Term Structure of Risk Factor Premiums Used for Pricing Assets: Emerging vs. Developed Markets

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The aim of this empirical study is to estimate and compare the term structure of risk factor premiums in developed and emerging markets. Most studies use dividend and variance swap data, but as that information is not available for all markets, we use wavelet decomposition of the observed return to calculate sensitivity to risk factors and obtain a term structure for risk factor premiums. The results show that only the market risk factor (for both types of markets) and the conservative minus aggressive factor (only for developed markets) show a term structure for risk premiums.

Keywords: term structure; risk premium; wavelets; multi-factorial CAPM; time-frequency decomposition.

Subject classification codes: C32; C38; G12.

1. Introduction

The term structure of equity is a recurrent subject in financial literature. Van Binsbergen and Koijen (2017) review the new literature on the term structure of equity. Recently, a novel methodology (Gomes and Ribeiro 2018; Bansal et al. 2019) was put forth to estimate a term structure for equity risk premiums which links holding period returns and maturity, using dividend and variance swap data simultaneously. Gomes and Ribeiro (2018) find that term structure is increasing and concave with the term and in the short-term horizon the risk premium is lower than the market risk premium. Bansal et al. (2019) use traded equity dividend strips from the U.S., Europe, and Japan from 2004 to 2017 to study the slope of the term structure of equity dividend risk premium and find that the term structure of dividend risk premium (growth rates) is positively (negatively) sloped in expansions and negatively (positively) sloped in recessions. But this approach has its drawbacks since data (dividend and variance swap) are not available for all markets (emerging markets and some developed markets) and only some risk factors are included in the implied asset pricing model (market risk and growth). Furthermore, in relation to the information available to estimate the term structure of risk premiums, Breugem and Marfè (2019) study the role of asymmetry in the information available about short-run and long-run effect news in an asset-pricing model with time-varying economic growth and find that when information mostly concerns short-run effect news, the model better accommodates the empirical evidence about the term structures of equity risk premiums.

For emerging markets, Salomons and Grootveld (2003) produced the first study which examines the ex post equity risk premium. Their results show that the equity risk premium in emerging markets is significantly higher than in developed markets, but this emerging risk premium varies over time although is neither normally nor symmetrically distributed and depends more on the economic cycle than on the countries' own economic measures. Donadelli and Persha (2014) use industry-level observed risk premium data for 19 emerging market countries across three regions of the world to first examine the contribution of each industrial stock market to the extra premium paid by emerging markets to international investors and show that correlations between excess industrial stock market returns and a certain amount of global economic policy uncertainty are consistently negative and follow similar patterns. This empirical evidence suggests that industrial stock markets are more closely related both within and across countries and regions than industry.

Also, and according to the seminal work by Fama and MacBeth (1973), the Capital Asset Pricing Model (CAPM) assumes a constant systematic risk or beta, however, Klemkosky and Martin (1975), Bollerslev, Engle, and Wooldridge (1988), and Harvey (1989) argue that the expectations of economic agents for future returns are conditional and therefore random variables rather than constant, implying that the beta of a risky asset should be time-varying. Several papers have found empirical evidence for variation in the conditional betas of equity portfolios (Jagannathan and Wang 1996; Lewellen and Nagel 2006; Bali 2008; Bali and Engle 2010).

Another part of recent literature on asset pricing has focused on studying the behaviour of the term structure of returns on risky assets. Campbell and Viceira (2005) show that the volatility of equity yields and the volatilities of expected returns are downward sloping over time. Lettau and Wachter (2011) showed that the slope of the dividend risk premium is downward. Bali, Engle, and Tang (2016) analysed the time-varying sensitivity of an asset to the market portfolio and to shifts in future investment opportunities. González, Nave, and Rubio (2018) reported differences over time and across portfolios of the relative weights of the total mixed-frequency conditional betas, concluding that value, small, low momentum, and low long reversal stocks have counter-cyclical betas, while growth, big, high momentum, and high long reversals have pro-cyclical betas. Furthermore, based on the arguments of Bansal and Yaron (2004), Bansal Dittmar, and Lundblad (2005), and Parker and Julliard (2005), only part of the information in the standard betas is relevant for pricing risky assets and this relevant part is concentrated in certain time-scale betas. This raises a question about the existence of a relationship between the premiums of each risk factor and the term of the investment (term structure).

From the financial literature on asset pricing model estimates, we find two main objectives. First, the predictive capacity of risk factors. Through GARCH-family techniques, for example, Phan, Sharma, and Narayan (2015) find the FGLS (Feasible Generalised Least Squares) approach is superior to the OLS (Ordinary Least Squares) and AOLS (Adjusted OLS) approaches in forecasting stock returns and Narayan and Liu (2018) include in their predictive model, besides the GARCH effect, the skewness and kurtosis of returns. Second, estimate risk premiums avoiding the error-in variable problem that arises in two-stage procedures such as Fama and MacBeth's (1973) method. To mitigate that bias, portfolios are typically used as test assets rather than individual stocks because portfolio betas are estimated more precisely than individual stock betas. Additionally, to avoid this drawback, Jegadeesh et al. (2019) propose an instrumental variable estimate for second pass that uses odd-month betas as instrumental variables and even-month betas as explanatory variables when month *t* is even and vice versa when month *t* is odd.

Our aim is to analyse the difference between developed and emerging market risk premiums. Narayan, Narayan, and Thuraisamy (2014) point out that emerging market risk return characteristics are different compared to developed markets, since emerging markets are highly volatile and provide attractive returns. For our objective, we should highlight that the outperformance of the FGLS model is data frequency-dependent. This implies that data frequency matters regarding forecasting outcomes and therefore should not be ignored. Narayan, Narayan, and Thuraisam (2014) use principal component analysis to avoid multicollinearity problems with regressors but these linear independent components show the variability of assets' excess returns and regressors in a unique frequency, which is of the observed data.

Our research question is: How different are the risk premiums between developed and emerging markets for each frequency? Answering this question is our main objective and our methodological contribution is novel since all of the above techniques use historical information to predict or estimate factor risk premium at the same frequency as the sample observations. Our proposal, from the frequency of observation, extracts the independent effect of each risk factor for different frequencies, and then we can also determine a term structure of the risk premiums. To our knowledge this is the first time that it is applied to equity markets. In this way, we can test the difference between the risk premiums of developed and emerging markets for different terms, and more importantly, guarantee the independence of the estimates of each frequency. An interesting feature of the proposed methodology is that while the FGLS approach does not assume that regressor is stationary, time-frequency wavelet decomposition results are always stationary.

From the information available for both market types (stock market returns), we estimated the term structure of risk factor premiums for the same factorial asset pricing model using a time-frequency wavelet decomposition of the sensitivity to risk factors (known as β) and then we compared the term structure of risk factor premiums in developed and emerging markets.

This paper is organized as follows. Section 2 presents the methodology applied in the paper. Section 3 describes the data. Section 4 presents the main empirical results. Section 5 offers our conclusions.

2. Methodology

Wavelet analysis is relatively new in economics and finance, although the literature on wavelets is growing rapidly (see Chakrabarty, Gunasekaran, and Dubey 2015, for a survey of wavelet analysis applied to financial markets). The use of wavelet decomposition in finance has been extended for different purposes. So Rua and Nunes (2012) assess CAPM market beta. Yi, Gençay, and Stephen (2013) use wavelets to detect jumps for high-frequency financial time series. Galleti (2012) and Saiti, Bacha, and Masih (2016) analyse contagion first during the US subprime crisis of 2007 and then among Islamic and non-Islamic Asian stock markets. Malagon, Moreno, and Rodriguez (2015) use wavelet decomposition to explain the idiosyncratic risk puzzle through the existence of market participants with different investment horizons. In emerging markets, there is a plethora of empirical research that investigates the timescale relationships between equity or exchange rate and bond, industrial prices, cryptocurrencies, and commodity markets (Kim and In 2007; Jammazi, Lahiani, and Nguyen 2015; Alaoui et al. 2015; Bekiros et al. 2016; Cai, Yuan, and Hamori 2017; Saâdaoui, Naifar, and Dohaiman 2017; Abid and Kaffel 2018; Omane-Adjepong, Alagidede, and Akosah 2019; Tweneboah 2019). Faria and Verona (2018) propose a method defined in the joint time-frequency domain to forecast stock market returns by wavelet decomposition with significant improvements.

About scale betas, Gençay, Selçuk, and Whitcher (2003, 2005) estimated a CAPM model on discrete wavelet decomposition and found that the relationship between the return of a portfolio and its beta becomes stronger as the wavelet scale increases. Fernandez (2006), Rhaeim, Ammou, and Mabrouk (2007), Aktan et al. (2009), Masih, Alzahrani, and Al-Titi (2010), Dajčman, Festić, and Kavkler (2013), Alaoui et al. (2015) found evidence that the fraction of systematic risk at lower frequencies has a higher association with lower frequencies of the market portfolio. Kang, In, and Kim (2017) presented a paper based on the wavelets framework that clarifies the explanatory power of different time-scale betas, but they only apply this methodology to the explanatory factors of the returns, not to the portfolios or assets. McNevin and Nix (2018) show that beta estimating is not straightforward, since the assumptions place restrictions on time horizons and frequency changes and the specific information does not remain stable over time. Therefore, a complete description of the systematic risk of investments in sectors requires estimates that capture time-varying behaviour at different frequencies.

Unlike Trimech et al. (2009) and Kang, In, and Kim (2017), this paper does not examine the relationship between stock returns and Fama-French risk factors with different time-scales, but analyses the relationship between time-scale portfolio returns and time-scale risk factors to estimate the time-scale betas. We use them as our basis to obtain the term structure of risk premiums. Our methodological contribution is important since it is not only a wavelet decomposition of risk factors but also of portfolio returns. Therefore, our results of the simultaneous decomposition (portfolios and factors) not only help to interpret the behaviour of portfolios for different scales of risk factors but also allow for management adapted to the different scales of each investment style for each different scale of risk factors. Unlike the scale-by-scale analysis of Gençay, Selçuk, and Whitcher (2003, 2005), this study shows that scale, length, and wavelet filter may be different for each factor and portfolio and also that standard errors of scale betas have to be consistent with the statistical properties of wavelet coefficients, in particular autoregressiveness, moving average, and heteroscedasticity, so other estimators such as Newey-West must be used.

Our methodological proposal has three stages. First, we extract time-scale orthogonal wavelet coefficients for different scales from portfolios returns and risk factors, like Gençay, Selçuk, and Whitcher (2003, 2005). Then we estimate the time-scales of the betas from wavelet signals or scale betas but analysing the statistical significance by Newey-West errors, and finally we determine the term structure of the risk premiums.

