather than from the global 1-year bond yield, pointing out the weak monetary independence of this country. This is also confirmed by the estimate of the degree of monetary independence, which is notably lower than that recorded for the other Asian countries. Specifically, Beyond this general feature, we observe however some notable differences in the estimated short-run coefficients of various countries which can be interpreted on the basis of the "impossible trinity" argument put forward in in Aizenman, et al. (2010). The four countries included in our panel are in fact highly heterogeneous across the elements of this theory (see **Errore. L'autoriferimento**

non è valido per un segnalibro.), and these structural differences strongly affect the interest rate pass-through from AEs conventional and unconventional monetary policies.

Figure 2 shows that South Korea and the Philippines have roughly the same degree of financial openness and exchange rate stability, even if the former country features a much higher value of the monetary independence index[18].

As argued in Caceres, et al. (2016), in addition to the degree of exchange rate flexibility and that of financial openness, other fundamentals matter in determining the reaction of domestic monetary policy to global interest rates influences. Among them, the degree of financial dollarization and the extent of Central Bank credibility are key factors in affecting domestic monetary policy autonomy and the size of international spillovers. Following a rise in the international interest rate and the consequent exchange rate depreciation, if most of the financial assets are denominated in foreign currency and the inflation expectations are not well anchored, the Central Bank might need to deliver a large interest rate movement to contrast the effects of the opening interest rate differential[19].

The above considerations are important to explain the effects of the domestic policy rate on the long-term yield recorded in this case. Indeed, although the Philippines' exchange rate regime is similar to that prevailing in the other Asian EMEs, the very high financial dollarization[20] explains the higher sensitivity to the monetary stance of advanced economies. The existence of a Central Bank with low credibility and with a large focus on exchange rate stabilization explains why an increase in the domestic policy rate is associated with a decrease in the long-run interest rate. Indeed, after an exchange rate depreciation, the Central Bank would overly react increasing the policy rate, while the consequent capital inflows would reduce the yield on long-term government bonds.

5 CONCLUDING REMARKS

This paper supports the weak version of the EHTS of interest rates for a group of Asian countries and provides information on the global factors affecting the maturity spread in the last decades. Assessing the conditions, under which the EHTS is satisfied, is important because if the EHTS holds, the yield curve provides information about market expectations of future short-term rates, while Central Banks, by controlling the short-term rate, can transmit the monetary impulses to the real sector (through the no arbitrage long-run equilibrium condition).

[18] The same applies also by comparing Malaysia and the Philippines.
[19] Caceres, et al. (2016) provide robust empirical evidence supporting the above arguments, based on a large panel of emerging market economies.
[20] Levy-Yeyati (2006) proposes the share of deposits denominated in foreign currency as a proxy for the degree of financial dollarization and reports that the Philippines has on average 28% of the deposits denominated in foreign currency while Malaysia and Singapore have roughly 2% of deposits denominated in foreign currency.

More specifically, this paper extends the empirical investigation carried out in Guerello & Tronzano (2016) on a panel of four Asian countries, where we provide robust evidence supporting the EHTS and document the influence of common factors on the yield curve.

We extend our empirical analysis along two main dimensions. First, we investigate whether, besides country-specific factors, the dynamics of the term structure in these Asian countries is significantly affected by various common global factors. Second, we focus on unconventional monetary policies implemented by some major advanced economies since the mid-2000s, and explore whether these large liquidity injections generated significant spillovers effects on the Asian term structures of interest rates.

Our main empirical findings may be summarized as follows.

We apply recent techniques for panel data cointegration with cross-sectional dependence and structural breaks and jointly analyze the short- and the long-run dynamics of the term structure and of the policy rate. After a preliminary data inspection, we implement some standard panel cointegration tests which reject the absence of cointegration and identify one regime-shift in the cointegration relationship at the end of 2005. Moreover, while documenting the empirical support for the EHTS before the regime-shift, we show that parameters restrictions associated with the EHTS are no more supported after this break.

We further investigate the dynamics of the Asian term structure focusing on the influence of common global factors and international spillovers. To this purpose, we extend the proposed Error Correction Model incorporating as exogenous variables the term structure of G4 interest rates and extract some stationary global factors from financial and macroeconomic data of major industrial countries. Two separate groups of common factors are identified: the former includes two macroeconomic shocks, while the latter includes alternative global liquidity indicators and a financial risk component related to stock market uncertainty.

