Time-Varying Risk and Risk Premiums in Frontier Markets

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Abstract

We study risk-return relationship in twenty Frontier country stock markets by setting up an international version of the intertemporal capital asset pricing model (International ICAPM). The systematic risk in this model comes from covariance of Frontier market stock index returns with world returns, proxied by US stock index returns. We also incorporate own country variances as additional determinants of Frontier country returns. Our model allows for the covariance risk to be time-varying. Time-varying correlations are captured by utilizing the Dynamic Conditional Correlations (DCC) model. The premium per unit of covariance risk is allowed to vary over time as well. Thus, both the risk and risk premium on Frontier country market returns are time-varying in our model. We find the conditional correlations, although modest on average, to vary over time, and suggestive of substantial diversification benefits from investing in Frontier markets versus a portfolio holding just US stocks. These correlations display no time trend, suggesting that diversification benefits have not diminished with recent globalization. Our results suggest statistically significant impact of both US covariance risk and own country variance risk in explaining Frontier country returns. Time-variation in the price of covariance risk is also found to be statistically significant for most Frontier market returns. However, own country variance risk is found to be quantitatively more important.

Key phrases: ICAPM; dynamic conditional correlations (DCC); time-varying parameters (TVP); stock market returns; Frontier markets

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1. INTRODUCTION

Cross-country correlations between financial market returns depend on financial openness of countries, as well as on the nature of cross-country economic and financial linkages. The more financially open a stock market is, the more synchronized its returns are expected to be with foreign markets; thus the greater the scope for high correlations. Low correlations among national stock markets, however, are key for international portfolio diversification. Hedging strategies depend on shocks to stock markets being relatively isolated. However, if stock markets are highly correlated, diversification benefits may be undermined. International asset allocation decisions and risk assessment are largely based on cross-country correlations as well.

Asset pricing studies frequently assume constant correlations between returns on different markets. Such an assumption is primarily motivated by convenience. However, in a dynamically changing economic environment, this assumption may not be realistic. For example, markets under study may be undergoing structural changes during the period of interest, or they may be experiencing macroeconomic reforms. Assuming constancy of correlations could be particularly inappropriate when Frontier markets are in consideration.

In this article, we study the risk-return relationship in twenty Frontier markets by setting up an international version of the intertemporal capital asset pricing model (International ICAPM) of Merton (1973). The systematic risk in this model comes from covariance of Frontier market returns with world returns (see Solnik 1974 and Stulz 1982). Our model allows for this covariance risk to be time-varying. Time-varying correlations are captured by utilizing the Dynamic Conditional Correlations (DCC) model of Engle (2002). The risk premium per unit of covariance risk (or, the price of covariance risk) is allowed to vary over time as well. Thus, both the risk and risk premium on Frontier country market returns are time-varying in our model.

Our model of Frontier market returns can be considered a time-varying parameter (TVP) model. Thus, it can be cast into a state space form. However, it is not time-invariant as the "coefficient" multiplying the state variable (the TVP parameter) is current period conditional covariance between Frontier market returns and world returns. Nonetheless, the TVP model can be estimated via the Kalman Filter.

Our study is motivated by a desire to explore potential diversification benefits to US investors from investing in these Frontier markets. Therefore, we use returns on US stock markets to proxy for world market returns (see Karolyi and Stulz, 2002).

The rest of the paper is organized as follows. Section 2 briefly reviews relevant literature on time-varying conditional correlations and their application in the international finance literature. We review some specific applications of the DCC model. We also briefly review the related international ICAPM literature. In section 3 we present data and some of its descriptive statistics. In section 4 we outline the DCC and International ICAPM models. In section 5 we present results on estimation of dynamic conditional correlations and the International ICAPM model. Section 6 offers concluding remarks and prospects for future research.

2. LITERATURE REVIEW

A detailed description of Dynamic Conditional Correlations (DCCs), introduced by Engle (2002), is given in Section 4.1. Here, in this section, we review its recent applications in the international finance literature. We also briefly review the extensive literature on international intertemporal capital asset pricing model (International ICAPM).

DCCs have been used, in conjunction with some version of the domestic

ICAPM model, to investigate risk-return relationships in the US equity market. For instance, Bali and Engle (2010) study risk-return relations on individual stocks in the Dow Jones Industrial Average (DJIA) index using time-varying covariances, modeled through DCCs, with the market returns. They find that risk premia induced by time-varying conditional covariation of individual stock returns with the market portfolio returns remain positive and significant, even after controlling for risk premia induced by conditional covariation with macroeconomic, financial, and volatility factors.

An international version of Merton's (1973) intertemporal capital asset pricing model (International ICAPM) was originally developed by Solnik (1974) and Stulz (1982), and applied extensively in the international finance literature by Harvey (1991) and others. Bali and Wu (2010) apply International ICAPM model to analyze international stock market returns and find that the risk premiums are positive and highly dependent on currency denominations. In a recent paper, You and Daigler (2010) utilize DCCs to explore scope for international portfolio diversification using emerging stock markets. They find little or no benefits for US investors from diversification beyond the S&P 500 stock index portfolio. On the other hand, Berger, Pukthuanthong and Yang (2011) report that frontier markets have low integration with the world market, thereby offering potentially significant diversification benefits. Cheng, Jahan-Parvar and Rothman (2010) use a Markov switching version of an International ICAPM to investigate Middle Eastern and North African (MENA region) countries and find presence of significant portfolio diversification opportunities.

Yiu, Ho and Jin (2010) use DCCs to explore correlations of Asian and Latin American stock markets with the US. They find modest time-varying correlations suggesting little diversification benefits. The correlations moreover increase significantly between 2007 and 2009, further reducing these benefits during the global financial turmoil. Syriopoulos and Roumpis (2009) employ DCCs to investigate time-varying comovement of South Eastern European developing markets with leading mature equity markets. Their study reports modest time-varying correlations, with no trend, indicating potential opportunities for portfolio diversification. Guesmi and Nguyen (2011) utilize DCCs within an International ICAPM model to examine integration of emerging market regions with the world market. They report positive local and world market risk premiums. Local market risk is found more important for emerging markets than world market risk, implying presence of some diversification benefits.

To summarize, the predominant opinion in current literature on international portfolio diversification is that there exist some diversification benefits from investing in developing countries. The literature, however, is inconclusive about the significance of these benefits.

3. Data

Daily MSCI Barra index closing prices are used for US and 20 Frontier stock markets for the period between December 1st, 2005 and June 30th, 2011. Daily percentage annualized returns for each country are calculated as follows:

$$R_{\mathrm{it}} = 252 * ln(P_{\mathrm{it}}/P_{\mathrm{i(t\text{-}1)}}) * 100$$

where P_{it} is each country's closing price index at time t.

We choose daily data since it better accounts for stock market dynamics and provides greater insight into cross-market interactions. The countries included are: Argentina, Bahrain, Bulgaria, Croatia, Estonia, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Mauritius, Nigeria, Oman, Pakistan, Qatar, Romania, Slovenia, Sri Lanka, Tunisia, and United Arab Emirates. These are chosen based on the MSCI classification as of July 1st, 2011. Lithuania, Serbia, Ukraine, Bangladesh, Vietnam, Trinidad and Tobago, Jamaica, Botswana and Ghana are also defined as Frontier markets, but are not included here due to lack of data for a sufficiently long period.

MSCI indices are established consistently across countries and thus provide an adequate ground for exploration of cross-market relations. They are value-weighted and calculated with dividends reinvested. In order to avoid double counting, stock prices of companies set up abroad are not included. All indices are in US dollars, which provides additional comparability across markets and implicitly takes care of currency market effects.

Descriptive statistics for US and the Frontier markets are reported in Table 1. The first four columns report the first four moments of returns. The last two columns present results from the Jarque-Bera test for normality and the mean-to-standard deviation (Sharpe ratios) for each country.

The first column of Table 1 shows that half the countries in our sample display positive annualized mean returns. These range from 18.631% for Mauritius to -26.617% for UAE (0.943% for the US). The annualized standard deviation of returns range from 727.337% for Kazakhstan to 284.556% for Tunisia (373.153% for the US). The third column shows that half the countries exhibit positive skewness. The null hypothesis for no skewness is rejected at 5% significance level for Estonia, Kazakhstan, Kenya, and Mauritius. The fourth column provides values of the fourth moment of returns indicating high and statistically significant positive excess kurtosis for all countries. The second to last column reports the Jarque-Bera test statistics. The null hypothesis of normal distribution of index returns is strongly rejected at the 5% significance level for all countires. Thus, when examining potential benefits of diversification, we need to consider the third and fourth moments as well, as emphasized by You and Daigler (2010).

The last column of Table 1 provides the mean-to-standard deviation (Sharpe ratio) for all markets. It is positive for half of the countries. The highest value is 0.005 for Mauritius and the lowest is -0.068 for Bahrain (0.003 for US). Further comparison of individual country mean-to-standard deviation ratios with US shows a relatively high return-standard deviation benefit for Argentina, Croatia, Kazakhstan, Mauritius, Sri Lanka, and Tunisia over the US index. Therefore, for US investors, diversification benefits from investing in these markets may be worthwhile if one assumes a normal distribution for returns.

In the next section we describe the methodology used to analyze dynamic conditional covariances between US and Frontier country returns, as well as time-variation in the payoff per unit of country risk exposure.

4. Methodology

In subsection 4.1 we briefly describe the DCC model for dynamic correlations following Engle (2000). In subsection 4.2 we present a simple international version of Merton's (1973) intertemporal capital asset pricing model (ICAPM) featuring time-variation in expected returns per unit of country covariance risk. We also discuss estimation of the ICAPM-TVP model using the Kalman Filter.

4.1 Dynamic Conditional Correlations

Cross-country diversification studies typically employ constant correlations to evaluate diversification benefits. This restrictive approach, however, ignores the possibility of correlations being time-varying. In this study we utilize time-varying conditional correlations in order to evaluate international diversification potential between Frontier countries and the US stock markets. In particular, we explore the Dynamic Conditional Correlation (DCC) model introduced by Engle (2002).

The time-varying correlation between two two zero mean variables r_{i} and r_{j} at period t is conditioned on known information at period $t-1$, and is defined as:

$$\rho_{\text{ij,t}} = \frac{q_{\text{ij,t}}}{\sqrt{q_{\text{ii,t}}q_{\text{jj,t}}}} = \frac{E_{\text{t-1}}[r_{\text{i,t}}r_{\text{j,t}}]}{\sqrt{E_{\text{t-1}}[r_{\text{i,t}}^2]E_{\text{t-1}}[r_{\text{j,t}}^2]}} \tag{1}$$

For convenience, we can write the variables as the product of the conditional standard deviation and the standardized disturbance:

$$r_{\text{i,t}} = \sqrt{h_{\text{i,t}}}U_{\text{i,t}}, \quad i = i, j \tag{2}$$

where $U_{\text{i,t}}$ is a standardized disturbance with zero mean and variance one for each series and $h_{\text{i,t}}$ is the conditional variance of $r_{\text{i,t}}$ estimated from the following univariate GARCH (1,1) model:

$$r_{i,\text{t}} = \gamma_0 + \gamma_1 r_{\text{i,t-1}} + \varepsilon_{\text{i,t}} \tag{3}$$

$$\varepsilon_{\text{i,t}} = \sqrt{h_{\text{i,t}}}z_{\text{t}} \tag{4}$$

$$z_{\text{t}} \sim iidN(0,1)$$

$$h_{\text{i,t}} = b_0 + b_1 h_{\text{i,t-1}} + b_2\varepsilon_{\text{t-1}}^2 \tag{5}$$

Substituting (2) in (1) allows the conditional correlation to be expressed as:

$$\rho_{\text{ij,t}} = E_{\text{t-1}}[U_{\text{i,t}}U_{\text{j,t}}] \tag{6}$$

It follows, the conditional correlation between two variables is the same as the conditional covariance between the standardized disturbances.