2.1. Discrete Wavelet Decomposition

To study time-scale component and the time-scale beta we use a wavelet decomposition. The main feature of wavelet analysis is that it enables separating out a variable into its constituent components of different scales. Wavelet transforms involve representing a general function in terms of simple, fixed building blocks at different scales and positions. A dyadic grid in the time-scale plane samples the time-scale parameters to form orthogonal bases with good time-frequency localisation properties. We use discrete decomposition since, unlike continuous decomposition, it allows us to extract from the time series the values of the factor loadings for the different frequencies, which we will later use in estimating the time structure of risk premiums.

Conceptually, a Discrete Wavelet Transform (DWT) of a time series X with N dimension entails extracting the scale (W) and the smooth (V) vectors. These elements cover the high frequency and low frequency behaviour, respectively. For a maximum frequency J^i, the original series can be represented as:

$$X \approx \sum_{j=1}^{R} W_j^T \cdot \left(W_j^* \cdot X\right) + \sum_{j=1}^{R} V_j^T \cdot \left(V_j^* \cdot X\right) = \sum_{j=1}^{R} D_j^T + S_R \quad (1)$$

where $R \leq J$ is the last frequency used in the explanatory model, ^{T} is transposed, $W_j^* = W_r^T \cdot X$ and $V_j^* = V_r^T \cdot X$. Eq. (1) is called multiresolution analysis and shows the original time series as the sum of a moving average value (S) and variations of X around this mean for different scales (D). The contribution of each scale factor D_j is defined as energy and represents the contribution to the sample variance of X due to changes in this factor: $\sigma_X^2 = \frac{1}{N}\sum_{j=1}^{N} W_j^{*2}$. Each element in the sub-matrix W_j , with (NxL) dimension, is a filter wavelet coefficient ($h_{t,l}$) and with $L \leq N$ depends on the selected filter type. Similarly, the sub-matrix V_j, with (NxL) dimension, is a filter scaling coefficient ($g_{t,l}$). Both types of coefficients are related as $g_{t,l} = (-1)^{(l+1)} \cdot h_{L-l-1}$. Different wavelet families have a trade-off between the degree of symmetry (i.e., linear phase characteristics of wavelets) and the degree to which ideal high-pass filters are approximated (Percival and Walden 2006). The degree of symmetry in a wavelet is important in reducing the phase shift of features during the wavelet decomposition. In this paper, unlike the studies above, the following filters (see Percival and Walden 2006) are tested:

- Haar: The simplest wavelet with a filter length of $L = 2$. This wavelet has compact support, however, it has just one vanishing moment and is piece-wise constant. The resulting wavelet basis functions have the significant additional disadvantage of being discontinuous.
- Daubechies: To overcome the disadvantage of the Haar wavelet, this wavelet filter has compact support and also has identified two sets of filters, namely, the extremal phase (D) and the least asymmetric (LA) or symmlets. These filters have even lengths L (between 2 and 20).
- Best Localised: This family refines the LA idea and penalises low frequency. The usual lengths are between 14 and 20.
- Coiflet: In this family of wavelet the scaling functions is vanishing moments. The wavelet is near symmetric. The usual lengths are between 6 and 30.

DWT is useful for decomposing time series data into an orthogonal set of components with different frequencies by checking the relationship between fluctuations in stock prices obtained from the reconstruction of the series by wavelet crystals. MODWT (Maximal Overlap Discrete Wavelet Transform), on the other hand, is a variant of DWT that can handle any sample size when $N - 2^J \neq 0$. The smooth and detail coefficients of MODWT multiresolution analysis are associated with zero phase filters and it produces a more asymptotically efficient wavelet variance estimator than the DWT. However, the MODWT loses the orthogonality. So, we apply MODWT but, unlike previous empirical studies, we select the most appropriate filter according to the orthogonality problem.

A secondary contribution of this empirical research is to study the optimal filter, scale, and length for each portfolio and risk factor, with three requirements: first, we select the filter with the most orthogonal signals or the determinant of correlation matrix among wavelet coefficients is close to 1; second, we select the scale with accumulated energy higher than 95%; and third, we select the length with the lowest RSME (Root Square Mean Error) of the original time series.

2.2. Multiscale Betas

The general multi-factor model for M portfolios and K risk factors is:

$$R_{i,t} - Rf_t = r_{i,t} = \beta_{0,i} + \sum_{k=1}^{K} \beta_{k,i} \cdot f_{k,t} + e_{i,t} \quad \forall i = 1, \dots, M \tag{2}$$

where R is monthly return, Rf is monthly risk-free rate and f is monthly risk factor value. The premium risk factor for each factor (λ_k) is estimated from:

$$r_{i,t+1} = \sum_{k=1}^{K} \beta_{k,i,t} \cdot \lambda_{k,t} \tag{3}$$

Such as Fama and MacBeth (1973), the risk factor-k premium for one-month (data frequency) term is $\hat{\lambda}_{1,k} = \frac{1}{T}\sum_{t=1}^{T} \lambda_{k,t}$.

If, however, we express the above model in time-scale format and replace monthly value for wavelet decomposition by scale coefficients (j) for both portfolios ($wr_{i,j,t}$) and risk factors ($wf_{k,j,t}$) then:

$$wr_{i,j,t} = \beta_{0,i,j} + \sum_{k=1}^{K} \beta_{k,i,j} \cdot wf_{k,j,t} + u_{i,j,t} \quad \forall i = 1, \dots, M \quad \forall j = 1, \dots, J \tag{4}$$

where $\beta_{i,j,k}$ is beta value for portfolio-i with respect to factor-k and scale-j and the vector $B_{i,k} = (\beta_{i,1,k}, \dots, \beta_{i,J,k})$ is the term structure of betas for factor-k. Note that since wavelets are orthogonal, Eq.(5) is estimated for each term separately. Finally, we estimate the term structure of the risk premium[ii] for each factor. First, we calculate the effect of each wavelet differentiating by term as:

$$wr_{i,j,t+1} = \sum_{k=1}^{K} \beta_{i,j,k,t} \cdot \omega_{j,k,t} \quad \forall j = 1, \dots, J \tag{5}$$

where $\omega_{j,k}$ shows the contribution to the risk premium of the wavelet of the term-j, since the wavelet decomposition explains the variation in time and frequency of the series observed for the original frequency. In this way, we obtain the risk factor-k and term-j premium as $\hat{\lambda}_{j,k} = \hat{\lambda}_{1,k} + \frac{1}{T}\sum_{t=1}^{T} \omega_{j,k,t}$.

3. Data

In this paper, we use monthly data from January 2004 until December 2019. The risk factors are obtained from French's data library[iii] for developed and emerging markets: Excess Return Market Portfolio on risk-free rate (Mkt-Rf), Small Minus Big portfolio returns (SMB), High Minus Low portfolio returns (HML), Robust Minus Weak portfolio returns (RMW), Conservative Minus Aggressive portfolio returns (CMA) and Momentum (WML).

Our portfolio sample are from Bloomberg and they are the equity market indexes including countries in developed and emerging markets to elaborate risk factors according to French's information. We have considered all the countries included in French's database, since we use their risk factors to facilitate the subsequent confirmation of our results, and the sample period is limited (beginning of the sample period) by the availability in Bloomberg of some emerging equity market indexes. In particular:

- *Countries included in developed markets*: Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, Great Britain, Hong Kong, Ireland, Italy, Japan, the Netherlands, Norway, New Zealand, Portugal, Sweden, Singapore, and the United States.
- *Countries included in emerging markets*: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Malaysia, Mexico, Pakistan, Peru, the Philippines, Poland, Qatar, Russia, Saudi Arabia, South Africa, South Korea, Taiwan, Thailand, Turkey, and the United Arab Emirates.

4. Empirical Results

4.1. Preliminary results: Wavelet Decomposition

Firstly, we apply 25 filters, with lengths of 5 to 30 days each for wavelet transform, as described above. Table-1 shows the selected filter and length for each factor and portfolio. The selection is made aiming for the wavelets to be as orthogonal as possible among the signals extracted (the determinant of the correlation matrix is close to one) with the selected scale wavelets that explain at least 95% of the covariance matrix and the smallest RSME (Root Square Mean Error) when rebuilding the original series (high- and low-pass filter).

[INSERT AROUND HERE TABLE-1]

Table-1 displays a secondary contribution of this paper for the selection of filter, scale, and length. First, in all cases up to the four-year scale we explain more than 95% of the behaviour of the original series. Our study of the term structure of the betas then has as a time limit a scale of four years. Second, unlike other empirical papers that apply wavelets to financial data[iv], as Reboredo, Rivera-Castro, and Ugolini (2017), we find that not all series require the same type of filter. Poland, for example, requires Best Localised. Regarding the length, we observe that the moving average (S) and its deviations (D) are longer (18 or 20 observations) than those used in the literature (eight observations), but they are consistent with the values used in other methodologies such as mixed data sampling (see González, Nave, and Rubio 2018). The selection of length and filter can condition subsequent results. Third, Fernandez (2006) and Masih, Alzahrani, and Al-Titi (2010) showed the contribution of each scale to total value at risk but unlike this paper they do not report the contribution of each wavelet or scale to the total systematic risk of the returns. We note that monthly excess returns contain relevant information for a frequency of at most three months to four years.

4.2. Analysis of Multiscale Betas

Now we estimate the sensitivity of market indexes to risk factors (Eq. (2)). We perform a rolling regression with four-year data, so the first result is December 2008 and the last November 2019. In Table-2 and for each index, we only show the sensitivity (β) mean value[v] estimates with the data in the original frequency.

[INSERT AROUND HERE TABLE-2]

Later, we estimate time-scale β from Eq. (4). Table-3 and Table-4 show the mean values by panels of each term and for developed and emerging markets, respectively.

[INSERT AROUND HERE TABLE-3 AND TABLE-4]

For the risk factors Mkt-Rf, SMB, HML, and RMW the values obtained for the sensitivities to these risk factors in both markets are similar using the data in the original frequency and also for the data of the wavelet decomposition's first terms (3 and 6 months and 1 year). This does not occur for vertex 2 and 4 years since their explanatory power is lower (see Table-1).

On the other hand, for the CMA and WML factors, note that while in emerging markets the sensitivity is less for all terms of wavelet decomposition than for the data in the original frequency, for developed markets, the sensitivities are only significant starting at 1 year. This result agrees with the evidence found by Fama and French (2017) on the same explanatory power about including CMA factor. From results of Table-2, Table-3 and Table-4, in Figure-1, we draw the time-scale mean-β for developed and emerging markets.