We show that both sets of common factors exert a significant influence on the Asian term structure. More specifically, as regards global macroeconomic shocks, we find that they have a reduced influence after the 2005 structural break. On the contrary, as regards the latter group of factors, global liquidity momenta significantly increase their influence after the structural break, thus documenting the strong quantitative effects of unconventional monetary policies implemented by advanced countries.

Accounting for the influence of global liquidity factors, moreover, provides a better picture of the conditions under which the EHTS is supported in these Asian countries. Actually, according to our estimates, the EHTS is supported after the September 2005 structural break only conditional upon the existence of global liquidity factors. This result provides empirical support for an extended version of the "Liquidity Premium" theory, incorporating both a time-varying risk premium and international spillovers effects.

Further empirical investigation, finally, provides interest insights about the short-run dynamics of Asian 10-year bond yields. We document some relevant differences between these countries as regards the relative importance of domestic versus international influences. Quite interestingly, moreover, we show that this heterogeneous behavior is related to some important structural differences among these countries in terms of the "impossible trinity" between monetary independence, financial openness and exchange rate stability emphasized in Aizenman, et al. (2010).

To sum up, before 2006, international spillovers mainly originated from global uncertainty and the global monetary stance and were largely offset by capital controls and exchange rate stabilization policies. Since September 2005, however, there have been large spillovers effects from the G4's Assets Purchasing Programs and the long-run refinancing operations for banking system, which have not been contrasted by the tightening of capital controls.

The main consequence was that in the last decade, at least for the Asian countries considered, long-run interest rates were strongly affected by international factors, so that monetary authorities partially lose control over this key variables. Moreover, as shown by the short-run equations results, no country was able to fully control the short-run dynamics of the 10-year yield, which was quite exclusively influenced global 1-year yield and long-run trend adjustments.

Although this paper contributes to the recent literature exploring the role of global common factors and of international interest rates spillovers, several research topics deserve further attention. It would be of great interest, for instance, to quantify the pros and cons of shielding from international interest rate spillovers. This would allow to quantify to what extent a decoupling from the monetary policy stance of advanced economies is optimal for EMEs and to explore new dimensions, besides the degree of capital account openness and that of exchange rate flexibility, along which the desired degree of monetary autonomy can be attained (i.e. the credibility of the policy framework, or the use of macroprudential reserve requirements).