To account for the dynamics of stock return correlations, Engle (2002) builds on Bollerslev's (1990) constant conditional correlation (CCC) model to allow conditional correlations to vary over time. In Engle's (2002) dynamic conditional correlation (DCC) model, the variance–covariance matrix of i assets is given by:

$$H_{\mathrm{t}} = D_{\mathrm{t}}\Omega_{\mathrm{t}}D_{\mathrm{t}} \tag{7}$$

where $D_{\mathrm{t}} = diag\{\sqrt{h_{\mathrm{ij,t}}}\}$ is the (NxN) diagonal matrix of time-varying standard deviations from univariate GARCH models with $\sqrt{h_{\mathrm{ii,t}}}$ on the $i-th$ diagonal and $\Omega_{\mathrm{t}} = \{\rho_{\mathrm{ij}}\}$ is the (NxN) time-varying conditional correlation matrix. The estimation of the DCC model involves two stages. In the first stage univariate volatility models are fitted for each variable and estimates of $\sqrt{h_{\mathrm{ii,t}}}$ are obtained. In the second stage, the variables are transformed by their estimated standard deviations from the first stage. That is $U_t = D_{\mathrm{t}}^{-1}\varepsilon_{\mathrm{t}}.U_{\mathrm{t}}$ is then employed to develop the DCC specification as follows:

$$Q_{\mathrm{t}} = S(1-\alpha_1-\alpha_2) + \alpha_1(U_{\mathrm{t-1}}\,U'_{\mathrm{t-1}}) + \alpha_2 Q_{\mathrm{t-1}} \tag{8}$$

and

$$\Omega_t = Q_{\mathrm{t}}^{*\text{-}1}Q_{\mathrm{t}}Q_{\mathrm{t}}^{*\text{-}1} \tag{9}$$

where $Q_{\mathrm{t}} = \{q_{\mathrm{ij,t}}\}$ is the covariance matrix of the standardized residuals U_{t}, $S = \{\overline{q}_{\mathrm{ij,t}}\}$ is the (NxN) unconditional covariance of U_{t}, and $Q_{\mathrm{t}}^{*} = (diag(Q_{\mathrm{t}}))^{-1/2}$ is a diagonal matrix composed of the squared roots of the diagonal elements of Q_{t}.

In (8) α_1 and α_2 capture the effects of previous shocks and previous dynamic correlations on the current dynamic correlation. The two parameters are non-negative, with the usual GARCH restriction of $\alpha_1+\alpha_2<1, \quad (\alpha_1,\alpha_2\geq 0)$ to guarantee Q_{t} is positive and mean reverting. This implies, that after a shock occurs, the correlation between the underlying variables will return to the long run unconditional level. When $\alpha_1 = \alpha_2 = 0$, the DCC model is reduced to the Bollerslev (1990) CCC model. A typical element of the correlation matrix Ω_{t} now has the following form:

$$\rho_{\mathrm{ij,t}} = \frac{q_{\mathrm{ij,t}}}{\sqrt{q_{\mathrm{ii,t}}}\sqrt{q_{\mathrm{jj,t}}}} \qquad \text{for } i, j = 1, 2...n \qquad \text{and } i \neq j \tag{10}$$

The DCC model is estimated by maximization of the following log-likelihood function:

$$L = -\frac{1}{2}\sum_{\mathrm{T=1}}^{\mathrm{T}}(nLOG(2\pi) + 2LOG|D_{\mathrm{t}}| + LOG|\Omega_{\mathrm{t}}| + U_{\mathrm{t}}^{'}\Omega_{\mathrm{t}}^{\text{-}1}U_{\mathrm{t}}) \tag{11}$$

Engle (2002) suggests estimating the DCC in a two-stage procedure. See Engle (2002) for details on estimation.

The standard DCC model provides a parsimonious parametrization of conditional correlations. That, however, comes with some limitations. One such limitation is the weakness of the model in capturing asymmetric effects of positive and negative shocks on conditional correlations. To account for any potential asymmetry, Cappiello et al. (2006) introduce the scalar asymmetric DCC (ADCC) model. The model allows conditional correlations to increase more when both returns are falling than when both are rising. Another limitation is the assumption that all correlations are driven by the same dynamic pattern which is hard to justify as the number of assets increases. Hafner and Franses (2003) address this issue by generalizing the DCC model by replacing the common α_1 and α_2 parameters with asset specific $\alpha_{1,\mathrm{i}}$ and $\alpha_{2,\mathrm{i}}$ parameters.

4.2 Time-Varying Intertemporal Relation Between Expected Returns and Risk

An international version of Merton's (1973) ICAPM and work by Bekaert and Harvey (1995) motivates the following specification for Frontier country risk and expected returns:

$$R_{\mathrm{k,t}} = \theta_{\mathrm{k}} + \beta\sigma_{\mathrm{us,k,t}} + \delta_{\mathrm{k}}\sigma^2_{\mathrm{k,t}} + u_{\mathrm{k,t}} \tag{12}$$

where $R_{\mathrm{k,t}}$ denotes expected returns for country k; $\sigma_{\mathrm{us,k,t}}$ denotes conditional covariance between US and country k returns, and $\sigma^2_{\mathrm{k,t}}$ represents local market conditional volatility. The parameter β reflects compensation (return) a representative investor must receive per unit of covariance risk exposure to US markets, and the parameter δ_{k} represents compensation per unit of local market risk (variance). Equation (12) states that investors in Frontier markets are compensated, in terms of expected returns, for bearing covariance risk with US markets and for bearing own-country risk. The error term $u_{\mathrm{k,t}}$ captures other factors affecting country returns, like regional integration and political risk. Such a model has recently been used to investigate whether world market risk and country-specific total risk are priced in international stock markets by Bali and Cakici (2010).

An important issue is whether investors' expected returns per unit covariance risk with US is constant. In the context of mature, industrial economies, such an assumption may be acceptable. However, it may be too strong when emerging markets are involved. Emerging economies often experience shifting industrial structure that will induce variation in investors' perception of risk exposure. To address the possibility of time-variation of expected premium per unit of covariance risk, we entertain a time-variable parameter (TVP) version of Eq. (12), ICAPM-TVP. Our model is specified as follows:

$$R_{\mathrm{k,t}} = \theta_{\mathrm{k}} + \beta_{\mathrm{t}}\sigma_{\mathrm{us,k,t}} + \delta_{\mathrm{k}}\sigma^2_{\mathrm{k,t}} + u_{\mathrm{k,t}} \tag{13}$$

$$u_{\mathrm{k,t}} \sim N(0, H_{\mathrm{k}})$$

$$\beta_{\mathrm{t}} = c(1-\rho) + \rho\beta_{\text{t-1}} + n_{\mathrm{t}} \tag{14}$$

$$n_t \sim N(0, Q)$$

$$E(u_{\mathrm{k,t}} n_{\mathrm{t}}) = 0$$

where the expected time-variable payoff per unit of covariance risk is captured by the parameter β_{t}.

Using the terminology of state space models, Eq. (13) is the measurement equation. It relates the observed (explained) variable $R_{\mathrm{k,t}}$ to the state variable (time-varying parameter) β_{t}. The "coefficient" $\sigma_{\mathrm{us,k,t}}$, multiplying the state variable is the current period conditional covariance between US and Frontier country K (country risk). The parameter δ_{k} captures the impact of current period own-market risk (return variance) $\sigma^2_{\mathrm{k,t}}$ and is assumed to be fixed rather than time-varying for simplicity. Both the dynamic conditional covariances $\sigma_{\mathrm{us,k,t}}$ and local market variances $\sigma^2_{\mathrm{k,t}}$ are estimated in a first step from the DCC model described earlier. Eq. (14) is the state equation describing the evolution of β_{t} as an AR(1) process. Detailed exposition of such state space models, along with their estimation via the Kalman filter, can be found in Harvey (1989) and Hamilton (1994).

In the next section we present results from estimation of the DCC and ICAPM-TVP models for each frontier country.

5. Empirical Results

We begin in subsection 5.1 by discussing results from estimation of the DCC model described in subsection 4.1. In subsection 5.2 we provide estimates from estimation of the ICAPM-TVP model described in subsection 4.2. Here we also describe the outcomes of several hypotheses tested to explore our ICAPM-TVP model.

5.1 Dynamic Conditional Correlations

The results from the estimation of the DCC model are presented in Table 2. The first column of Table 2 presents the estimated values for the constant term γ_0 in Eq.(3). The estimated parameter is statistically significant for 8 Frontier markets. For the US and the remaining markets, the term is found to bear no statistical importance. The AR(1) term, γ_1, is presented in the second column of Table 2. The estimates are statistically significant and positive for the US and 12 Frontier markets, while statistically significant and negative only for Bulgaria. For 6 countries, the AR(1) coefficient is not statistically significant. The constant term $b_0$of Eq.(5) is offered in the third column of Table 2. The estimates are statistically significant for all countries, but the US, Argentina, and Mauritius. The GARCH and ARCH parameters b_1 and b_2 are presented in columns 4 and 5 respectively. Both parameters are statistically significant for all countries.

The last two columns of Table 2 report the estimates of the DCC parameters α_1 and α_2 in Eq. (8). The two parameters capture the effects of previous dynamics in covariances and shocks to the US and Frontier market returns. The estimates of α_1 are statistically significant for all Frontier markets but Jordan, Lebanon, and Romania; the α_2 values are not significant only for Jordan. The statistical significance of the parameters for most countries reveals a substantial time-variation of conditional covariances. The closer the sum of α_1 and α_2 to one, the greater the covariance persistence.

Descriptive statistics of estimated dynamic conditional correlations (DCCs) for each Frontier country are reported in Table 3. The first column reports unconditional constant correlations between Frontier countries and US market returns. The second and third columns report maximum and minimum values of the DCCs for each country over the sample time span investigated. The next four columns present the first four moments of the DCCs. The last two columns report results from the Jarque-Bera test for normality and the Ljung-Box test for autocorrelation in the DCCs.

Fifteen countries exhibit positive correlation with the US. Argentina is most highly correlated, with correlation coefficient equal to 0.563. For most of the remaining 14 markets, constant correlations are below 0.20, suggesting potential diversification benefits based on non-time varying correlations. Five countries display low negative correlations. These are Bahrain, Jordan, Nigeria, Oman, and Qatar. Negative correlations also suggest diversification opportunities from investing in these Frontier countries.

DCCs for majority of the countries have a range lower than 0.25. A high value of 0.891 is reached between US and Argentina. Their standard deviations range from 0.145 for Bulgaria to essentially 0 for Nigeria. 15 countries exhibit negative skewness, implying the predominant expectation of investors for most countries is for positive correlation. The null hypothesis of no skewness is rejected at 5% significance level for Bulgaria, Lebanon, Nigeria, Qatar, and Sri Lanka. High and statistically significant positive excess kurtosis is found for 17 markets. This implies, that the variance of DCCs is largely due to infrequent extreme deviations from the mean, rather than modestly sized deviations. Skewness and excess kurtosis in DCCs suggest that their distributions are possibly non-normal, indicating the presence of extreme values. This is further suggested by the results from the Jarque-Bera normality tests. The null hypothesis for normal distribution of index returns is strongly rejected at the 5% significance level for all countries except Estonia. Ljung-Box test shows that DCCs for 12 countries are highly serially correlated at 6 lags, suggesting possible predictability of correlations. No statistically significant autocorrelation is exhibited by the DCCs for Bahrain, Jordan, Mauritius, Nigeria, Pakistan, Slovenia, Tunisia, and UAE.