[INSERT AROUND HERE FIGURE-1]

Figure-1 shows that, for the market risk factor, the sensitivity of emerging markets is higher than developed markets', but this difference decreases with time. For SMB, HML, RMW, and CMA factors, we find that the sensitivity is similar up to the one-year vertex, but from this term the difference increases over time for emerging markets. Finally, regarding the WML factor, we observe that the sensitivity of developed markets is higher and the difference with respect to emerging markets increases over time.

The main implications of these results for investors are that risk factors such as RMW, CMA, and WML do not show significant relevance in both types of markets (low betas). Thus, Mkt-Rf is the main risk factor that explains the difference between emerging and developed markets. Additionally, sensitivity to the HML factor is more important in developed markets, while emerging markets are more sensitive to the SMB factor.

To verify the robustness and performance of the estimated models, in Table-5 and Table-6 we show an resume of alpha ratio or the ratio of the average absolute value of the alphas over the average absolute value of portfolio excess return, defined for a portfolio-i as $alpha_i = \frac{mean|\beta_{0,i}|}{mean|\bar{r}_i|}$, where $\beta_{0,i}$ is constant for Eq. (2) and Eq. (4). This ratio measures the dispersion of the alphas produced by a given asset pricing model relative to the dispersion of average excess returns and the low values suggests better performance of the model (alpha controlled). Additionally, *out R^2* is the out-of-sample R-square, which is estimated as $R_{out}^2 = 1 - \frac{MSE_{out}}{MSE_{mean}}$, where MSE_{out} is the mean square error of the out-of-sample predictions from our proposed model, and MSE_{mean} is the mean squared error of the historical sample mean. So, if $R_{out}^2 > 0$ then our proposed predictive regression model predicts returns better than the historical mean (see Welch and Goyal 2008). Finally, the endogeneity is analysed by regressing the error term from the predictive regression model on the error term from the predictor variable and the null hypothesis is of no endogeneity (see Devpura, Narayan, and Sharma et al 2018) (supplementary appendix shows all results).

[INSERT AROUND HERE TABLE-5 AND TABLE-6]

Regarding the results of Table-5 and Table-6, firstly note that the *alpha* ratio is lower in all cases for the models estimated from the wavelet decomposition values than using the original data and this indicates better performance since the constant variation is controlled. Second, out-of-sample R^2 presents lower values for the original data (1 month) than for the first wavelet frequencies (3 and 6 months and 1 year). Furthermore, while in the original frequency there are cases with negative values (New Zealand, Greece, the Czech Republic, and Poland) for the estimates from the wavelet decomposition this is not the case. Note that the predictive capacity of wavelet decomposition decreases with the term, as expected from the results of Table-1.

For the original frequency, out-of-sample R^2 is observed very close to zero especially for emerging markets (Qatar and Saudi Arabia). According to these results, the wavelet information obtains better performance than the data in the original frequency. Additionally, the results in Table-5 and Table-6 indicate that developed markets show fewer endogeneity problems than emerging markets and that these problems are less as the term increases, that is, there are more significant cases for the original data (1 month) than for the vertex of the longer term structure (starting at 3 months). Finally, the risk factor with the highest cases of endogeneity is WML.

4.3. Term Structure of Risk Premiums

First, to estimate risk premiums, Eq. (3) and Eq. (5), for monthly data and wavelet decomposition respectively, are estimated. The parameters are in Table-7.

[INSERT AROUND HERE TABLE-7]

From Table-7, we obtain the term structure of risk factor premiums in Table-8.

[INSERT AROUND HERE TABLE-8]

To compare the results for developed and emerging markets, Figure-2 shows the annualised results of term structure premiums for each risk factor.

[INSERT AROUND HERE FIGURE-2]

Note in Figure-2 that for some factors (SMB, HML, RMW, and WML) the spread between developed and emerging markets is constant over time and with higher premiums for developed markets. SMB, HML, and RMW in particular show a spread of around 6% annualised. Even for HML and RMW the sign of the premium is negative for emerging markets. As for the WML factor, the spread is around 2% annualised. In short, for these factors no temporal evolution of the risk premium is observed.

The results for Mkt-Rf and CMA are different. For the CMA factor, only developed markets show a variation of the risk premium with the term; the premium for developed markets is higher than emerging ones and after six months the spread increases. Finally, there only seems to be a time structure for both types of market for market risk premium; this is the only case in which the emerging market premium is higher than developed markets'. Additionally, we observe that market risk premium decreases with the term, although the spread remains similar for all terms, between 2.5% and 3%. Finally, to test this evidence, we check using a Wald-test if the difference between developed and emerging market risk premiums for each term and factor is the same. The results are below in Table-9.

[INSERT AROUND HERE TABLE-9]

From Table-9, note that only for Mkt−Rf and CMA factors do we reject the hypothesis on the constant spread between emerging and developed markets.

5. Conclusions

For the 2004–2019 period in monthly frequency and using a wavelet decomposition we estimate the term structure of risk premium (from 1 month to 4 years) for the usual risk factors utilised in asset pricing models for both developed and emerging markets.

The results have relevant evidence for investors. Firstly, they highlight that both types of markets are not overly sensitive to RMW, CMA, and WML factors. Specifically, Mkt-Rf is the most relevant factor in both types of markets and while HML shows higher sensitivities for developed markets, the SMB factor does for emerging markets.

Secondly, the evidence indicates that the spread (emerging higher than developed) remains constant for all terms, around 6% annual, for SMB and HML. Therefore, the investment horizon does not affect the spread return in emerging or developed markets.

Finally, the market risk factor (Mkt-Rf) is the only one that shows a term structure for both types of markets and with a negative slope. In this case, unlike the previous ones, and as the existing literature has already verified, the emerging market risk premium is higher than in developed markets in all terms. However, these term structures show a similar spread for all terms (around 3%).

Therefore, our empirical evidence is relevant for investors and economic agents insofar as it simplifies the analysis of differences in risk premiums between both types of markets, since they show that these markets are more sensitive to Mkt-Rf, SMB, and HML, and also that the spreads between the risk premiums of both types of market are independent of the term.

A secondary contribution of this study is to prove that the wavelet filter (filter type and length) applied for the decomposition must be chosen to maximise the orthogonality and minimise the prediction error of the original series (explanatory power or energy of over 95%).

In short, while we observe that Mkt-Rf is an explanatory factor for both types of markets, HML shows higher weight in developed markets, and on the contrary, SMB does so in emerging markets. This seems to indicate that the size effect is more important in emerging markets as a guarantee of future results, while in developed countries abnormal returns or expected growth options (measured by the market-to-book ratio) are preferable. There may be several causes of this differentiation, which allow development of future new studies, such as the relevance of the financial information of firms listed in emerging markets compared to developed ones, the guarantee of future earnings in emerging markets depends on the size of the firm and the investor in emerging markets does not adequately identify the growth expectations of the firms or includes them as a component of the size of the company.

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TABLES

Table 1. Selection Wavelet Filter

Risk Factors	Filter	Determ	RSME	E% 3 months	E% 6 months	E% 1 year	E% 2 years	E% 4 years	Accumul.%
Panel A. Developed markets factors									
Mkt-Rf	D-18	0.9894	0.0331	43.50%	23.42%	14.55%	9.95%	6.42%	97.85%
SMB	LA-20	0.9931	0.0106	48.15%	22.65%	14.72%	4.38%	7.44%	97.33%
HML	D-18	0.9743	0.0133	41.90%	24.43%	18.67%	4.84%	7.08%	96.92%
RMW	D-18	0.9914	0.0084	42.29%	25.93%	19.16%	6.82%	4.38%	98.58%
CMA	D-18	0.9925	0.0113	33.67%	15.91%	29.42%	14.80%	4.07%	97.86%
WML	D-18	0.9889	0.0261	36.66%	30.19%	13.82%	10.77%	5.75%	97.19%
Panel B. Developed markets indexes									
Australia	D-18	0.9798	0.0279	45.07%	21.35%	13.98%	9.44%	6.63%	96.47%
Austria	LA-20	0.984	0.0573	40.19%	19.44%	18.34%	11.04%	7.30%	96.31%
Belgium	D-18	0.9883	0.0371	38.21%	26.72%	11.41%	9.31%	8.71%	94.36%
Canada	D-18	0.9919	0.0281	40.23%	18.80%	22.04%	10.86%	6.38%	98.31%
Switzerland	D-18	0.963	0.0273	42.98%	22.66%	14.18%	8.19%	7.00%	95.01%
Germany	LA-8	0.9684	0.0401	44.66%	28.60%	13.28%	6.84%	4.73%	98.11%
Denmark	D-18	0.9862	0.0393	41.80%	21.83%	18.33%	8.54%	5.75%	96.25%
Spain	D-18	0.9661	0.0392	48.25%	25.37%	11.13%	7.63%	5.69%	98.08%
Finland	D-18	0.9853	0.0415	40.30%	25.34%	16.04%	6.70%	9.04%	97.41%
France	D-18	0.9805	0.0342	45.54%	27.24%	11.57%	7.40%	5.29%	97.03%
Great Britain	D-18	0.9908	0.0254	53.68%	23.57%	9.09%	6.45%	5.34%	98.13%
Hong Kong	D-18	0.9955	0.0448	47.38%	21.11%	15.86%	10.77%	4.48%	99.60%
Ireland	LA-20	0.9641	0.0449	38.74%	20.19%	17.37%	10.59%	8.21%	95.10%
Italy	LA-20	0.9431	0.0427	47.84%	24.60%	10.90%	7.99%	5.73%	97.06%
Japan	D-18	0.9686	0.0422	44.31%	22.39%	17.02%	7.93%	4.38%	96.02%
Netherlands	D-18	0.9846	0.0355	45.96%	22.88%	12.75%	9.00%	6.59%	97.19%
Norway	D-18	0.9857	0.0445	39.77%	23.58%	19.58%	8.79%	5.62%	97.33%
New Zealand	D-18	0.9719	0.0246	46.34%	24.90%	10.26%	6.56%	3.92%	91.98%
Portugal	D-18	0.9864	0.0407	41.26%	26.04%	13.32%	9.60%	7.97%	98.19%
Sweden	D-18	0.9851	0.0331	50.27%	20.32%	12.60%	7.14%	7.44%	97.77%
Singapore	D-18	0.9919	0.0388	43.42%	21.13%	15.95%	10.94%	7.53%	98.97%
United States	D-18	0.9771	0.0305	45.97%	23.95%	13.54%	7.89%	5.29%	96.65%
Panel C. Emerging markets factors									
Mkt-Rf	D-18	0.9925	0.0474	41.71%	19.50%	17.77%	12.85%	6.63%	98.46%
SMB	D-18	0.9934	0.0128	44.56%	24.84%	16.73%	7.85%	4.90%	98.88%
HML	D-18	0.9936	0.0122	43.21%	24.04%	12.52%	11.85%	4.44%	96.05%
RMW	D-18	0.9875	0.009	39.38%	28.90%	12.97%	6.88%	7.32%	95.45%
CMA	LA-20	0.9959	0.0105	41.22%	21.06%	19.63%	11.92%	5.01%	98.83%
WML	D-18	0.9911	0.0226	34.63%	31.48%	13.36%	11.49%	7.88%	98.84%
Panel D. Emerging markets indexes									
Argentina	LA-20	0.9941	0.0781	47.96%	29.24%	11.84%	4.59%	4.52%	98.14%
Brazil	D-18	0.9935	0.0487	44.71%	24.15%	16.49%	9.95%	2.64%	97.93%
Chile	D-18	0.993	0.0351	45.22%	24.93%	13.71%	6.86%	6.82%	97.54%
China	LA-20	0.9556	0.0681	42.07%	23.33%	9.23%	12.79%	9.38%	96.80%
Colombia	LA-20	0.9959	0.0503	40.66%	24.67%	18.73%	3.86%	5.10%	93.02%
Czech Republic	D-18	0.9936	0.0437	42.03%	22.67%	16.04%	9.82%	6.02%	96.58%
Egypt	D-18	0.9882	0.0746	42.41%	25.60%	11.93%	9.95%	6.43%	96.31%
Greece	D-18	0.993	0.3329	57.71%	22.74%	10.20%	5.43%	1.93%	98.02%
Hungary	D-18	0.9935	0.0509	40.53%	23.76%	16.48%	9.13%	6.41%	96.30%
India	D-18	0.9907	0.0464	46.85%	23.37%	13.52%	10.18%	5.04%	98.96%
Indonesia	LA-20	0.9991	0.045	40.48%	21.74%	15.74%	13.81%	6.21%	97.97%
Malaysia	LA-20	0.9987	0.0273	41.70%	23.62%	11.93%	11.18%	9.68%	98.11%