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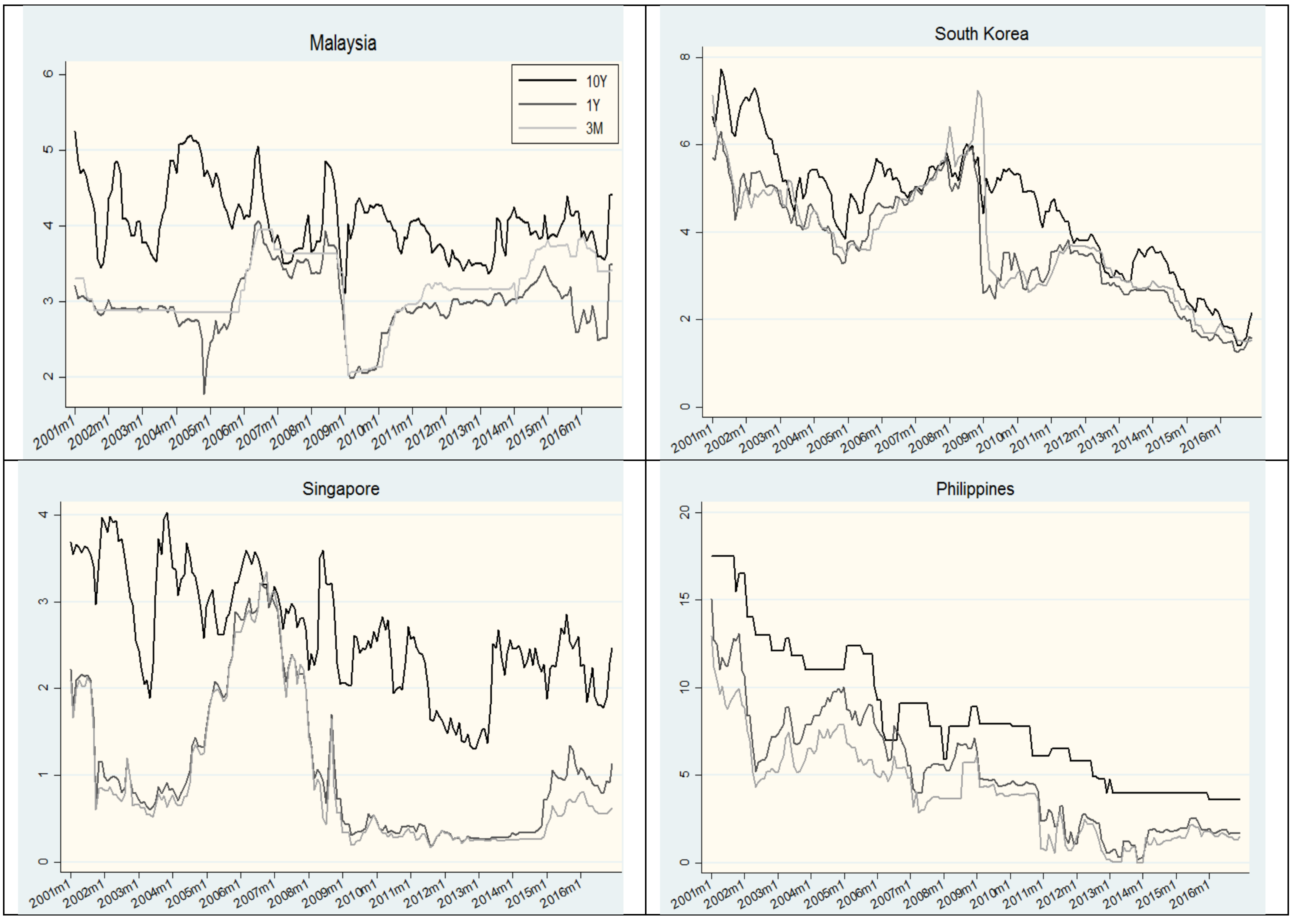
Annex A Data Description

The database is composed of the series for the three interest rates for 4 Asian emerging markets, namely Malaysia, South Korea, Singapore and Philippines and few factors. The series span from January 2001 and December 2016 with monthly frequency.

The three interest rates considered are the long-term rate, the short-term rate and the monetary policy rate. As a proxy of the long-term and the short-term rates, we select respectively the 10-year government bond yields and the 1-year government bond yields, as provided by the local Central Bank. As a proxy of the monetary policy rate, the 3-months money market rate is employed. It is the average yield of the assets exchanged on the money market with residual maturity shorter than 90 days. Specifically, we employ the 91-days treasury bill rate for Philippines and Singapore, whereas we use the 3-month interbank rate for Malaysia and for South Korea. All the series are found in Datastream® and they are neither seasonally nor working days adjusted.

Table 7 below shows the graphs of the timeline of the three interest rates for each of the Asian emerging countries considered.