The DCCs, as well as the constant unconditional correlations are plotted in Fig. 1. Typically, DCCs range between -0.2 and 0.2. The greatest magnitude is displayed for DCCs between US and Argentina, about 0.9 in 2007, and between US and Bahrain, about 0.5 in 2009. Several countries display very low DCCs. Such countries, like Jordan and Kuwait, exhibit almost no correlation with US throughout the sample period. Most volatile DCCs are found for Argentina, Bahrain, and Kazakhstan. No significant time-variability in DCCs are found in Mauritius, Nigeria, Pakistan and Slovenia. DCCs exhibit a slightly positive trend over our sample period for 6 frontier markets. Such a trend illustrates decrease over time in diversification benefits between US and these markets.

The relatively low cross-country correlations and the absence of a significant time trend or pattern in them suggest that increasing globalization over the past years did not significantly affect correlations between US and Frontier markets. This may be a result of industry mixes within each country being sufficiently different from US to induce low correlations, or business cycles in US and Frontier countries being out of phase.

In summary, our results indicate modest DCCs, providing substantial diversification benefits from investing in Frontier markets. We show that correlations of many Frontier markets with US do in fact vary over time and are non-normally distributed, suggesting the presence of extreme values. They display largely no trend, suggesting no diminishing of diversification benefits over time. We detect a significant level of autocorrelation, suggesting that correlation patterns may be predictable. Our findings imply that portfolio diversification based solely on constant correlations could lead to inaccurate estimates of its benefits. Thus, investors need to take time-variation of correlations into account in order to fully evaluate the efficacy of their diversification strategies.

5.2 ICAPM-TVP Estimates for Frontier Markets

This subsection reports estimates of the ICAPM-TVP model for 20 Frontier countries, applied to MSCI data for the period between December 1st, 2005 and June 30th, 2011. Maximum likelihood parameter estimates and standard errors are reported in Table 4. Tests of hypothesis related to important restricted versions of the ICAPM-TVP model are presented in Table 5.

Estimates in Table 4 show that Frontier countries are vastly different from each other in terms of magnitude and signs of estimated parameters. This is to be expected as these countries/ markets may be at different levels of development, or at different stages of the business cycle during the less than 6-year sample period considered here. The first column reports estimates of unconditional mean returns θ_{k}. The largest recorded value is 150.3 daily percent annualized returns for Pakistan. For four countries, estimated mean returns are negative, with the lowest for Sri Lanka at -101.4 percent annualized. These estimates, however, are statistically significant for only four countries. Estimates of the price of own country market variance risk δ_{k} are reported in the second column. The highest estimate is for Sri Lanka (0.203) and the lowest for Pakistan (-0.46). The estimates are positive for only six Frontier markets. These estimates are statistically significant for all but three countries.

Negative risk-return relationships have been well-documented in the literature using both aggregate country level and firm level data. See, for example, Whitelaw (1994) and Ang et al (2006). The predominantly negative estimates of local market risk prices imply the possibility of sizeable hedging and discount rate news components in Frontier market risk (Gou and Whitelaw (2006), Brandt, Jin, and Wang, (2009)). Gou and Whitelaw (2006) investigate the possibility of a negative market risk premium. They find that sizeable market risk hedging component may induce negative risk-return relationship. Brandt, Jin, and Wang (2009) break the conditional variance of US market returns into components associated with cash flow news and discount rate news. They find that sizeable discount rate news component, in addition to the hedging component, may also induce negative risk premia.

Estimates of mean covariance risk premium with US markets, represented by parameter C in Eq. (14), are reported in column 4. These risk premia are positive for 13 countries, and range from a high of 635.55 for Oman to a low of -835.2 for Slovenia. These values are, however, statistically significant for only 5 countries. Estimated values of the AR parameter ρ governing time-variation in covariance risk premium β_{t} are presented in column 5. The estimates are positive for 18 countries, and range from a high of 0.999 for Jordan to a low of -0.819 for Bulgaria. These values are statistically significant for 18 countries. The last column of Table 5 reports the estimates of the standard deviation $\sqrt{Q}$ of shocks n_{t}, driving time variation in these premia. The estimated values are statistically significant for all countries. Statistically significant estimates of ρ and $\sqrt{Q}$ imply some predictability of covariance risk premia.

The various panels of Figure 2 plot the fitted and observed Frontier market returns, while the panels of Figure 3 present the decomposition of Frontier country fitted returns into US and local market components. Quantitatively significant impact of US market risk is found only for Argentina. For all other countries, the US component is very small relative to the local market component. This implies that evolution of returns in these countries is governed primarily by local market factors and not by US market covariance risk. This is in line with results reported in Bali and Cakici (2010).

Table 5 reports results from hypothesis tests performed to test restricted versions of the ICAPM-TVP model. Statistical significance of estimated parameters is tested via the LR test. Test statistics for the null hypothesis ($H_0 : \beta_{\mathrm{t}} = 0$) for each Frontier market are reported in the first column of Table 5. The LR test detects statistically significant impact of the covariance risk (null hypothesis is rejected) for 14 of the 20 Frontier markets at the 5% significance level and for additional 2 countries at 10%.

LR test statistics for the null hypothesis of no time-variation in covariance risk premia ($H_0 : \beta_{\mathrm{t}} = constant$) are reported in the second column of Table 5. Time-variability of β_{t} is statistically significant (null hypothesis is rejected) for 14 countries at the 5% significance level and for additional 2 countries at 10%. These countries are the same as the countries for which the null hypothesis for no impact of the covariance risk is rejected. The results indicate that if risk premium exists, then it is time-variabe. Understanding the factors that may contribute to such time-variability would be a worthwhile exercise.

The second to last column of Table 5 reports the test statistics from exploring the null hypothesis of no impact of US covariance risk ($H_0 : \beta_{\mathrm{t}} = 0$), when the alternative model features constant risk premia ($H_1 : \beta_{\mathrm{t}} = constant$). The results indicate statistically significant impact of covariance risk (null hypothesis is rejected) for only 4 of the 20 Frontier markets at the 5% significance level. These are Nigeria, Qatar, Romania, and UAE. At the 10% significance level, the null hypothesis is rejected for Mauritius as well. The outcomes from this hypothesis test further emphasize the importance of time-variability of covariance risk prices. The results indicate that if time-variability in covariance risk prices is not taken into account, the impact of US covariance risk may erroneously be found to be statistically insignificant and easily omitted.

The last column of Table 5 presents test statistics from exploring the null hypothesis of no impact of local Frontier market risk ($H_0 : \delta_k = 0$). The LR test detects statistically significant impact of local Frontier market risk (null hypothesis is rejected) for all Frontier markets, except Argentina and Croatia.

In summary, the ICAPM-TVP estimation detects statistically significant impact of US covariance risk and local market risk for most Frontier markets. We detect statistically significant and often predictable time-variation in covariance risk premia for most countries. Our results emphasize the importance of accounting for time-variability of the price of US covariance risk in understanding time variation in Frontier market stock returns.

6. Conclusion

We study the risk-return relationship in twenty Frontier markets by setting up an international version of the intertemporal capital asset pricing model (International ICAPM). The systematic risk in this model comes from covariance of Frontier market returns with world returns, proxied by US stock index returns. We also incorporate own country variances as additional determinants of Frontier country returns. Our model allows for the covariance risk to be time-varying. Time-varying correlations are captured by utilizing the Dynamic Conditional Correlations (DCC) model of Engle (2002). The risk premium on covariance risk is allowed to vary over time as well, using a time-varying parameter (TVP). Thus, both the risk and risk premium on Frontier country market returns are time-varying in our model.

The International ICAPM-TVP model can be cast into a state space form. However, it is not time-invariant as the "coefficient" multiplying the state variable (the TVP parameter) is (time-varying) current period conditional covariance between US and Frontier markets. The model nonetheless can be estimated by the Kalman Filter.

Results from estimation of the DCC model indicate modest average conditional correlations, suggestive of substantial diversification benefits from investing in Frontier markets. Correlations between most Frontier markets and US do in fact vary over time and are non-normally distributed due to presence of extreme values. They display largely no time trend, suggesting that diversification benefits have not diminished despite recent globalization. We detect a significant level of autocorrelation in these correlations, indicating predictability. Results from ICAPM-TVP estimation suggest that Frontier markets differ significantly from each other. We detect statistically significant impact of both US covariance risk and own country variance risk in explaining Frontier country returns. Time-variation in the price of covariance risk is also found to be statistically significant for most Frontier market returns. However, own country variance risk is found to be quantitatively more important.

Overall, results from our study show that international stock market diversification benefits might still hold, despite recent increased globalization and integration of financial markets. For accurate estimation of portfolio diversification benefits, investors must consider time-variation in conditional correlations of stock market returns as well as in country covariance risk prices. A logical extension of research presented in this article is understanding of factors that may contribute to time-variation and predictability in covariance risk premia. Exploration of portfolio diversification benefits further by constructing investment opportunity sets, calculating mean Sharpe ratios, and considering higher moments of returns to capture downside risk and possibility of large shocks to stock returns is also worthwhile. This can be done by comparing the above quantities with and without including Frontier market indexes in the investment portfolio.

Table 1: Distributional Characteristics of Annualized Daily Percentage Logarithmic Returns. The table provides mean, standard deviation, skewness, kurtosis, Jarque-Bera test statistic, and mean-to standard deviation (Sharpe) ratio for each frontier market and US.

Country	Mean	St.Dev	Skewness	Kurtosis	Jarque-Bera	Mean/St.Dev
Argentina	9.38	592.93	-0.626	10.84	3827.41	0.016
Bahrain	-24.3	356.44	-3.596	64.67	233902.71	-0.068
Bulgaria	-14.7	504.67	-1.589	16.401	11508.027	-0.029
Croatia	9.86	418.53	-0.156	9.438	2520.702	0.024
Estonia	-6.68	511.29	0.13*	7.127	1037.792	-0.013
Jordan	-19.7	343.70	-0.787	11.254	4283.52	-0.057
Kazakhstan	13.98	727.33	0.315*	10.095	3078.657	0.019
Kenya	2.14	360.31	0.378*	13.306	6479.127	0.006
Kuwait	-7.68	410.17	-1.114	11.906	5113.558	-0.019
Lebanon	2.52	417.12	-0.126	17.766	13263.225	0.006
Mauritius	18.63	365.83	0.181*	12.81	5846.367	0.051
Nigeria	0.60	387.45	-0.258	6.067	587.032	0.002
Oman	-3.61	374.72	-1.576	27.798	37910.577	-0.009
Pakistan	-5.98	450.35	-0.608	6.512	838.552	-0.013
Qatar	-4.94	449.67	-0.704	12.831	5983.325	-0.011
Romania	-2.9	643.75	-1.456	21.302	20836.586	-0.005
Slovenia	2.34	396.66	-0.361	9.713	2765.997	0.006
Sri Lanka	9.37	363.65	1.931	24.674	29404.741	0.026
Tunisia	9.59	284.55	0.094	9.046	2220.283	0.033
UAE	-26.6	546.43	-0.633	14.334	7891.139	-0.05
USA	0.94	373.15	-0.268	-2397.46	5758.433	0.003

Note: The statistics are based on 1456 daily observations of country returns between December 1st, 2005 and June 30th, 2011 as given by MSCI Barra country indices. All country indices are in US currency. The null hypothesis of no kurtosis is rejected for all countries and * indicates the null hypothesis for no skewness is rejected at 5% level. The distribution of the Jarque-Bera test statistic is approximates $\chi^2(2)$, with 5.99 critical value at the 5% level.