Mexico	D-18	0.9948	0.0355	47.56%	21.37%	14.14%	7.28%	5.48%	95.83%
Pakistan	D-18	0.985	0.051	41.01%	29.84%	12.54%	8.59%	4.12%	96.10%
Peru	LA-20	0.9994	0.0657	43.45%	13.56%	19.62%	10.65%	7.77%	95.05%
Philippines	D-18	0.9931	0.0382	49.74%	19.46%	12.96%	8.56%	6.48%	97.20%
Poland	BL-20	0.981	0.0408	53.34%	20.31%	9.75%	7.04%	7.37%	97.81%
Qatar	D-18	0.9854	0.061	44.97%	25.46%	12.39%	9.97%	4.90%	97.70%
Russia	D-18	0.9938	0.0579	38.68%	20.01%	20.46%	11.87%	6.32%	97.33%
Saudi Arabia	D-18	0.97	0.06	40.80%	26.20%	11.23%	11.08%	6.60%	95.91%
South Africa	D-18	0.9874	0.0285	56.73%	17.31%	10.85%	6.53%	4.65%	96.07%
South Korea	LA-20	0.9952	0.0358	52.95%	18.04%	14.42%	8.95%	4.06%	98.42%
Taiwan	D-18	0.9953	0.0404	43.14%	19.79%	19.43%	11.31%	6.13%	99.80%
Thailand	D-18	0.9942	0.0427	42.89%	23.59%	12.53%	13.48%	4.47%	96.96%
Turkey	LA-20	0.996	0.0557	49.31%	25.62%	11.31%	8.11%	4.54%	98.89%
United Arab Emirates	D-18	0.9642	0.0568	34.70%	24.58%	12.69%	14.14%	9.40%	95.52%

Note: *Portfolio* are stock market indexes. *D*, *LA,* and *BL* are Daubechie, Least Asymmetric, Best Localised, respectively. *E%* is accumulated energy or explanatory power. *Determ* is determinant of wavelet correlation matrix. *RSME* is root squared mean error.

Table 2. Mean value of results β estimate for monthly excess returns

Country	Mkt-Rf	SMB	HML	RMW	CMA	WML
Panel A. Developed markets indexes						
Australia	0.6974	-0.0838	0.1248	0.1636	-0.2348	0.0839
Austria	1.0663	-0.0338	0.4002	-0.661	-1.1713	-0.0196
Belgium	0.7049	-0.3266	0.1578	-0.2924	-0.4255	0.016
Canada	0.5478	0.1598	0.2593	-0.0479	-0.8058	0.0435
Switzerland	0.5202	-0.7663	0.0448	-0.5385	0.0416	0.0449
Germany	0.9179	-0.5326	0.1536	-0.1781	-0.4742	0.0558
Denmark	0.5843	0.2527	0.0725	-0.1957	-0.7337	0.1758
Spain	0.8984	-0.7002	0.4617	-0.0901	-0.1161	-0.1532
Finland	0.8375	-0.1108	0.0867	0.0216	-0.4056	-0.0238
France	0.8474	-0.723	0.3746	-0.0288	-0.2586	0.0392
Great Britain	0.7602	-0.3799	0.2555	0.4286	0.021	0.0958
Hong Kong	1.0686	-0.027	-0.1523	0.301	-0.707	-0.0457
Ireland	0.5116	0.0892	0.4205	-0.4197	-0.8743	-0.0849
Italy	0.8817	-0.792	0.8998	-0.2706	-0.5166	-0.0517
Japan	0.7788	-0.0724	0.2702	-0.6257	-0.4854	0.2204
Netherlands	0.8324	-0.3653	0.314	0.074	-0.4056	0.1233
Norway	0.9206	0.0759	0.3074	0.4596	-0.8929	0.1942
New Zealand	0.429	0.1979	0.0798	0.4437	0.0121	0.0057
Portugal	0.8208	-0.1075	0.4557	0.2198	-0.4334	-0.0419
Sweden	0.7589	-0.091	-0.3208	0.102	0.1241	-0.1075
Singapore	0.8619	0.1493	0.0439	0.2987	-0.3949	0.0037
United States	0.9049	-0.299	-0.1024	-0.0623	0.254	-0.0146
Panel B. Emerging markets indexes						
Argentina	0.6108	0.334	0.9103	-1.3359	-1.0376	-0.4034
Brazil	0.6882	-0.4667	0.6272	-0.2826	0.0292	-0.2813
Chile	0.5194	0.1553	-0.3093	0.2007	0.308	-0.147
China	0.5346	0.2026	0.9402	-0.2548	-0.7218	0.1302
Colombia	0.3652	0.5337	-0.5965	0.6299	1.0689	-0.2121
Czech Republic	0.5898	0.2042	0.3677	0.7222	-0.1493	-0.1164
Egypt	0.4722	0.4445	0.2452	0.0503	1.2843	-0.5675
Greece	0.8681	0.1603	0.3801	-1.4475	-1.3412	-0.4675
Hungary	0.507	0.418	1.0344	0.0067	-0.8464	-0.2621
India	0.7231	-0.2946	-0.5266	0.0552	-0.4852	-0.0798
Indonesia	0.6931	0.2314	-0.0506	0.1579	0.1413	0.1918
Malaysia	0.365	0.1871	-0.029	0.2444	-0.0861	0.0532
Mexico	0.4179	-0.2977	0.1131	-0.0434	-0.0303	-0.0241
Pakistan	0.2859	0.2219	1.0116	1.1098	-0.1469	0.1247
Peru	0.6902	0.3169	0.6736	-0.3977	-0.4601	-0.3536
Philippines	0.6248	0.2584	-0.3733	0.3039	-0.1476	0.2482
Poland	0.6825	0.0735	0.3019	0.6971	-0.0445	-0.0166
Qatar	0.4864	-0.0504	0.3841	0.5004	0.1288	-0.2631
Russia	0.5899	-0.2781	0.176	-0.4327	-0.3866	-0.1296
Saudi Arabia	0.5629	0.3954	-0.2674	0.1094	0.5637	-0.2706
South Africa	0.5275	-0.153	-0.0026	0.1946	0.1659	0.0456
South Korea	0.6507	0.0318	0.3398	0.5163	-0.0592	0.0987
Taiwan	0.7129	0.344	-0.0538	0.1324	0.2773	-0.0224
Thailand	0.6659	0.1764	-0.1246	-0.4804	-0.0921	0.2581
Turkey	0.8733	0.0975	-0.13	0.7556	0.8552	-0.1836
United Arab Emirates	0.252	0.4403	0.4153	0.1456	-0.3324	0.1928