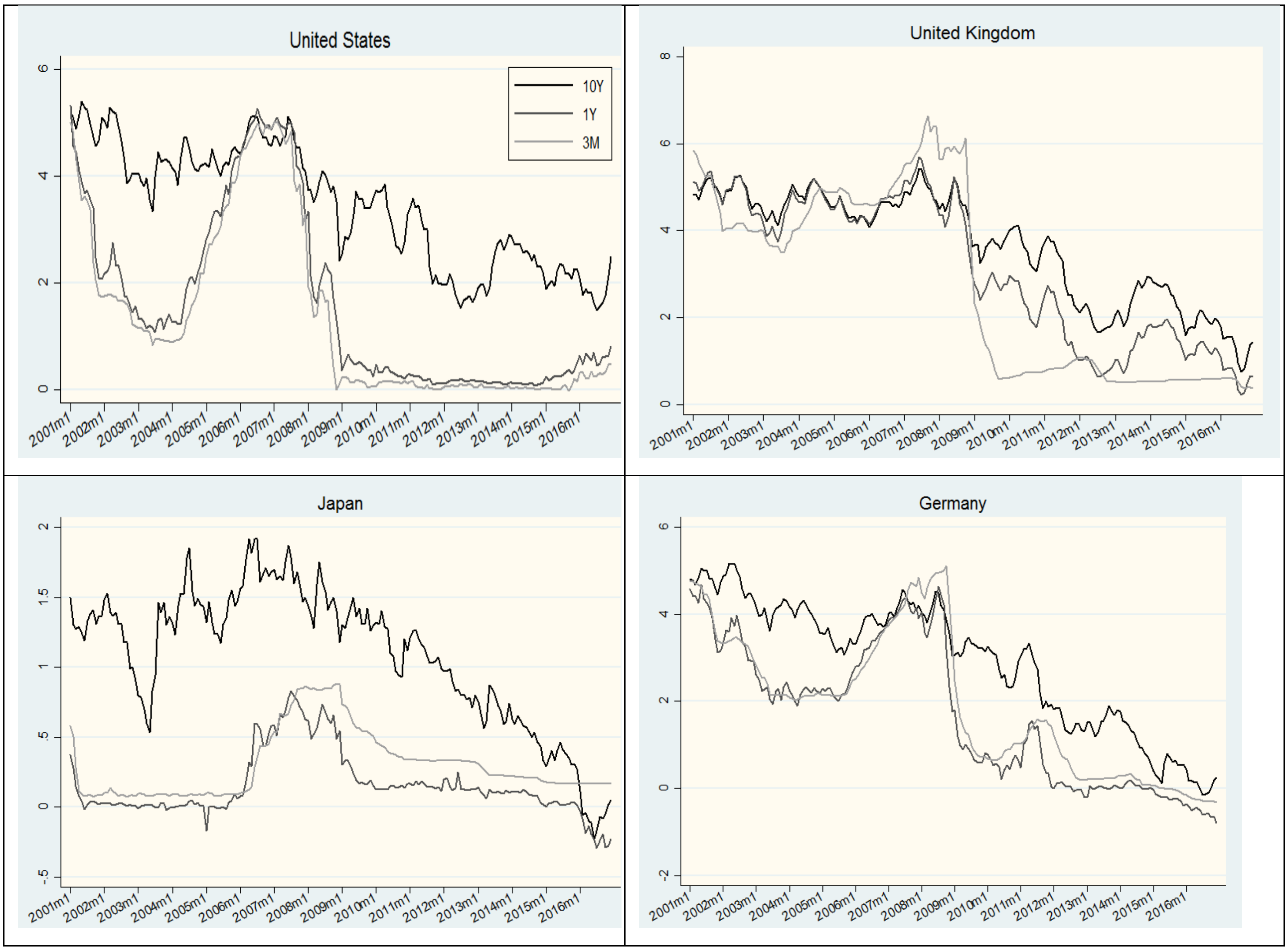
Table 7 EMEs Interest Rates - timeline



10-year government bond yields (10Y); 1-year government bond yield (1Y); 3-month money market rate (3M). Font: Datastream

Few factors are added to the analysis. They are extracted from four advanced economies' data, namely the G4 countries: US, UK, Japan and Germany. The first group of factors are extracted from the long-run interest rate, the short-run interest and the monetary policy rate. As a proxy of the long-run and the short-run interest rates, we use respectively the 10-year government bond yield and the 1-year government bond yield. The policy rates are approximated by the 3-month LIBOR for UK, 3-month EURIBOR for Germany and the money market rates for US and Japan. All data are downloaded by the IMF International Financial Statistics and are neither seasonally adjusted nor working day adjusted. The series have been regressed on a time trend to extract stationary factors. Table 8 shows the graphs of these series for the each of the G4 countries.

Table 8 G4 Interest Rate - timeline



10-year government bond yields (10Y); 1-year government bond yield (1Y); 3-month money market rate (3M). Font: IMF International Financial Statistics