Table 2: Estimation results from DCC-GARCH models

GARCH models: $R_{i,\mathrm{t}} = \gamma_0 + \gamma_1 R_{\mathrm{i,t\text{-}1}} + \varepsilon_{\mathrm{i,t}}, \varepsilon_{\mathrm{i,t}} = \sqrt{h_{\mathrm{i,t}}} z_{\mathrm{t}}, z_{\mathrm{t}} \sim iidN(0,1),\ h_{\mathrm{i,t}} = b_0 + b_1 h_{\mathrm{i,t\text{-}1}} + b_2 \varepsilon^2_{\mathrm{t\text{-}1}}$, $i = 1, 2....21$.

DCC equations: $Q_{\mathrm{t}} = S(1 - \alpha_1 - \alpha_2) + \alpha_1 (U_{\mathrm{t\text{-}1}}\ U'_{\mathrm{t\text{-}1}}) + \alpha_2 Q_{\mathrm{t\text{-}1}},\ R_t = Q^{*\text{-}1}_{\mathrm{t}} Q_{\mathrm{t}} Q^{*\text{-}1}_{\mathrm{t}}$

Country	γ_0	γ_1	b_0	b_1	b_2	α_1	α_2
USA	10.995	-0.081	0.00	0.927	0.082		
	(6.0744)	(0.028)	(0.000)	(0.007)	(0.01)		
Argentina	31.24	0.046	16.53	0.814	0.129	0.046	0.912
	(12.109)	(0.028)	(38.23)	(0.032)	(0.024)	(0.01)	(0.022)
Bahrain	-19.26	0.056	63.37	0.796	0.177	0.095	0.000
	(6.927)	(0.036)	(8.279)	(0.019)	(0.023)	(0.000)	(0.000)
Bulgaria	12.672	-0.055	43.05	0.862	0.123	0.008	0.991
	(9.304)	(0.029)	(13.428)	(0.021)	(0.021)	(0.000)	(0.000)
Croatia	18.262	0.117	62.95	0.882	0.075	0.018	0.97
	(8.997)	(0.028)	(20.254)	(0.028)	(0.017)	(0.01)	(0.021)
Estonia	0.722	0.055	23.117	0.885	0.113	0.01	0.971
	(4.021)	(0.028)	(7.745)	(0.014)	(0.016)	(0.008)	(0.031)
Jordan	-9.463	0.03	10.947	0.931	0.06	0.018	0.000
	(6.598)	(0.028)	(3.763)	(0.009)	(0.009)	(0.000)	(0.377)
Kazakhstan	20.051	0.002	61.38	0.886	0.103	0.019	0.958
	(13.142)	(0.029)	(17.927)	(0.015)	(0.016)	(0.007)	(0.017)
Kenya	0.504	0.321	11.727	0.904	0.09	0.003	0.992
	(4.502)	(0.027)	(3.874)	(0.008)	(0.01)	(0.000)	(0.000)
Kuwait	10.011	0.064	19.95	0.927	0.06	0.027	0.000
	(8.087)	(0.029)	(4.344)	(0.008)	(0.007)	(0.000)	(0.000)
Lebanon	-5.891	0.103	87.671	0.738	0.25	0.008	0.963
	(8.856)	(0.032)	(21.239)	(0.039)	(0.042)	(0.007)	(0.031)
Mauritius	17.926	0.184	10.551	0.68	0.282	0.000	0.576
	(7.167)	(0.032)	(22.575)	(0.044)	(0.046)	(0.000)	(0.000)
Nigeria	0.507	0.381	74.608	0.761	0.185	0.000	0.609
	(2.995)	(0.028)	(18.55)	(0.037)	(0.03)	(0.000)	(0.000)
Oman	13.906	0.085	15.11	0.865	0.144	0.033	0.000
	(5.893)	(0.032)	(3.973)	(0.011)	(0.016)	(0.000)	(0.000)
Pakistan	20.696	0.095	98.51	0.775	0.167	0.000	0.001
	(8.597)	(0.029)	(16.928)	(0.024)	(0.021)	(0.000)	(0.000)
Qatar	8.512	0.103	39.473	0.885	0.098	0.056	0.000
	(9.545)	(0.031)	(8.927)	(0.014)	(0.014)	(0.000)	(0.000)
Romania	20.422	0.017	17.81	0.965	0.031	0.011	0.986
	(13.812)	(0.027)	(6.443)	(0.003)	(0.004)	(0.005)	(0.006)
Slovenia	13.759	0.173	73.529	0.808	0.134	0.000	0.000
	(7.655)	(0.028)	(23.963)	(0.044)	(0.031)	(0.000)	(0.000)
Sri Lanka	0.497	0.238	29.249	0.822	0.175	0.011	0.925
	(1.874)	(0.03)	(5.824)	(0.021)	(0.025)	(0.011)	(0.064)
Tunisia	12.749	0.073	42.267	0.802	0.157	0.005	0.986
	(6.009)	(0.03)	(10.557)	(0.027)	(0.023)	(0.005)	(0.014)
UAE	0.461	0.123	31.767	0.925	0.064	0.002	0.994
	(0.000)	(0.029)	(7.772)	(0.007)	(0.008)	(0.002)	(0.005)

Note: *Represent statistical significance at the 5%, and 1% levels, respectively. Numbers in parenthesis represent standard errors of estimates The estimates are based on 1456 daily observations of country returns between December 1st, 2005 and June 30th, 2011 as given by MSCI Barra country indices. All country indices are in US currency.

Table 3: Dynamic Conditional Correlations (DCCs) statistics for frontier market returns versus US. The table provides mean, standard deviation, skewness, kurtosis and Jarque-Bera test statistic for DCCs. Constant correlations are given in the first column.

Country	ρ	Max	Min	Mean	St.Dev	Skewness	Kurtosis	Jarque-Bera	Ljung-Box Q(6)
Argentina	0.563	0.891	0.000	0.594	0.111	-0.856	4.58	329.357	5852.113
Bahrain	-0.006	0.543	-0.422	0.003	0.069	-0.051	14.018	7366.275	5.493
Bulgaria	0.128	0.358	-0.15	0.089	0.145	0.256*	1.554	142.788	8587.543
Croatia	0.229	0.359	-0.159	0.152	0.097	-0.389	3.068	37.126	7903.064
Estonia	0.141	0.304	0.048	0.145	0.048	-0.01	3.062	0.261	7520.882
Jordan	-0.024	0.098	-0.183	-0.016	0.017	-0.196	18.31	14231.09	1.544
Kazakhstan	0.175	0.448	-0.18	0.153	0.091	-0.457	3.756	85.594	7487.996
Kenya	0.031	0.148	-0.052	0.057	0.047	-0.258	2.223	52.708	8471.084
Kuwait	0.01	0.196	-0.044	0.027	0.011	2.272	48.003	4124.22	32.761
Lebanon	0.067	0.133	-0.085	0.002	0.034	0.644*	4.165	98.605	7151.362
Mauritius	0.042	0.071	0.000	0.071	0.002	-26.92	725.99	7782.967	0.001
Nigeria	-0.009	0.000	-0.001	-0.001	0.000	26.92*	726.0	8157.192	0.001
Oman	-0.014	0.203	-0.16	0.033	0.026	-0.142	13.69	6937.94	10.362
Pakistan	0.018	0.046	0.000	0.046	0.001	-26.92	725.993	7547.11	0.009
Qatar	-0.006	0.539	-0.254	0.021	0.045	1.119*	22.637	2370.062	7.566
Romania	0.252	0.462	-0.148	0.201	0.126	-0.068	2.276	32.868	8440.583
Slovenia	0.182	0.143	0.000	0.143	0.005	-26.92	726.0	8255.15	0.001
Sri Lanka	0.019	0.166	-0.052	0.05	0.029	0.297*	4.006	82.954	5762.253
Tunisia	0.072	0.083	0.000	0.083	0.003	-26.92	726.001	8252.661	0.001
UAE	0.072	0.031	0.000	0.031	0.001	-26.92	726.0	8224.873	0.002

Note: The statistics are based on 1456 daily observations of country returns between December 1st, 2005 and June 30th, 2011 as given by MSCI Barra country indices. All country indices are in US currency. The null hypothesis of no kurtosis is rejected for all countries and * indicates the null hypothesis for no skewness is rejected at 5% level. The distribution of the Jarque-Bera test statistic is approximates $\chi^2(2)$, with 5.99 critical value at the 5% level. The Ljung-Box test statistic is based on 6 lags and is asymptotically distributed as $\chi^2(6)$ with critical value of 12.59 at the 5% level.

Table 4. Parameter Estimates for ICAPM -TVP Model

ICAPM - TVP model for Frontier countries:

$$R_{\mathrm{k,t}} = \theta_{\mathrm{k}} + \beta_{\mathrm{t}}\sigma_{\mathrm{us,k,t}} + \delta_{\mathrm{k}}\sigma^2_{\mathrm{k,t}} + +u_{\mathrm{k,t}},\ u_{\mathrm{k,t}} \sim N(0, H_{\mathrm{k}}), \beta_{\mathrm{t}} = c(1-\rho) + \rho\beta_{,t-1} + n_{\mathrm{t}},\ n_t \sim N(0, Q),$$
$$E(u_{\mathrm{k,t}}n_{\mathrm{t}}) = 0$$

Standard errors are reported in parentheses below the parameter estimates.

Country	θ_{k}	δ_{k}	$\sqrt{H_{\mathrm{k}}}$	c	ρ	$\sqrt{Q}$
Argentina	0.601	0.011	783.552	0.599	0.086	286.087
	(1.194)	(0.026)	(29.62)	(0.000)	(0.036)	(21.416)
Bahrain	64.49	-0.275	0.818	2.883	0.101	352.351
	(17.836)	(0.047)	(0.000)	(0.000)	(3.085)	(6.533)
Bulgaria	135.642	-0.356	0.000	72.865	-0.819	496.096
	(26.865)	(0.051)	(0.000)	(88.263)	(0.000)	(9.199)
Croatia	0.599	-0.002	1.071	0.599	0.13	418.565
	(2.907)	(0.027)	(3.093)	(0.000)	(0.000)	(7.76)
Estonia	-4.639	0.035	2284.63	-122.793	0.127	367.69
	(20.081)	(0.062)	(130.87)	(329.95)	(0.057)	(15.75)
Jordan	35.813	-0.193	2.518	-335.737	0.999	342.592
	(23.281)	(0.064)	(6.544)	(395.84)	(0.000)	(6.353)
Kazakhstan	23.974	0.064	1507.75	-338.109	-0.185	661.198
	(64.465)	(0.065)	(183.78)	(200.33)	(0.123)	(17.192)
Kenya	17.572	0.003	1554.18	-402.66	0.771	320.828
	(27.173)	(0.067)	(161.12)	(330.437)	(0.039)	(7.197)
Kuwait	71.539	-0.23	4223.29	284.092	0.267	386.647
	(175.98)	(0.105)	(1234.2)	(5080.95)	(0.415)	(12.355)
Lebanon	-33.688	0.135	6484.01	-696.385	0.242	324.965
	(20.128)	(0.05)	(405.17)	(411.583)	(0.067)	(7.861)
Mauritius	-17.098	-0.018	1404.53	594.571	0.701	338.408
	(24.089)	(0.067)	(885.13)	(532.989)	(0.242)	(18.466)
Nigeria	67.662	-0.198	166824.95	599.987	0.542	157.604
	(49.493)	(0.143)	(5992.91)	(2845.61)	(0.028)	(14.131)
Oman	26.618	-0.136	4048.29	635.55	0.13	330.35
	(22.467)	(0.041)	(537.625)	(456.51)	(0.091)	(11.036)
Pakistan	150.299	-0.46	4826.03	604.182	0.475	362.806
	(67.059)	(0.084)	(1094.21)	(1317.96)	(0.121)	(28.454)
Qatar	53.807	-0.166	3408.24	490.002	0.244	416.4
	(28.169)	(0.06)	(588.246)	(389.849)	(0.177)	(10.294)
Romania	126.059	-0.257	2004.86	145.591	0.061	434.975
	(49.697)	(0.093)	(91.587)	(114.236)	(0.054)	(14.635)
Slovenia	186.403	-0.185	2713.04	-833.162	0.153	39.211
	(27.622)	(0.076)	(52.661)	(280.015)	(0.026)	(19.102)
Sri Lanka	-101.64	0.203	3054.165	951.809	0.402	286.239
	(25.515)	(0.058)	(193.183)	(371.037)	(0.077)	(7.472)
Tunisia	77.481	-0.191	818.001	-188.621	0.488	270.387
	(27.671)	(0.077)	(256.396)	(222.065)	(0.146)	(8.383)
UAE	119.107	-0.322	3580.96	400.865	0.648	512.207
	(39.137)	(0.074)	(756.751)	(571.34)	(0.091)	(12.526)

Note: Estimates are based on 1456 daily observations of country returns between December 1st, 2005 and June 30th, 2011 as given by MSCI Barra country indices. All country indices are in US currency.