Table 3. Mean value of time-scale β for developed markets

Countries	Panel A. Mkt-Rf					Panel B. SMB				
	3m	**6m**	**1y**	**2y**	**4y**	**3m**	**6m**	**1y**	**2y**	**4y**
Australia	0.6778	0.7450	0.6039	0.7900	0.4604	-0.2015	-0.0446	-0.3769	0.1657	1.0842
Austria	0.9836	-0.6159	-0.7637	1.2087	2.4345	-0.6610	-0.2372	2.4589	7.0692	5.0651
Belgium	0.6222	0.8735	0.8146	0.7683	0.5822	-0.6817	-0.3454	1.1760	-0.8495	0.2036
Canada	0.5137	0.5873	0.5993	0.6093	-0.5380	-0.1634	-0.2796	0.0258	-0.0793	-1.6215
Switzerland	0.3896	0.4992	0.9850	-0.1515	0.3005	-1.0754	0.4379	1.2001	-0.5385	1.1695
Germany	0.7275	-0.5553	-0.7731	0.8304	0.9723	-0.5292	-0.4339	-2.5811	1.1119	0.3238
Denmark	0.4691	0.7580	0.7208	0.2565	-0.2323	0.1810	-0.4062	1.4048	-1.1994	0.2738
Spain	0.8654	0.8723	1.2699	0.3088	1.1309	-0.5143	-0.3397	1.6225	-1.1715	-1.3141
Finland	0.6925	0.8848	1.2254	-0.0383	0.2845	-0.2104	-0.4141	0.4644	0.2261	0.1759
France	0.7794	0.9684	1.0441	0.0831	0.9670	-0.8388	0.1201	0.8503	0.1912	0.7689
Great Britain	0.7402	0.7488	0.7303	0.6566	0.1730	-0.7037	-0.0171	0.2123	0.1974	0.5054
Hong Kong	1.1511	1.0345	0.8758	2.3574	-0.1771	-0.0478	-0.1249	0.2842	0.3572	-0.3143
Ireland	0.3840	-0.4392	-0.1298	1.9024	-0.0561	-0.1733	-0.2225	0.7579	4.6416	2.8925
Italy	0.8040	-0.5860	-0.3694	1.0142	2.6057	-0.8789	-1.2127	0.0866	3.1531	6.3137
Japan	0.7842	1.1873	0.8575	-1.0962	1.7712	-0.0582	-0.1044	-1.2987	0.1249	1.5629
Netherlands	0.8192	1.0090	0.8698	0.4854	0.0279	-0.4060	-0.2494	1.3072	0.3300	0.2120
Norway	0.8492	1.0455	0.8948	0.1322	-0.0087	-0.2403	-0.7209	-0.2702	0.0681	-0.1921
New Zealand	0.2619	0.4989	0.5090	0.9752	1.2663	-0.1375	-0.0678	-1.3662	-0.3505	1.8168
Portugal	0.7295	0.8969	0.6333	1.4566	3.3024	-0.4732	-0.5975	0.1278	-0.4549	2.6090
Sweden	0.7525	0.9923	0.8344	-0.6534	0.0859	-0.0957	0.2023	0.6673	-0.0714	-0.5930
Singapore	0.8207	0.9832	0.8204	0.5850	-0.3664	0.1071	-0.4210	-0.2838	0.2504	-0.4419
United States	0.8829	0.9378	0.8593	0.5698	0.2736	-0.2186	0.3205	0.2344	0.0514	-0.6638

Countries	Panel C. HML					Panel D. RMW				
	3m	**6m**	**1y**	**2y**	**4y**	**3m**	**6m**	**1y**	**2y**	**4y**
Australia	-0.1732	0.2170	0.2911	-0.4943	0.3554	0.3556	0.4318	0.0792	-0.5781	-1.8325
Austria	0.0352	0.2014	2.4369	-1.7515	-7.4772	-0.4887	0.0282	0.1044	-4.2197	9.8268
Belgium	0.0592	-0.6602	-0.0974	0.2015	0.6946	-0.0033	0.0059	-0.9552	0.1691	-3.4908
Canada	-0.1733	0.3184	0.8967	0.8042	3.0360	-0.1126	-0.1853	-0.5356	-0.0447	-2.0254
Switzerland	-0.3384	-0.2666	-0.3289	0.7568	-0.7937	-0.6586	0.1903	0.1435	0.8178	-2.6240
Germany	0.3540	1.3029	-1.5001	-2.1542	4.4750	-0.1380	-0.1441	-1.9118	-1.6336	3.8103
Denmark	-0.4216	-0.2622	1.5936	1.2596	1.6894	0.8748	-0.4589	-1.5175	0.3873	-6.5234
Spain	1.0507	-0.1424	-0.5827	-1.0424	-0.4965	0.2862	-0.1502	-0.5154	0.6255	1.6435
Finland	-0.6193	0.4367	0.8400	-0.8314	1.5778	0.8993	-0.3575	-0.4310	-0.3048	-3.0824
France	0.2612	-0.0063	-0.1493	-0.6108	-1.1965	0.1157	0.0848	-0.1987	-0.5830	-1.0837
Great Britain	0.1348	0.2215	-0.0047	-0.6555	0.7907	0.6663	0.1990	0.0324	-0.2611	-1.3920
Hong Kong	0.1738	-0.6295	0.3997	0.1158	2.3010	1.4140	-0.0138	-1.4818	-0.1065	-5.5690
Ireland	-0.3335	-0.3949	1.1265	0.0359	-1.9377	-0.2368	0.3034	1.7798	-2.4751	3.2271
Italy	0.9408	-0.0256	1.8990	-1.1785	-6.6328	0.1402	0.3586	0.5431	-1.3349	7.7195
Japan	0.5438	0.0957	-0.2814	0.4298	-3.6475	-0.0795	0.3310	0.4440	-0.2192	0.7125
Netherlands	0.3615	-0.1585	0.3773	-0.6581	0.9374	0.7532	0.0944	-0.5162	-0.0289	-4.2817
Norway	0.0759	0.0926	1.4253	0.5453	2.3447	0.5602	0.0618	-0.2439	-0.4893	-3.6226
New Zealand	0.1572	0.1622	0.8567	0.1226	-1.9366	0.4371	0.8678	0.5490	0.8878	1.2164
Portugal	0.7430	-0.4425	-0.7933	0.2523	-4.8759	0.5129	-0.1727	-1.0994	-1.9352	4.9105
Sweden	-0.5970	-0.5797	0.7073	-0.3506	0.5794	0.7978	0.1571	-0.6051	0.2474	-2.9048
Singapore	0.4226	-0.2094	-0.0121	1.4731	2.6251	0.3701	0.0289	-0.7958	-0.9853	-5.6549
United States	-0.2594	0.0011	0.0659	-0.5015	1.1072	-0.2843	-0.1027	-0.0708	0.8116	-1.3223

Countries	Panel E. CMA					Panel F. WML				
	3m	**6m**	**1y**	**2y**	**4y**	**3m**	**6m**	**1y**	**2y**	**4y**
Australia	0.0001	0.0001	-0.6442	0.1302	0.0001	0.0001	0.0001	0.0169	0.4301	0.0363
Austria	0.0001	0.0001	-1.1982	-3.1433	0.0001	0.0001	0.0001	0.3922	2.3492	-1.0373
Belgium	0.0001	0.0001	-0.2741	0.1330	0.0001	0.0001	0.0001	0.0598	-0.0615	0.0500
Canada	0.0001	0.0001	-1.6850	-1.1516	0.0001	0.0001	0.0001	-0.1029	-0.2541	0.1966

Switzerland	0.0001	0.0001	0.8543	-1.2823	0.0001	0.0001	0.0001	0.2080	-0.3037	-0.2614
Germany	0.0001	0.0001	-0.8069	0.5472	0.0001	0.0001	0.0001	-0.7461	1.2692	0.6202
Denmark	0.0001	0.0001	-2.4949	-1.8964	0.0001	0.0001	0.0001	0.5433	-1.0002	0.5039
Spain	0.0001	0.0001	1.6576	0.3390	0.0001	0.0001	0.0001	0.0447	-0.6534	-0.7592
Finland	0.0001	0.0001	-0.3837	-4.3906	0.0001	0.0001	0.0001	-0.2382	-0.2195	0.4577
France	0.0001	0.0001	0.1495	-2.3705	0.0001	0.0001	0.0001	-0.1302	0.1038	-0.1661
Great Britain	0.0001	0.0001	-0.0653	0.1151	0.0001	0.0001	0.0001	0.1158	0.1592	0.0851
Hong Kong	0.0001	0.0001	-1.6857	6.2616	0.0001	0.0001	0.0001	0.1970	0.4646	0.0746
Ireland	0.0001	0.0001	0.2095	-1.5057	0.0001	0.0001	0.0001	0.2686	1.1231	0.3750
Italy	0.0001	0.0001	-1.2648	-0.6493	0.0001	0.0001	0.0001	0.6461	0.2068	0.0444
Japan	0.0001	0.0001	-0.1968	-7.3263	0.0001	0.0001	0.0001	-0.2403	-0.2933	-0.4268
Netherlands	0.0001	0.0001	-0.4294	-2.2139	0.0001	0.0001	0.0001	0.2963	-0.1345	0.1125
Norway	0.0001	0.0001	-2.5856	-4.2720	0.0001	0.0001	0.0001	0.4886	-0.5392	0.4855
New Zealand	0.0001	0.0001	-0.9524	1.0010	0.0001	0.0001	0.0001	-0.0798	0.0482	-0.1048
Portugal	0.0001	0.0001	0.1748	-0.5872	0.0001	0.0001	0.0001	-0.1344	-0.3415	-0.2622
Sweden	0.0001	0.0001	-1.0417	-6.3405	0.0001	0.0001	0.0001	0.1980	-0.5670	-0.5710
Singapore	0.0001	0.0001	-0.6803	-0.4124	0.0001	0.0001	0.0001	0.0301	-0.1227	-0.1133
United States	0.0001	0.0001	-0.1142	0.0100	0.0001	0.0001	0.0001	-0.0235	-0.0027	0.0251

Note: The factor loadings are displayed by panels. These values are estimated by Eq.(4).