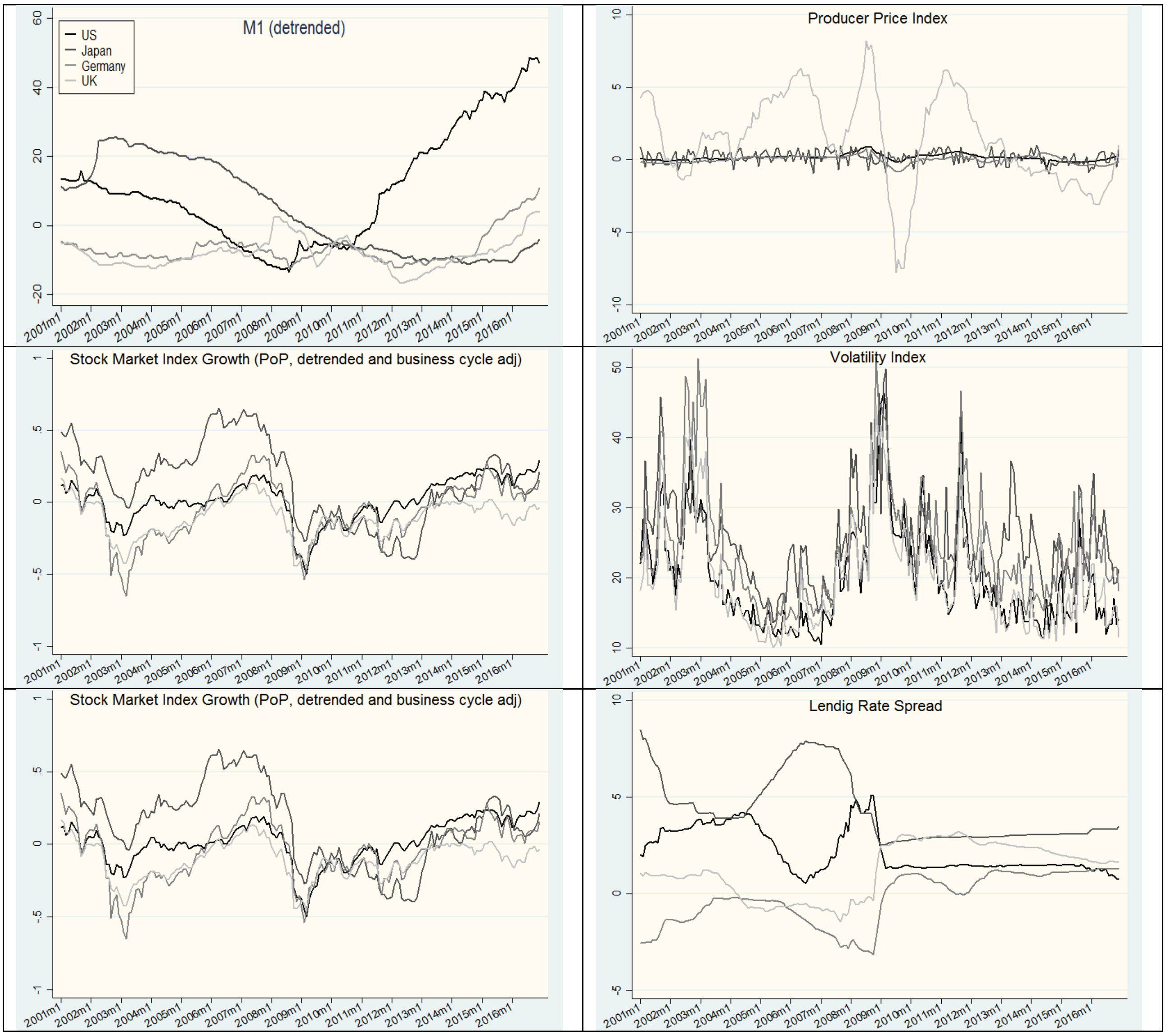
The factors are extracted also from a larger set of series, specifically for each of the G4 countries the following series have been considered and plotted in Table 9:

- Monetary base: we employ the measure of narrow money, namely M1 aggregates in national currency. They are provided by IMF International Financial Statistics
- Equities index: percentage growth period on period of the stock market price index, end of the period values. They are provided by IMF International Financial Statistics and regressed on the Composite

Leading Indicator and the Producer Price Index provided by the OECD, Main Economic Indicator database and on a time trend.

- Volatility Index: the average over the period of the closing price of the country's main volatility index, respectively VIX for US, VSTOXX for Germany, VFTSE for UK and JNIV for Japan. Font: Bloomberg®.
- Lending Rate Spread: difference between the prime banking interest rate on loans and the interbank interest rate. The series have been regressed on a time trend. The series are provided by the OECD, Main Economic Indicator database.
- Loans growth: percentage growth period on period of the total amount of commercial loans in national currency, end of the period values. They are regressed on the Composite Leading Indicator and the Producer Price Index provided by the OECD, Main Economic Indicator database and on a time trend. The data are seasonally adjusted.