Table 5. Hypothesis Tests

The table presents values of test statistics obtained by examining the ICAPM - TVP model of Frontier market returns. Our ICAPM - TVP model is specified as follows:

$R_{\mathrm{k,t}} = \theta_{\mathrm{k}} + \beta_{\mathrm{t}}\sigma_{\mathrm{us,k,t}} + \delta_{\mathrm{k}}\sigma^2_{\mathrm{k,t}} + +u_{\mathrm{k,t}}$, $u_{\mathrm{k,t}} \sim N(0, H_{\mathrm{k}})$, $\beta_{\mathrm{t}} = c(1-\rho) + \rho\beta_{\mathrm{t\text{-}1}} + n_{\mathrm{t}}$, $n_t \sim N(0, Q)$, $E(u_{\mathrm{k,t}}n_{\mathrm{t}}) = 0$.

Statistical significance of parameters is tested via the likelihood ratio (LR) test, which is approximately chi-squared. The sample spans from December 1st 2005 to June 30th 2011. The following hypotheses are tested –

1. $LR\{\beta_{\mathrm{t}} = 0\,(c = Q = 0)\}$ is a test for no impact of US covariance risk in the ICAPM - TVP model. The 5% χ^2_2 p-value equals 5.99.

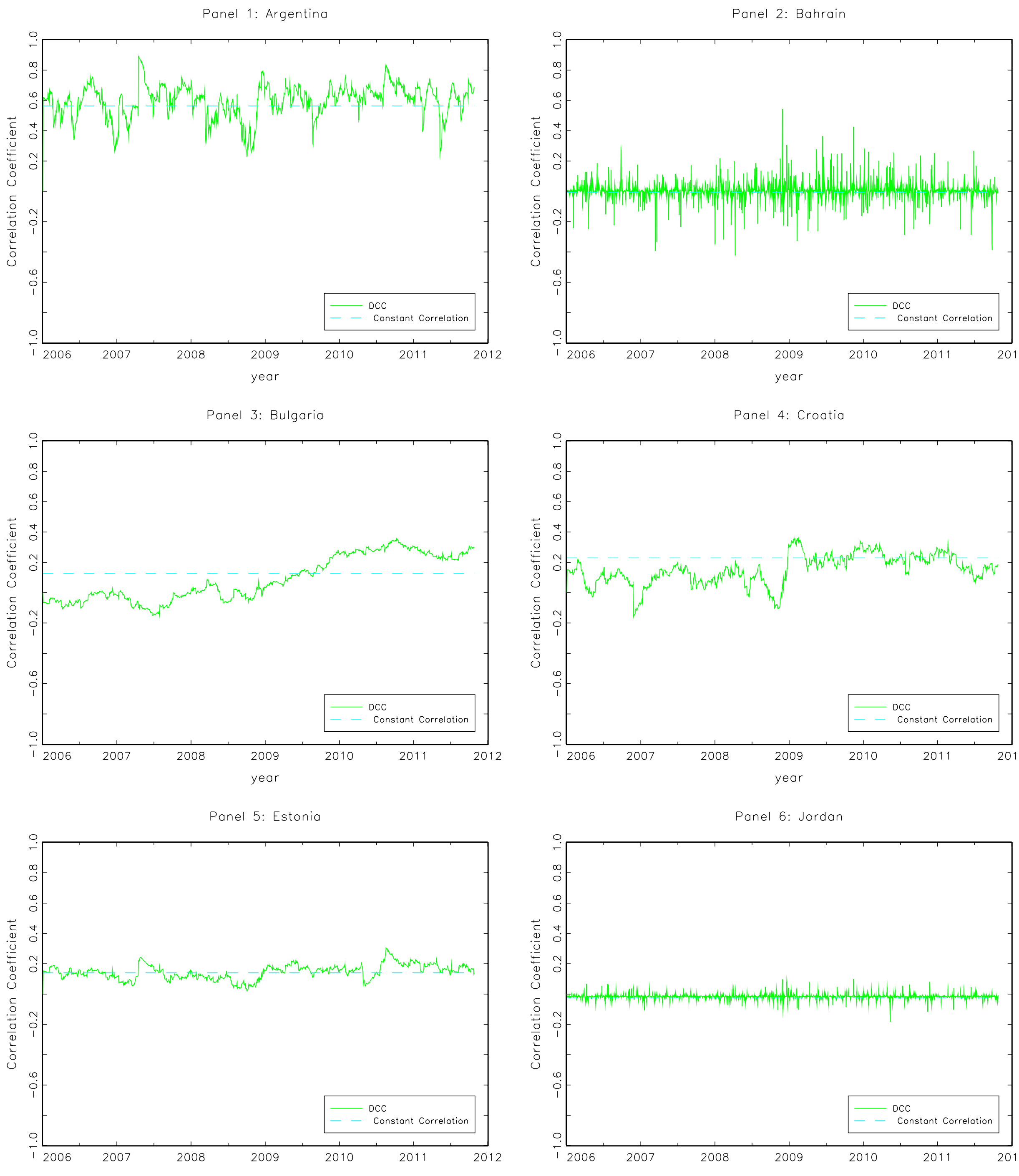
2. $LR\{\beta_{\mathrm{t}} = \beta,\, a\,constant\,(\rho = Q = 0)\}$ is a test for no time-variation in the AR(1) parameter of the ICAPM - TVP model. The 5% χ^2_2 p-value equals 5.99.

3. $LR\{\beta = 0\}$ is a test for no impact of US covariance risk in a constant coefficient ICAPM model ($\beta_{\mathrm{t}} = constant$). The 5% χ^2_1 p-value equals 3.84.

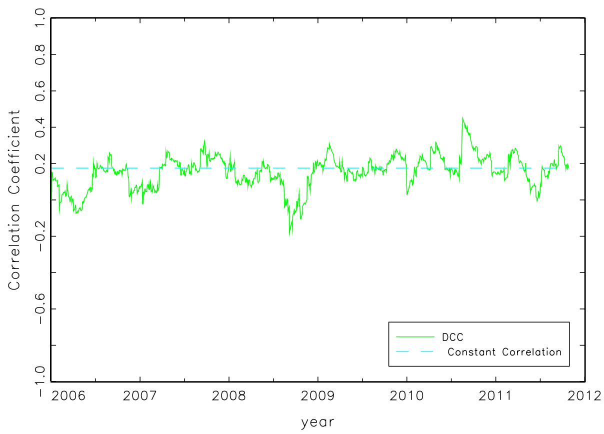
4. $LR\{\delta_{\mathrm{k}} = 0\}$ is a test for no impact of Frontier market risk in the ICAPM - TVP model. The 5% χ^2_1p-value equals 3.84.

	Hypothesis Tested			
Country	$\beta_{\mathrm{t}} = 0$ $(c = Q = 0)$	$\beta_{\mathrm{t}} = constant$ $(\rho = Q = 0)$	$H_0 : \beta_{\mathrm{t}} = 0$ $H_1 : \beta_{\mathrm{t}} = constant$	$\delta_{\mathrm{k}} = 0$
Argentina	289.79	289.663	0.136	0.176
Bahrain	0.059	0.046	0.012	33.59
Bulgaria	0.581	0.567	0.014	51.199
Croatia	0.094	0.019	0.075	0.007
Estonia	96.28	96.272	0.007	96.636
Jordan	3.29	3.276	0.014	8.825
Kazakhstan	36.808	36.583	0.225	37.715
Kenya	81.23	80.804	0.426	81.572
Kuwait	5.326	5.326	0.000	20.343
Lebanon	269.973	269.529	0.443	270.388
Mauritius	26.169	23.274	2.895	24.053
Nigeria	344.066	338.501	5.565	344.642
Oman	28.078	28.077	0.001	49.259
Pakistan	40.415	40.414	0.000	88.761
Qatar	28.949	22.889	6.06	31.838
Romania	219.982	213.726	6.256	221.216
Slovenia	41.154	41.155	0.000	50.292
Sri Lanka	188.912	188.919	0.006	234.599
Tunisia	5.448	5.4532	0.004	12.822
UAE	28.877	18.501	10.375	37.575

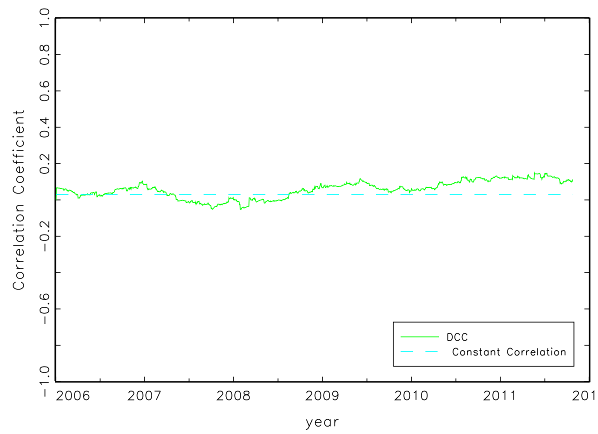
Figure 1
Dynamic Conditional Correlations between US and Frontier Markets