Table 4. Mean value of time-scale β for emerging markets

Countries	Panel A. Mkt-Rf					Panel B. SMB				
	3m	6m	1y	2y	4y	3m	6m	1y	2y	4y
Argentina	0.2507	-0.3736	-0.3513	-0.1209	-0.4449	-0.5943	-0.4964	0.1548	0.7607	6.6022
Brazil	0.5904	0.6579	0.6655	1.0088	0.3189	-0.4709	-1.047	-0.6668	0.2367	0.1865
Chile	0.4361	0.2179	0.5679	0.3211	0.0544	-0.1627	-0.0663	0.0372	1.488	1.2455
China	0.4524	-0.1232	0.361	0.9789	6.4709	-0.2813	-0.0954	-1.0871	0.5803	-6.3271
Colombia	0.1038	-0.3836	-0.6338	0.4111	-0.4464	0.3738	-0.9015	-0.905	0.8537	3.8951
Czech Republic	0.624	0.8044	0.607	-0.0597	0.6208	0.2056	-0.3445	0.0064	0.3421	1.3803
Egypt	0.1529	0.7276	0.6853	0.4295	1.6258	0.801	-0.5373	1.4905	0.4573	-0.9173
Greece	0.7224	-1.3499	0.4283	-0.6084	-0.9573	-1.248	-0.07	-1.3592	1.6854	2.3968
Hungary	0.4863	0.7911	0.7335	0.4731	0.1023	0.2109	0.7874	0.0744	0.1367	3.9209
India	0.7181	0.8387	0.9616	0.9151	0.2161	-0.2494	0.3074	0.1319	-1.186	-0.2649
Indonesia	0.5983	-0.5901	-0.4818	-0.6665	-0.6199	0.0398	-0.2793	-0.6179	1.3323	1.538
Malaysia	0.3513	-0.1792	-0.2832	0.2149	-0.5208	0.3602	-0.1142	0.0467	0.0925	1.2313
Mexico	0.3114	0.7432	0.3997	0.0196	0.4208	-0.6365	-0.075	0.1198	0.331	2.1717
Pakistan	0.1251	0.4454	0.1964	-0.135	1.0537	-0.0155	-0.2941	1.164	-0.0174	1.55
Peru	0.4917	-0.5736	0.0207	-0.1938	-2.4385	-0.6549	-0.6095	-1.1032	1.9758	4.3237
Philippines	0.5526	0.6292	0.4195	1.0474	0.0547	0.2457	0.2193	0.6658	0.4066	1.9788
Poland	0.7261	-0.6222	-0.2394	-0.1309	-0.1096	0.0032	-0.1769	-0.2378	0.476	3.052
Qatar	0.329	0.9376	0.0529	-0.0748	0.3695	-0.5304	0.8066	0.5939	1.3729	-4.0524
Russia	0.7099	0.8579	0.9941	0.05	0.5209	-0.0417	0.8015	-0.8169	-0.6268	1.7294
Saudi Arabia	0.3002	-0.0544	0.5521	-0.3088	0.5132	0.0543	-0.3138	1.0174	0.0224	-3.8725
South Africa	0.5625	0.6122	0.3418	0.4427	0.5287	-0.3298	-0.0627	-0.7814	-0.0023	0.0277
South Korea	0.6575	-0.35	-0.3776	-0.1043	0.6716	0.0946	0.229	0.2464	1.2172	1.6491
Taiwan	0.7301	0.8197	0.7633	0.3805	0.9475	0.6678	0.5123	-0.2564	-0.0633	-0.5435
Thailand	0.5221	0.7653	0.6598	1.3032	-0.2307	0.2873	0.4443	0.3319	0.5987	1.7751
Turkey	0.7554	-0.5464	-0.0946	-0.4616	0.2794	0.4146	-0.0311	-0.3428	0.2974	1.1783
United Arab Emirates	0.19	-0.0161	-0.1463	0.8648	0.0198	0.1254	0.1185	0.5636	0.8221	-2.6525
Countries	*Panel C. HML*					*Panel D. RMW*				
	3m	**6m**	**1y**	**2y**	**4y**	**3m**	**6m**	**1y**	**2y**	**4y**
Argentina	1.6627	-1.8704	-0.8187	-0.042	-1.4346	-1.4654	-2.1343	4.4678	1.0489	1.9556
Brazil	0.8244	1.5045	-0.2335	0.2565	1.1686	-0.6315	1.5335	-0.7438	-1.7989	3.04
Chile	0.0533	-0.3852	-0.0536	0.5254	1.5574	0.2011	-1.1561	-0.3525	0.8684	3.4545
China	1.6021	1.8209	0.0911	-2.1814	-8.8957	1.5252	-0.1798	0.2441	0.5456	-27.7058
Colombia	-0.4418	0.2503	0.42	0.7487	0.4327	1.2292	0.9885	0.3014	3.5155	3.0692
Czech Republic	-0.1318	0.1013	1.2382	1.0838	0.5109	0.5493	2.0276	0.7203	-1.3625	1.2748
Egypt	-1.046	-0.4146	0.4351	-2.0199	4.2758	-1.9831	1.8495	2.0264	-2.8819	4.3618
Greece	1.4613	1.6996	1.683	2.3191	-1.2714	-1.6288	-6.5202	3.0741	2.4995	-1.125
Hungary	1.4059	0.1365	0.2289	2.1731	1.1187	-0.1867	0.2177	-1.2972	0.6944	2.2385
India	-0.0588	-0.2066	0.0885	-1.1096	0.9575	-0.6607	0.9057	0.5307	0.2663	2.6894
Indonesia	0.0828	0.4809	-0.7105	1.5435	-1.3447	0.1113	0.225	-0.5889	-0.5148	-1.6224
Malaysia	-0.2639	-0.5985	0.1863	-0.3574	-0.3491	-0.152	-0.9045	0.2913	0.1826	-0.1186
Mexico	0.1987	-0.2665	0.2335	1.5092	-0.466	-0.3661	0.5699	-1.0733	0.2827	2.6766
Pakistan	1.9617	-1.0854	-1.4952	1.5643	0.2594	0.4146	3.188	-0.7457	-0.7881	0.3674
Peru	0.9367	0.2046	-0.1926	0.9283	3.846	0.0855	-0.1369	3.6502	4.4615	5.0682
Philippines	0.1927	-1.4438	-0.5792	0.7189	0.6317	-0.4349	-0.4247	-1.3278	2.1336	2.9812
Poland	0.2774	0.0307	0.9082	-0.1941	-1.5612	0.8322	-0.8745	2.2365	1.2406	-2.4527
Qatar	1.2209	0.1581	-0.8903	2.8435	5.3895	0.1464	1.5598	-2.4069	4.8551	0.6388
Russia	0.4898	0.7408	0.434	-0.434	-2.7154	-0.8231	-0.3976	0.8349	-3.7346	-0.3509
Saudi Arabia	0.4425	1.3833	-0.4939	-0.5907	4.939	-0.2757	0.7189	4.0314	-3.5271	2.4999
South Africa	0.1667	-0.3971	0.9767	-0.1349	-0.6379	0.5297	0.1674	0.8241	-0.8433	-0.3568
South Korea	0.8107	-0.8554	0.4883	0.909	-3.3261	0.6121	-0.6141	2.7135	2.2054	-2.9346
Taiwan	-0.2958	-0.2855	-0.4715	0.4148	-1.0029	-0.4191	0.648	-0.8903	0.6603	-2.0606
Thailand	0.4109	0.0834	-0.5718	-0.5446	2.0307	-0.9924	-1.5924	-1.3464	2.5119	4.5415

Turkey	0.8523	0.0971	0.6937	2.0619	-3.0605	0.3234	-1.7094	1.9743	2.6097	-6.2136
United Arab Emirates	0.9269	-0.4543	0.3047	1.1642	7.1555	-0.5359	1.2487	2.3317	5.6206	-0.4027
Countries	*Panel E. CMA*					*Panel F. WML*				
	3m	**6m**	**1y**	**2y**	**4y**	**3m**	**6m**	**1y**	**2y**	**4y**
Argentina	-0.701	-4.2014	-4.0929	-4.2365	-2.4202	-0.3659	0.5886	-1.4339	-0.5225	-0.6512
Brazil	-0.2944	0.3953	-1.267	0.9522	-1.9705	-0.0985	-0.4461	-0.0924	-0.5226	0.0532
Chile	0.3368	-0.6469	0.5363	-0.5552	-1.1485	-0.1777	-0.3927	-0.2394	-0.9117	0.3839
China	-0.3817	1.4552	1.2463	-2.778	-0.3592	0.4627	-0.905	-0.9449	0.4912	-3.1576
Colombia	0.7583	0.635	-0.9832	-0.9451	-1.7813	0.2421	-0.2839	0.8011	0.8637	-0.1613
Czech Republic	-0.1358	-0.048	0.5952	0.7463	-0.4387	0.0628	-0.355	0.0789	-0.1927	0.287
Egypt	0.9433	-1.8403	1.0366	2.331	-4.776	-0.9159	-0.929	-1.3458	-1.581	-0.3236
Greece	-0.7895	-3.924	3.6195	-2.5421	-2.1769	0.1796	1.1243	-0.3762	5.7964	-1.1397
Hungary	-0.8176	-0.1295	1.306	-0.2047	-1.2001	-0.2933	-0.7798	0.6277	-0.4761	0.2881
India	-0.5931	0.4764	1.0722	-0.3417	-1.5629	0.1254	-0.5485	-0.4589	1.2301	0.4606
Indonesia	0.4465	-1.0696	-2.4025	-2.5777	-0.0325	0.1202	-0.1891	-0.2039	-0.307	0.6283
Malaysia	-0.14	-1.0712	-0.9905	-1.3479	-1.4329	0.0608	0.0303	-0.5739	0.6147	0.3596
Mexico	0.0233	0.1673	0.2474	0.5514	-0.7368	-0.2593	0.1011	0.1553	0.6443	-0.4392
Pakistan	-0.5588	-2.5385	-0.2791	1.9011	-1.2551	0.5772	-0.3846	-1.0235	0.4559	-0.3439
Peru	0.1495	-0.8741	-3.8046	-4.325	-5.9935	-0.4038	0.1499	-0.1924	0.7114	2.7955
Philippines	-0.2982	0.4066	2.2761	-0.6671	0.496	0.2985	0.2618	0.1217	-0.3952	-0.0796
Poland	-0.1771	-0.9808	-2.4618	0.0616	-0.744	-0.0825	0.2189	-0.7675	-0.1939	-0.4257
Qatar	-0.5292	-1.3873	1.1215	2.5418	-4.0931	0.0251	-0.3662	0.732	-0.7889	1.5312
Russia	0.2654	0.9918	-0.6024	1.6557	-0.6386	-0.2268	-0.104	-0.1158	-0.8984	0.0275
Saudi Arabia	-0.1348	0.5352	0.6164	0.4419	-4.9507	0.4021	-1.2031	-1.0294	-1.9482	1.4773
South Africa	0.3084	-0.0314	0.4311	-0.3779	-0.4757	0.0727	0.1259	0.0216	-0.1687	0.1848
South Korea	-0.3348	-1.4959	-2.2312	-0.823	0.3855	0.3585	0.0991	-0.1827	-0.22	-0.9531
Taiwan	0.1278	-0.5106	-0.6954	0.4858	2.0773	0.0254	0.0393	-0.4969	0.0598	-0.5211
Thailand	-0.6448	1.0754	-0.1633	-0.2961	-2.5223	0.7226	0.3917	0.0824	0.3892	1.0126
Turkey	0.6711	-0.2317	-3.3362	-0.6239	1.5512	0.2632	0.8608	0.3925	0.7787	-0.5891
United Arab Emirates	-0.2711	-0.6285	0.5944	0.9417	-4.5447	0.4925	0.2707	-1.9067	0.2774	2.1756

Note: The factor loadings are displayed by panels. These values are estimated by Eq. (4).