Table 9 G4 Financial Variables - timeline



Annex B Single Country Unit Root Tests

As a preliminary step for our empirical investigation, we implement some stationarity test on the single series. The length of the series suggests that there might be multiple structural breaks both in the constant and in the slope of the trend and, as argued in this case the simple Dickey & Fuller (1979) type tests are not consistent. The alternative test proposed by Perron (1989) allows for a structural break and a moving average process for the error term under both the null and the alternative hypotheses, making the test more consistent. Kim & Perron (2009) extended this procedure for a break at unknown time, while Papell & Prodan (2006) test allows for multiple breaks at unknown dates. We also consider the LM test of Lee & Strazicich (2003) with two structural breaks at unknown date.

Table 10 Unit Root Tests

	10-Year Gov. Bonds Yields				1-year Gov. Bond Yields				Money Market Rate			
	MY	**KO**	**SN**	**PH**	**MY**	**KO**	**SN**	**PH**	**MY**	**KO**	**SN**	**PH**
Philip & Perron (1988) test for Unit Root												
stat	-32.67	-13.01	-26.73	-16.5	-14.29	-14.58	-4.84	-23.45	-7.24	-13.58	-6.35	-24.95
5%	-21.8	-21.8	-21.8	-21.8	-21.8	-21.8	-21.8	-21.8	-21.8	-21.8	-21.8	-21.8
1%	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5
Kim & Perron(2009) Unit Root Test with a structural break under both H0 and Ha in both trend and constant												
break date	05/08	03/01	04/08	01/02	09/16	11/08	09/01	11/01	12/08	01/09	09/01	11/10
stat	-4.71	-2.9	-4.46	-3.73	-2.67	-3.38	-1.46	-3.57	-2.32	-3.02	-1.78	-4.22
stat trimm.	-3.38	-2.54	-2.96	-3.79	-2.74	-2.31	-1.41	-3.25	-2.18	-2.62	-1.66	-4.13
5%	-4.53	-4.01	-4.53	-4.01	-4.1	-4.53	-4.01	-4.01	-4.53	-4.53	-4.01	-4.49
Prodan & Papel (2006) Unit Root Test with 2 structural breaks under both H0 and Ha in both trend and constant												
break date	07/03	10/04	03/03	03/03	05/05	04/04	05/05	10/02	11/05	07/05	04/04	06/08
break date	04/06	02/09	02/13	10/05	08/08	09/08	08/08	09/10	10/08	10/08	10/07	09/10
stat	-6.44	-6.47	-6.75	-5.67	-6.03	-6.83	-4.9	-4.97	-6.26	-8.31	-5.05	-5.7
5%	-5.96	-5.96	-5.96	-5.96	-5.96	-5.96	-5.96	-5.96	-5.96	-5.96	-5.96	-5.96
1%	-6.45	-6.45	-6.45	-6.45	-6.45	-6.45	-6.45	-6.45	-6.45	-6.45	-6.45	-6.45
Lee & Stradicich (2003) LM Unit Root Test with two structural breaks under both H0 and Ha in both trend and constant												
break date	08/03	02/03	05/11	11/02	08/05	05/05	11/04	12/02	12/05	11/05	11/04	12/05
break date	03/05	08/08	07/13	11/05	11/08	03/08	02/08	01/11	03/09	04/09	02/08	09/11
stat	-5.77	-5.74	-6.75	-4.45	-4.8	-4.57	-3.1	-4.61	-3.78	-4.46	-3.82	-5.7
5%	-5.59	-5.74	-5.73	-5.59	-5.74	-5.74	-5.59	-5.74	-5.74	-5.74	-5.96	-5.71
1%	-6.16	-6.41	-6.32	-6.16	-6.41	-6.41	-6.16	-6.41	-6.41	-6.41	-6.45	-6.33

The results for the unit root tests with respectively one or two breaks at unknown dates are reported in Table 10 along with the simple Phillips & Perron (1988) test. The null hypothesis of unit root in the series is not rejected for most of the countries, but the test points out stationarity in both the ten-year government bond yields series for Malaysia and Singapore. Since the LM test of Lee & Strazicich (2003) and the Kim & Perron (2009) test with trimming instead indicate a unit root in those series, the rejection of the null hypothesis is attributable to either the rejection of unit root with two breaks versus no-break or one break or the assumed quick jump at the break date (AO specification) instead of slow moving innovations (IO specification).