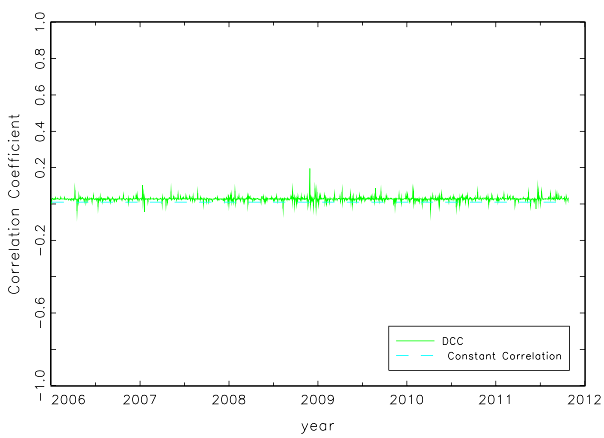
Panel 7: Kazakhstan



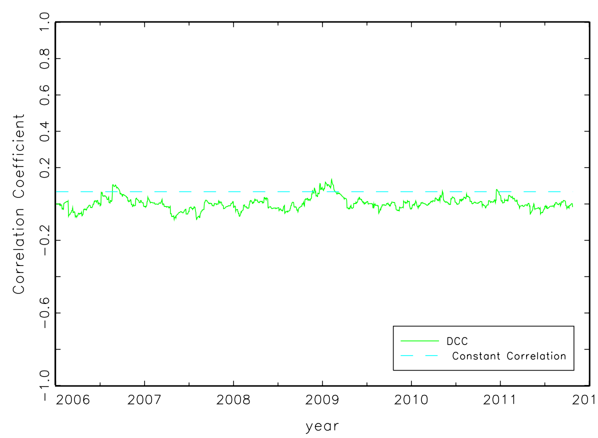
Panel 8: Kenya



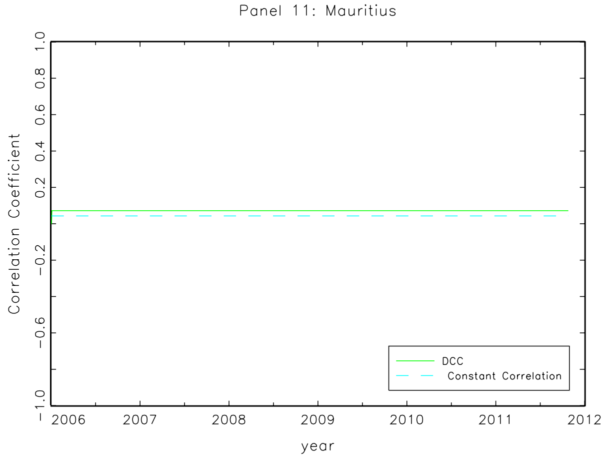
Panel 9: Kuwait



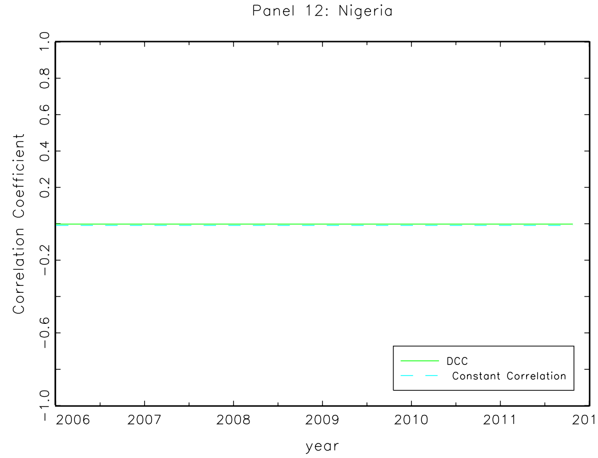
Panel 10: Lebanon



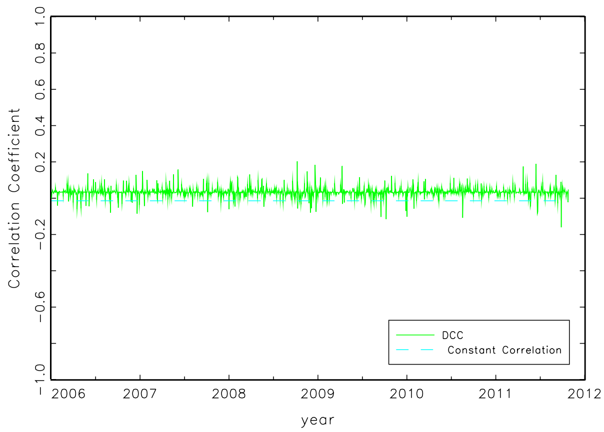
Panel 11: Mauritius



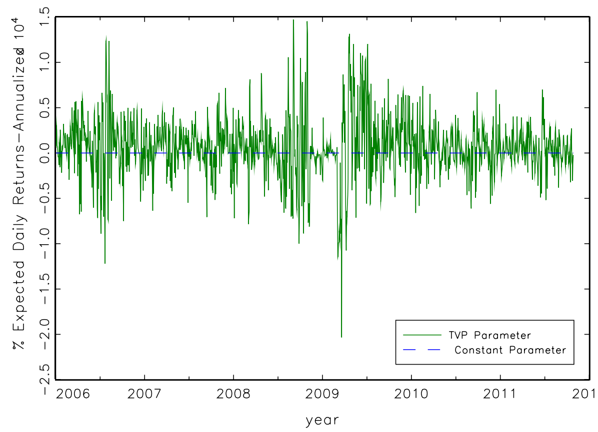
Panel 12: Nigeria



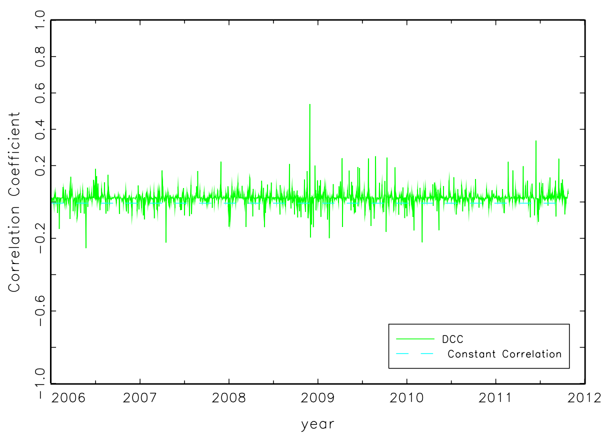
Panel 13: Oman



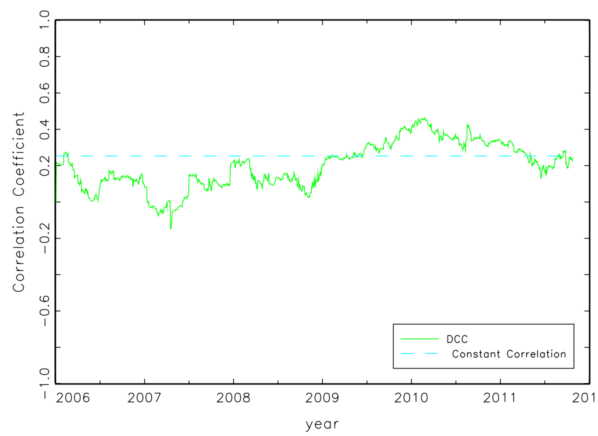
Panel 14: Pakistan



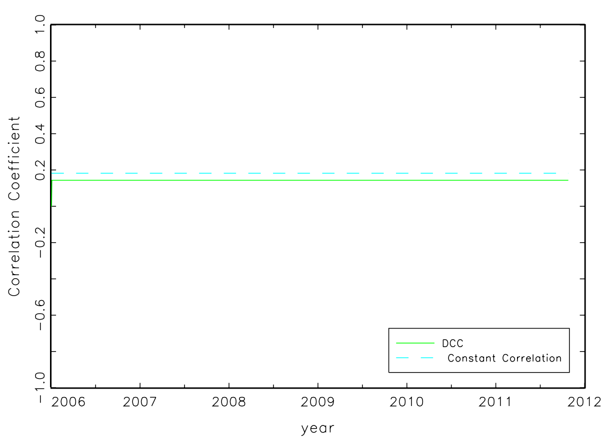
Panel 15: Qatar



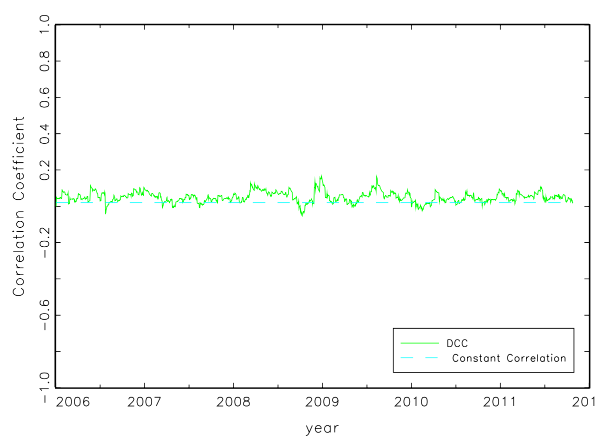
Panel 16: Romania



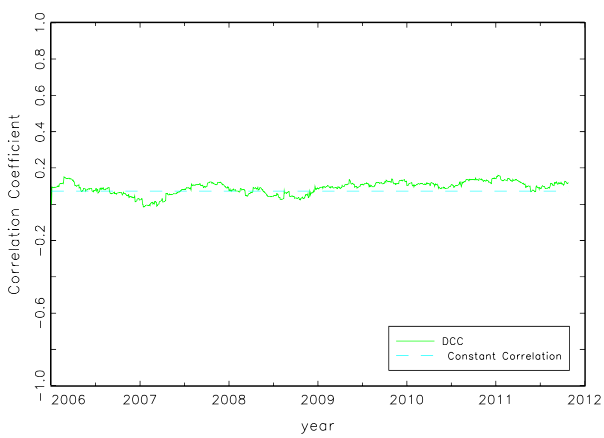
Panel 17: Slovenia



Panel 18: Sri Lanka



Panel 19: Tunisia



Panel 20: UAE

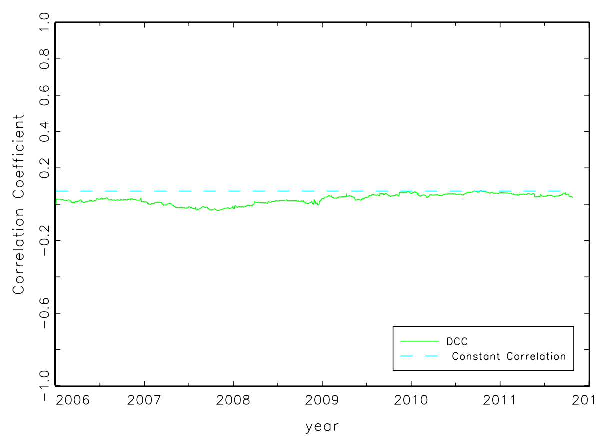
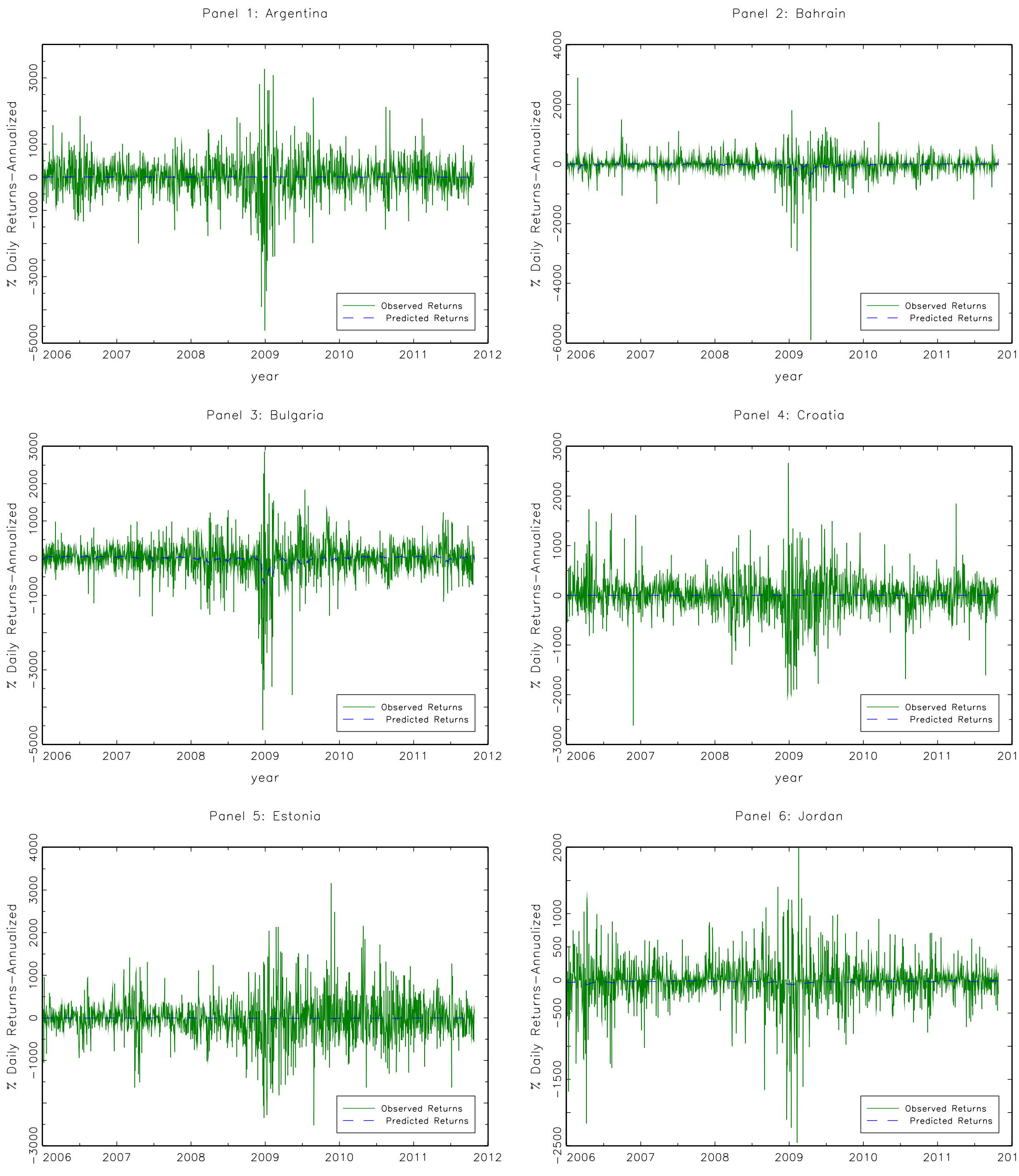
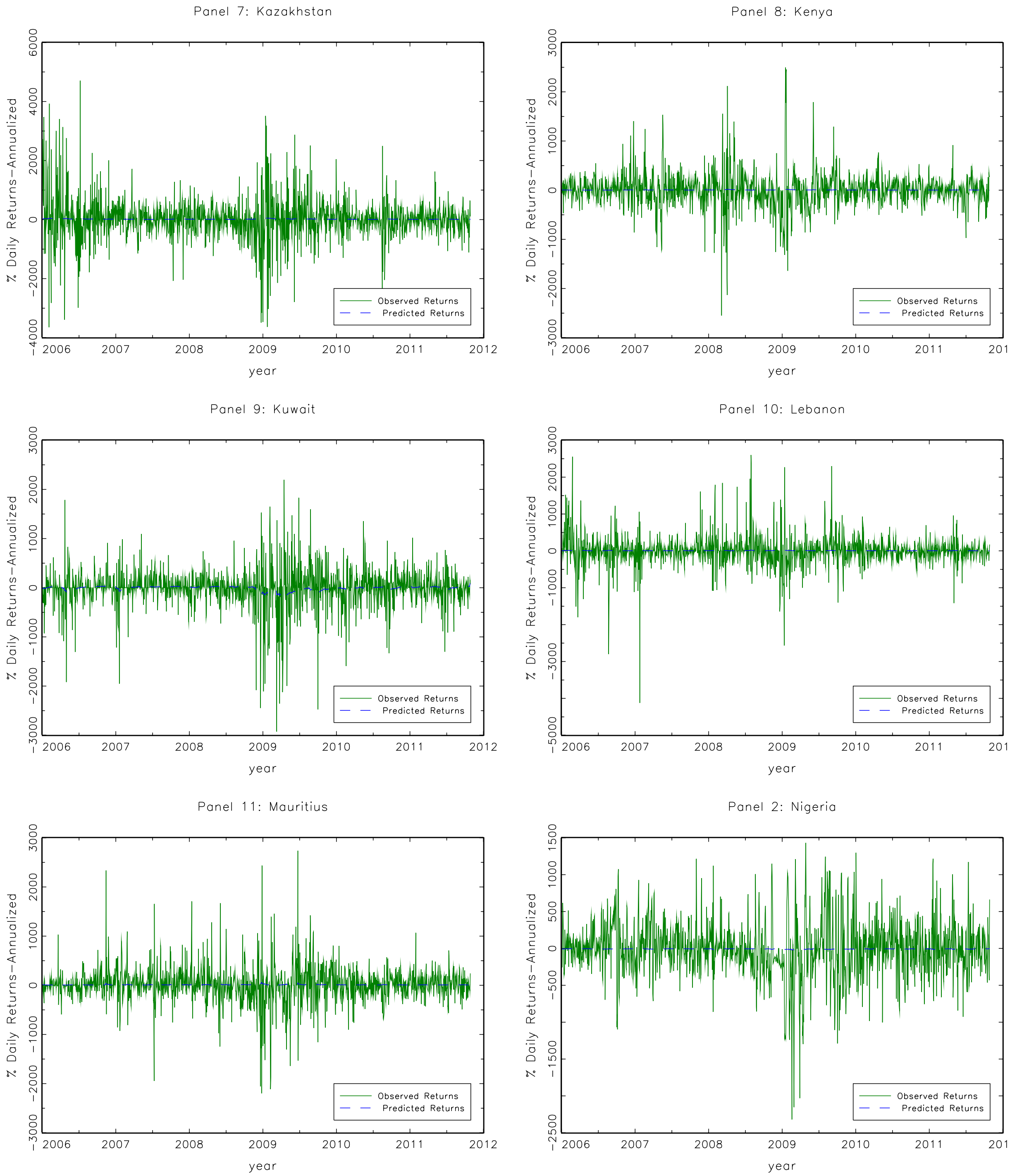
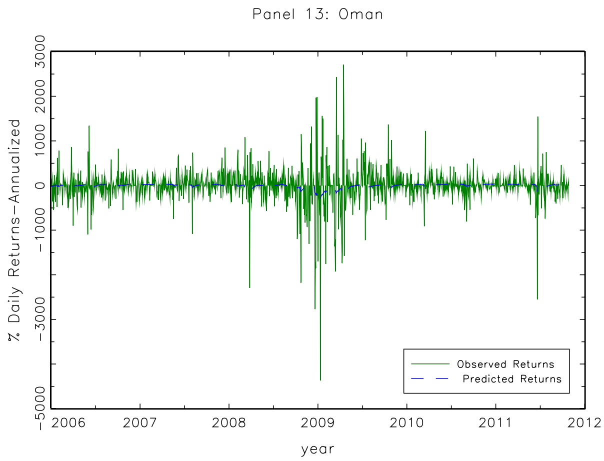
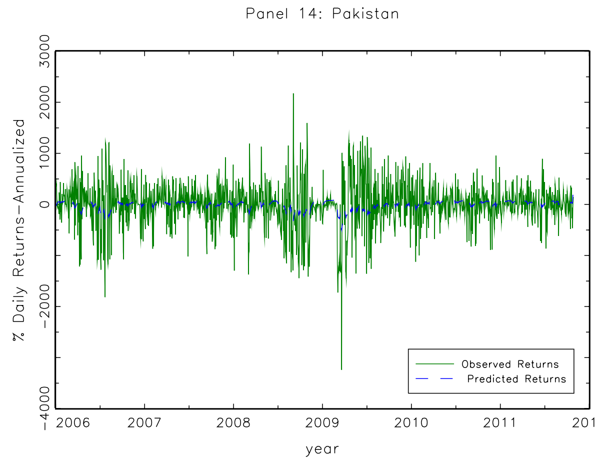


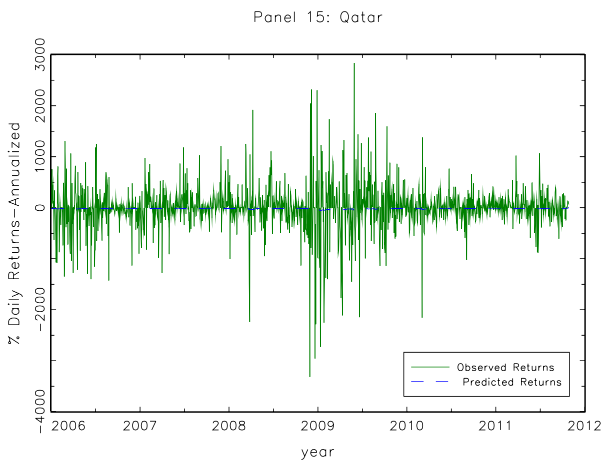
Figure 2
Frontier Market Returns and Fitted Values from the ICAPM-TVP Model