Table 5. Robustness of the results, Performance of model and Endogeneity for developed markets models

	alpha	**out R^2**	**alpha**	**out R^2**	**Mkt-Rf**	**SMB**	**HML**	**RMW**	**CMA**	**WML**	**Mkt-Rf**	**SMB**	**HML**	**RMW**	**CMA**	**WML**
Country	**Original 1 month**		**3 months**		**Original 1 month**						**3 months**					
Australia	0.0895	0.4098	0.0404	0.7802	0.11	-0.99	0.34	0.77	0.66	1.71	0.46	1.16	0.55	-0.45	1.31	1.84
Austria	0.0590	0.4230	0.0463	0.7103	0.49	-1.48	-1.15	1.41	0.34	1.57	-0.52	0.87	-1.32	-0.67	-1.43	1.92
Belgium	0.1154	0.3777	0.0287	0.8350	-1.33	-0.49	-0.04	0.20	-0.14	2.14(*)	-1.84	1.00	-0.31	0.18	-0.12	2.07(*)
Canada	0.0770	0.4741	0.0326	0.7243	0.02	-1.74	-1.02	0.13	0.54	1.88	-1.58	1.78	-0.47	-0.88	-0.72	1.96(*)
Switzerland	0.1139	0.2880	0.0823	0.7452	0.14	-0.59	-1.61	0.45	-0.96	1.79	0.92	0.48	-1.31	1.23	-1.52	1.95
Germany	0.1631	0.5482	0.0717	0.8830	0.02	-0.45	-1.58	1.72	-1.11	2.06(*)	-0.05	1.06	-0.03	-0.44	-0.34	1.83
Denmark	0.1311	0.0722	0.2345	0.7142	-1.14	-1.06	1.28	0.32	0.12	2.12(*)	-1.17	0.84	-0.89	-0.65	-0.02	1.49
Spain	0.2187	0.4816	0.1125	0.7919	-0.58	-0.50	-0.06	1.63	-1.64	1.24	-1.42	0.82	-1.20	-1.63	-1.36	1.85
Finland	0.1769	0.4254	0.0634	0.8943	-0.45	0.41	0.64	-0.52	1.25	1.97(*)	-1.50	1.15	-0.85	-1.64	-0.74	1.91
France	0.1892	0.6268	0.0710	0.9282	-0.27	-1.29	-0.24	1.53	-1.75	1.65	-0.45	1.57	-1.75	-1.47	-0.40	1.18
Great Britain	0.1288	0.5733	0.0997	0.8447	0.19	-0.41	0.98	1.58	-0.05	1.47	-1.43	1.59	0.79	-1.84	-0.55	1.48
Greece	0.6638	-0.0202	0.0821	0.6127	-0.15	-0.79	-0.42	1.39	0.91	-1.38	-0.77	-0.46	-0.67	0.39	-0.02	0.51
Hong Kong	0.1892	0.3790	0.0920	0.9792	-0.36	-0.07	0.57	0.64	1.62	1.63	-0.11	1.42	-0.35	-1.17	0.63	1.78
Ireland	0.2390	0.0938	0.1215	0.7902	-1.16	-1.18	0.32	0.98	0.71	1.53	-1.50	-1.80	-1.19	1.19	-0.98	1.64
Italy	0.2438	0.5640	0.1303	0.7963	-1.12	-1.44	-1.52	0.60	-1.75	2.09(*)	-1.28	0.46	-1.02	-0.25	-1.59	2.11(*)
Japan	0.1387	0.3007	0.0827	0.8214	0.04	-1.26	-0.46	0.24	0.95	1.98(*)	0.60	-1.73	0.09	0.21	-0.98	1.86
Netherlands	0.1987	0.4189	0.1276	0.8818	-0.06	-0.64	-0.08	1.29	-0.44	1.56	-0.29	0.82	-0.80	0.92	-1.85	1.60
Norway	0.2603	0.3080	0.0917	0.8548	0.76	-1.42	0.38	1.57	1.42	0.99	0.89	0.96	-1.50	0.90	0.71	1.48
New Zealand	0.2217	-0.4053	0.1249	0.6994	0.74	-1.25	1.30	0.45	1.73	2.04(*)	1.00	-1.36	0.26	1.26	0.92	1.29
Portugal	0.2106	0.1753	0.1218	0.7916	0.00	-1.73	-0.13	1.74	-0.22	2.07(*)	-0.12	1.33	0.51	0.40	-1.47	1.53
Sweden	0.1747	0.2877	0.0950	0.8448	-1.77	-0.16	1.34	0.01	0.47	1.99(*)	-1.44	1.68	1.04	-0.82	-0.60	1.84
Singapore	0.1467	0.4646	0.0771	0.7357	-0.34	-1.55	1.63	1.47	1.48	1.96(*)	0.80	0.22	0.35	0.63	0.77	1.27
United States	0.1583	0.9006	0.0842	0.9876	-0.01	0.66	1.32	-0.10	0.40	2.08(*)	-0.79	0.93	-1.10	-0.97	-1.39	1.65

Note: Table-5 only shows the 1 month (original frequency of data) and 3 months (first wavelet), the rest of results can be consulted in the supplementary appendix. The table shows the p-values corresponding to the coefficient of each risk factor and (**) and (*) mean that the null hypothesis is rejected at 1% and 5% respectively.

Table 6. Robustness of the results, Performance of model and Endogeneity for emerging markets models

	alpha	**out R^2**	**alpha**	**out R^2**	**Mkt-Rf**	**SMB**	**HML**	**RMW**	**CMA**	**WML**	**Mkt-Rf**	**SMB**	**HML**	**RMW**	**CMA**	**WML**
Country	**Original 1 month**		**3 months**		**Original 1 month**						**3 months**					
Argentina	0.3497	0.0162	0.0041	0.3705	-0.99	-0.51	-0.51	1.54	0.90	3.1(**)	-0.23	0.51	1.28	0.94	-0.63	0.56
Brazil	0.1132	0.0145	0.0012	0.3851	-2.58(**)	0.88	-2.34(**)	2.51(**)	0.23	5.77(**)	-0.35	1.54	-0.90	-0.34	-0.54	1.76
Chile	0.1295	0.0243	0.0016	0.3280	0.31	0.39	1.49	1.76	0.66	3.56(**)	-0.38	0.34	0.71	0.74	-0.06	1.00
China	0.1107	0.0112	0.0017	0.3074	-0.66	-1.53	0.61	0.22	0.01	2.95(**)	-0.55	-0.45	0.62	0.36	-1.26	0.75
Colombia	0.1596	0.0281	0.0026	0.2543	-1.32	0.12	0.56	-0.20	0.20	1.54	1.20	0.27	0.56	0.77	0.64	-0.16
Czech Republic	0.1688	-0.0022	0.0014	0.3189	-0.53	1.20	0.09	0.51	-1.62	2.43(**)	0.66	1.66	0.16	-0.17	1.11	1.47
Egypt	0.3293	0.0100	0.0025	0.3376	-3.28(**)	0.22	-1.12	0.10	1.10	0.55	-0.61	0.33	-0.34	-1.24	0.99	0.06
Greece	0.8188	0.0006	0.0029	0.1523	-0.12	-1.32	-0.44	1.38	-1.23	-1.94	0.39	-1.30	-0.96	0.07	-1.43	-1.17
Hungary	0.4065	0.0134	0.0008	0.3091	-0.76	-3.12(**)	-1.32	2.95(**)	3.46(**)	4.09(**)	-0.12	-0.62	-0.39	0.84	-0.35	1.55
India	0.2994	0.0291	0.0005	0.3649	-0.47	-3.66(**)	0.61	0.39	0.02	6.58(**)	-0.03	-0.61	-1.61	-0.58	-1.89	0.49
Indonesia	0.2693	0.0486	0.0033	0.3256	-0.54	-0.77	0.90	0.60	1.06	6.23(**)	1.04	1.26	0.30	-1.20	-0.05	1.88
Malaysia	0.3340	0.0395	0.0013	0.3529	0.05	0.42	1.49	0.41	1.31	5.3(**)	-1.11	0.20	0.57	-0.96	0.87	1.42
Mexico	0.1874	0.0333	0.0033	0.3533	-0.06	-0.68	0.39	1.06	-2.22(*)	5.32(**)	-0.35	0.44	-0.71	-1.36	-1.71	1.73
Pakistan	0.2947	0.0342	0.0023	0.2770	-0.26	0.16	2.48(**)	2.12(*)	0.37	3.17(**)	-0.85	1.09	-0.14	0.15	-0.97	1.43
Peru	0.1187	0.0143	0.0022	0.2935	-1.71	-0.24	-0.76	0.67	-0.36	4.31(**)	-1.03	0.42	-0.91	0.59	-0.29	0.93
Philippines	0.2054	0.0424	0.0772	0.3007	1.59	-0.47	0.59	-0.76	1.13	7.37(**)	0.07	0.77	-0.19	-0.16	0.14	1.59
Poland	0.2448	-0.0081	0.0003	0.3179	-1.16	-0.52	1.97(*)	2.45(**)	0.53	6.42(**)	0.94	0.28	0.35	-0.08	-0.65	1.79
Qatar	0.1730	0.0092	0.0011	0.2639	-1.84	0.29	-0.40	0.95	0.74	3.21(**)	-0.45	-0.32	-0.31	0.02	-1.63	0.50
Russia	0.2335	0.0213	0.0009	0.2926	-1.77	-1.59	-2.07(*)	-0.09	-0.58	4.27(**)	-0.61	-0.69	-1.95	-1.35	-0.58	1.94
Saudi Arabia	0.1569	0.0018	0.0005	0.2168	-2.49(**)	1.50	-0.04	-0.88	3.03(**)	5(**)	-0.55	1.84	0.47	-0.75	-0.89	0.68
South Africa	0.1548	0.0449	0.0014	0.3219	0.07	0.45	1.59	0.39	-0.80	6.97(**)	0.82	1.10	0.54	-0.48	-1.17	1.90
South Korea	0.1599	0.0213	0.0015	0.3359	-0.87	-0.55	3.24(**)	0.37	1.22	11.31(**)	1.66	-0.55	1.20	-1.31	-1.56	1.95
Taiwan	0.1598	0.0149	0.0012	0.3580	-0.88	-1.08	-1.14	-0.97	1.54	9.2(**)	0.04	-0.36	-1.77	-1.51	0.01	1.90
Thailand	0.2085	0.0298	0.0049	0.3225	1.39	0.12	-1.03	-0.17	1.21	7.05(**)	1.64	-1.86	-0.60	0.08	-1.21	1.92
Turkey	0.1465	0.0173	0.0084	0.3186	-1.79	1.37	1.20	0.04	0.29	5.89(**)	0.08	1.31	0.83	-1.48	-0.66	1.94
U.A.E.	0.2878	0.0136	0.0005	0.2839	-0.51	1.12	-0.39	-0.22	2.56(**)	3.53(**)	0.14	0.47	-0.85	0.63	-0.27	0.64

Note: Table-6 only shows the 1 month (original frequency of data) and 3 months (first wavelet), the rest of results can be consulted in the supplementary appendix. The table shows the p-values corresponding to the coefficient of each risk factor and (**) and (*) mean that the null hypothesis is rejected at 1% and 5% respectively.

Table 7. Parameters of term structure of systematic risks

Panel A. Original (one month)

Markets	Param.	Mkt-Rf	SMB	HML	RMW	CMA	WML	mean R^2 adj.
Developed	λ_{1m}	0.0085	0.0078	0.0032	-0.0001	0.0020	0.0110	50.04%
Emerging	λ_{1m}	0.0104	0.0035	-0.0014	-0.0049	-0.0011	0.0095	42.00%

Panel B. Three months

Markets	Param.	Mkt-Rf	SMB	HML	RMW	CMA	WML	mean R^2 adj.
Developed	ω_{3m}	0.0002	0.0000	-0.0005	0.0000	-0.0027	0.0000	48.75%
Emerging	ω_{3m}	0.0009	-0.0001	-0.0002	-0.0001	0.0005	0.0007	32.57%

Panel C. Six months

Markets	Param.	Mkt-Rf	SMB	HML	RMW	CMA	WML	mean R^2 adj.
Developed	ω_{6m}	0.0002	0.0002	0.0001	-0.0002	-0.0029	0.0000	46.30%
Emerging	ω_{6m}	0.0010	0.0002	-0.0001	-0.0001	0.0000	-0.0001	33.08%

Panel D. One year

Markets	Param.	Mkt-Rf	SMB	HML	RMW	CMA	WML	mean R^2 adj.
Developed	ω_{1y}	0.0003	0.0000	-0.0001	0.0001	0.0001	0.0002	43.24%
Emerging	ω_{1y}	0.0002	0.0000	0.0000	0.0000	0.0000	0.0001	41.39%

Panel E. Two years

Markets	Param.	Mkt-Rf	SMB	HML	RMW	CMA	WML	mean R^2 adj.
Developed	ω_{2y}	-0.0001	-0.0002	0.0001	0.0000	0.0001	-0.0003	41.71%
Emerging	ω_{2y}	-0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	30.57%

Panel F. Four years

Markets	Param.	Mkt-Rf	SMB	HML	RMW	CMA	WML	mean R^2 adj.
Developed	ω_{4y}	-0.0006	-0.0001	0.0000	0.0002	0.0027	0.0006	39.13%
Emerging	ω_{4y}	-0.0009	-0.0001	0.0000	0.0000	0.0000	0.0000	36.94%

Note: Results of Panel A are obtained by Eq.(3), while the rest of the results are from Eq.(5)

Table 8. Term structure of risk factors premiums

Panel A. Developed markets

Term	Mkt-Rf	SMB	HML	RMW	CMA	WML
1m	0.00847	0.00776	0.00322	-0.00008	0.00199	0.01096
3m	0.00868	0.00780	0.00272	-0.00008	-0.00069	0.01096
6m	0.00869	0.00799	0.00330	-0.00025	-0.00095	0.01096
1y	0.00874	0.00778	0.00313	0.00004	0.00204	0.01119
2y	0.00832	0.00758	0.00329	-0.00011	0.00208	0.01064
4y	0.00786	0.00770	0.00325	0.00008	0.00467	0.01160

Panel B. Emerging markets

Term	Mkt-Rf	SMB	HML	RMW	CMA	WML
1m	0.01044	0.00351	-0.00139	-0.00489	-0.00114	0.00945
3m	0.01138	0.00339	-0.00154	-0.00497	-0.00066	0.01011
6m	0.01143	0.00366	-0.00150	-0.00496	-0.00118	0.00940
1y	0.01060	0.00352	-0.00141	-0.00491	-0.00112	0.00957
2y	0.01019	0.00352	-0.00141	-0.00488	-0.00113	0.00943
4y	0.00950	0.00345	-0.00144	-0.00488	-0.00116	0.00946

Note: The factor risk premium for each term is estimated from results of Table-7 and for risk factor-*k* and term-*j* premium as $\hat{\lambda}_{j,k} = \hat{\lambda}_{1,k} + \frac{1}{T}\sum_{t=1}^{T} \omega_{j,k,t}$.

Table 9. Test of term spread of risk factor premiums

Factors	Wald test	p-value
Mkt-Rf	14.4119	0.013
SMB	0.8585	0.973
HML	1.8659	0.867
RMW	1.0650	0.957
CMA	12.9277	0.024
WML	1.8634	0.868

Note: The null hypothesis is that the difference between emerging and developed risk factor premiums is the same for each term.

FIGURES

Figures caption

- Figure 1. Mean time-scale sensitivity of developed and emerging markets of each risk factor

- Figure 2. Term structure of annualised risk premiums.

Figure 1. Mean time-scale sensitivity of developed and emerging markets of each risk factor

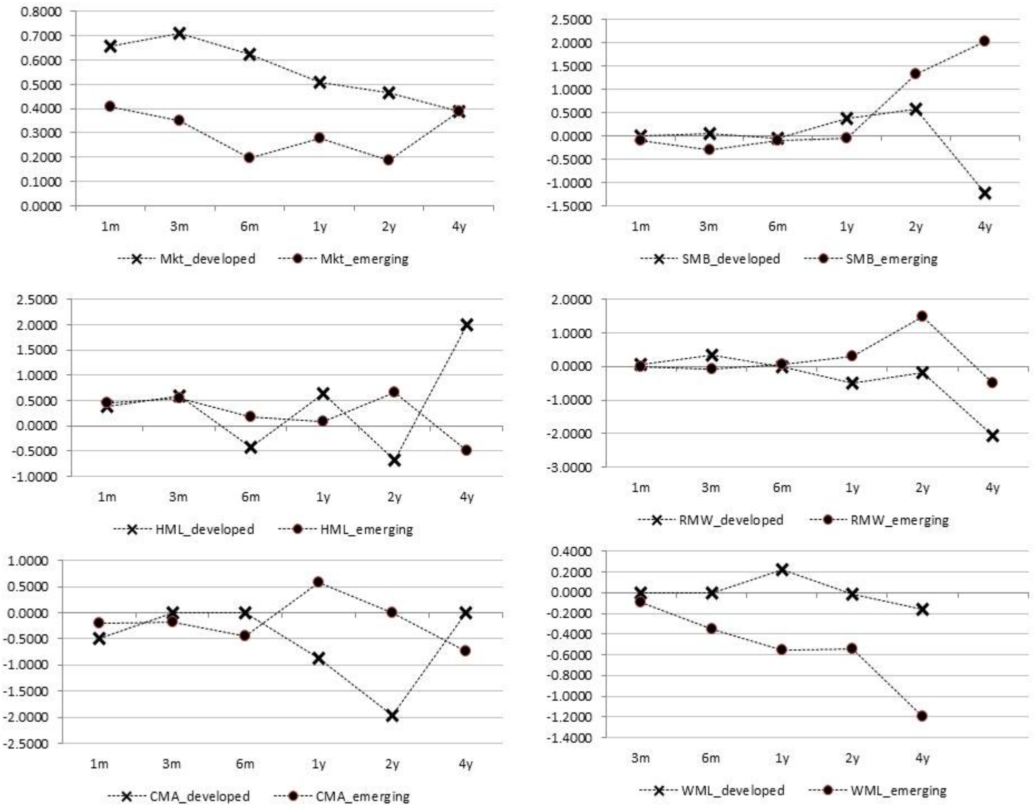
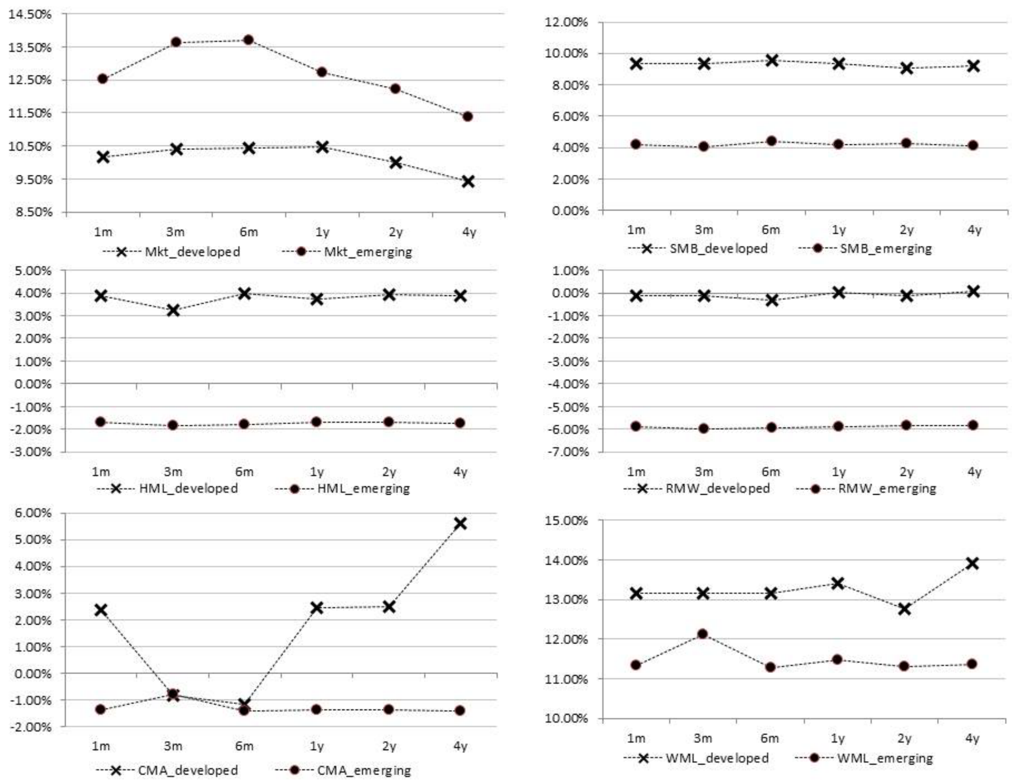


Figure 2. Term structure of annualised risk premiums.



ENDNOTES

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[i] According to Percival and Walden (2006) and to avoid the assumption of circularity, this requires the condition $J < \log_2[N/(L-1)]$, where L is the width of the wavelet filter.

[ii] Note that we use continuous wavelet transform instead of discrete decomposition. We could determine neither the betas for different time scales nor the risk premiums from the scale betas.

[iii] Available at: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#International

[iv] Daubechies Least Asymmetric filter with a wavelet filter length of eight observations is a common wavelet filter in other empirical studies of financial markets (see Gençay, Selçuk, and Whitcher 2005; Fernandez 2006; and Rhaeim, Ammou, and Mabrouk 2007).

[v] The rest of the results are available upon request.