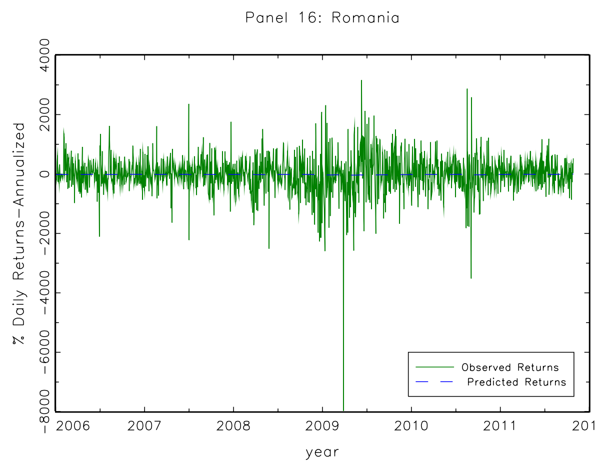


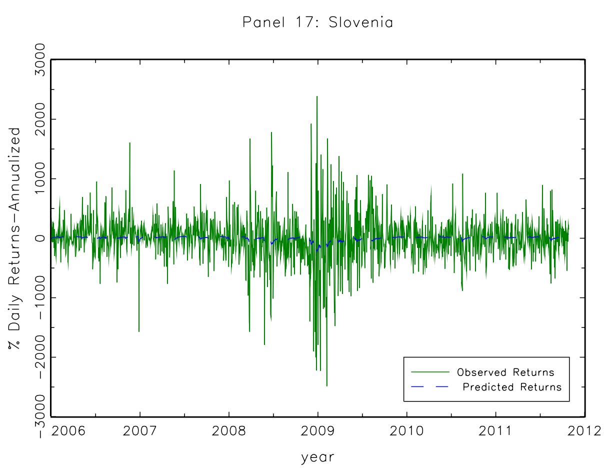

Panel 7: Kazakhstan
% Daily Returns−Annualized
6000
4000
2000
0
−2000
−4000
2006 2007 2008 2009 2010 2011 2012
year
Observed Returns
Predicted Returns
Panel 8: Kenya
% Daily Returns−Annualized
3000
2000
1000
0
−1000
−2000
−3000
2006 2007 2008 2009 2010 2011 2012
year
Observed Returns
Predicted Returns
Panel 9: Kuwait
% Daily Returns−Annualized
3000
2000
1000
0
−1000
−2000
−3000
2006 2007 2008 2009 2010 2011 2012
year
Observed Returns
Predicted Returns
Panel 10: Lebanon
% Daily Returns−Annualized
3000
2000
1000
0
−1000
−3000
−5000
2006 2007 2008 2009 2010 2011 2012
year
Observed Returns
Predicted Returns
Panel 11: Mauritius
% Daily Returns−Annualized
3000
2000
1000
0
−1000
−2000
−3000
2006 2007 2008 2009 2010 2011 2012
year
Observed Returns
Predicted Returns
Panel 2: Nigeria
% Daily Returns−Annualized
1500
1000
500
0
−500
−1500
−2500
2006 2007 2008 2009 2010 2011 2012
year
Observed Returns
Predicted Returns

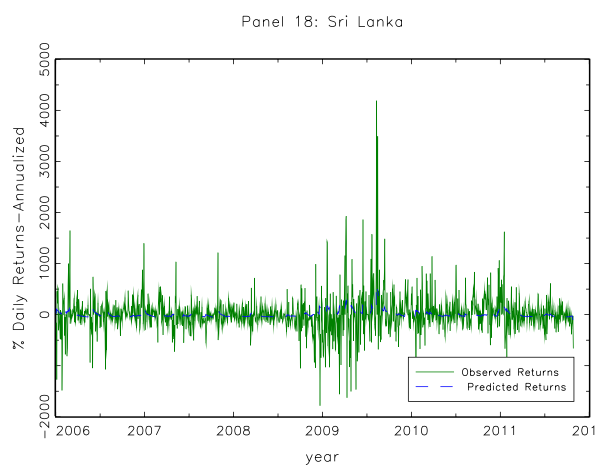

Panel 13: Oman
% Daily Returns−Annualized
−5000
−3000
−1000
0
1000
2000
3000
2006
2007
2008
2009
2010
2011
2012
year
Observed Returns
Predicted Returns

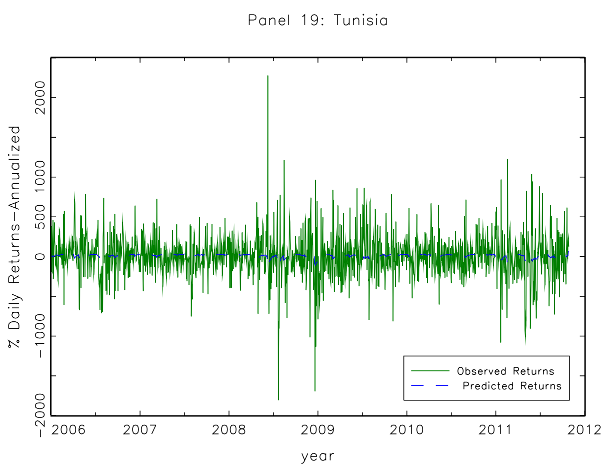

Panel 14: Pakistan
% Daily Returns−Annualized
−4000
−2000
0
1000
2000
3000
2006
2007
2008
2009
2010
2011
2012
year
Observed Returns
Predicted Returns


Panel 15: Qatar
% Daily Returns−Annualized
−4000
−2000
0
1000
2000
3000
2006
2007
2008
2009
2010
2011
2012
year
Observed Returns
Predicted Returns


Panel 16: Romania
% Daily Returns−Annualized
−8000
−6000
−4000
−2000
0
2000
4000
2006
2007
2008
2009
2010
2011
2012
year
Observed Returns
Predicted Returns


Panel 17: Slovenia
% Daily Returns−Annualized
−3000
−2000
−1000
0
1000
2000
3000
2006
2007
2008
2009
2010
2011
2012
year
Observed Returns
Predicted Returns


Panel 18: Sri Lanka
% Daily Returns−Annualized
−2000
0
1000
2000
3000
4000
5000
2006
2007
2008
2009
2010
2011
2012
year
Observed Returns
Predicted Returns


Panel 19: Tunisia
% Daily Returns-Annualized
-2000
-1000
0
500
1000
2000
2006
2007
2008
2009
2010
2011
2012
year
Observed Returns
Predicted Returns

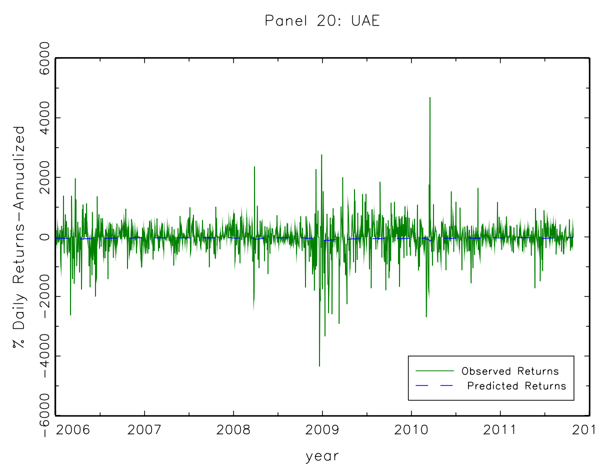
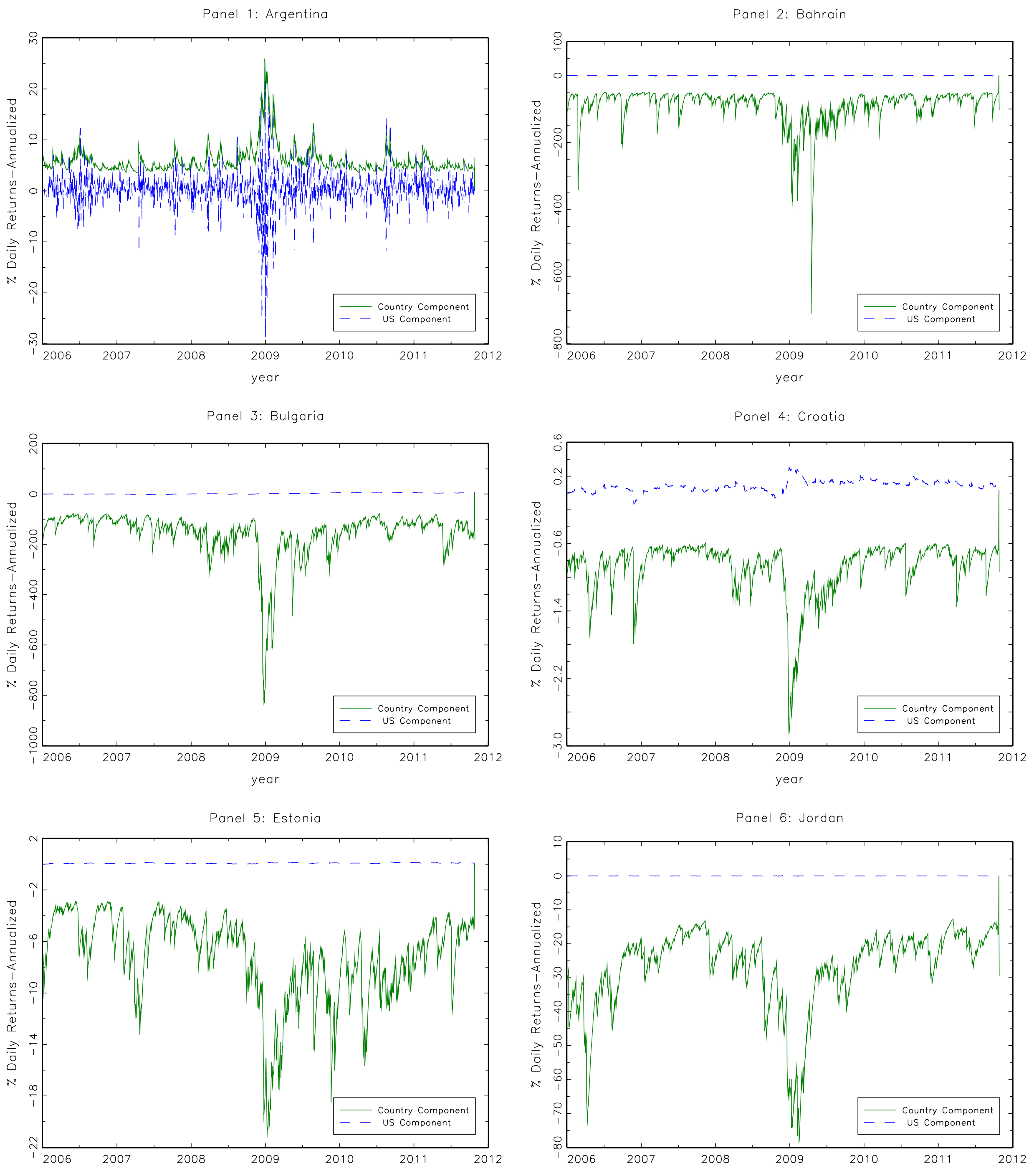
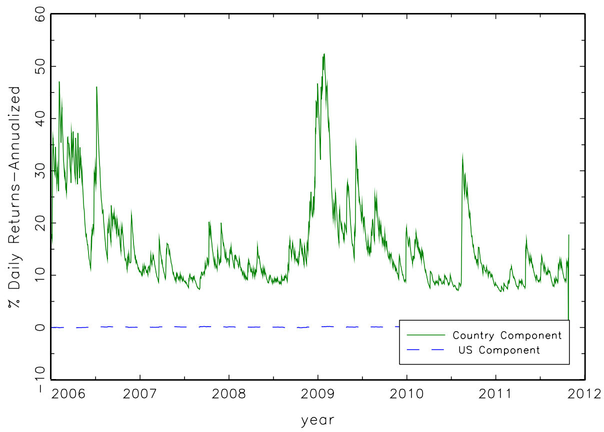

Panel 20: UAE
% Daily Returns-Annualized
-6000
-4000
-2000
0
2000
4000
6000
2006
2007
2008
2009
2010
2011
2012
year
Observed Returns
Predicted Returns

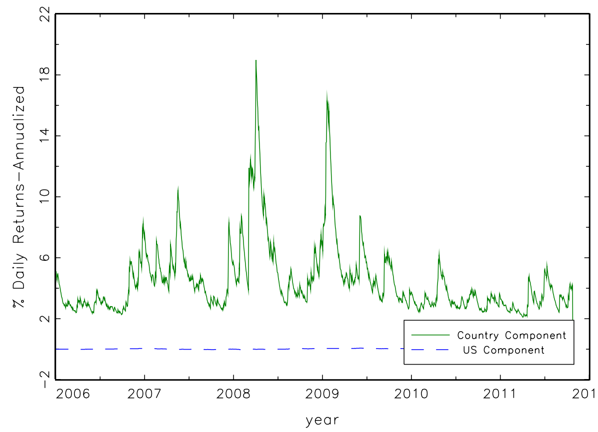
Figure 3
US and Local Market Components of Frontier Market Returns
Estimated by the ICAPM-TVP Model



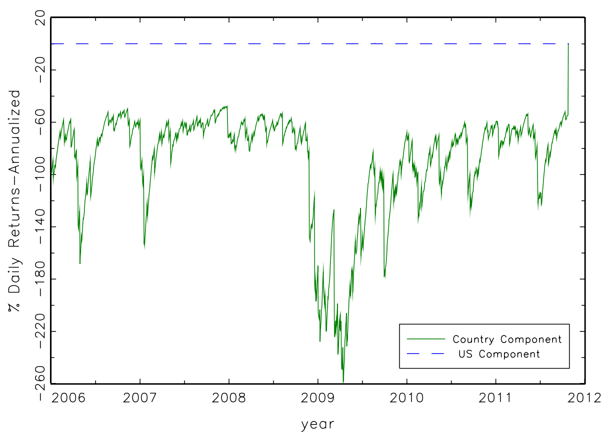
Panel 7: Kazakhstan



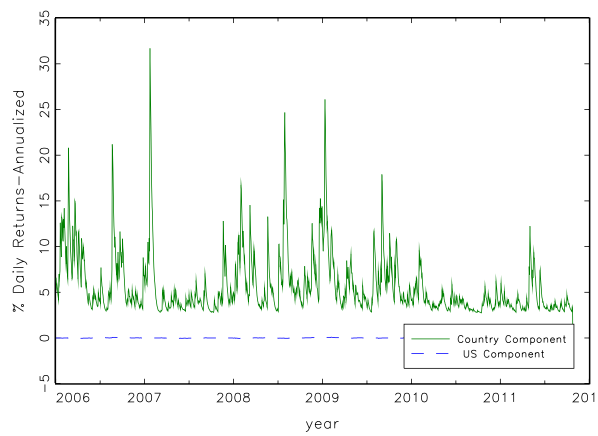
Panel 8: Kenya



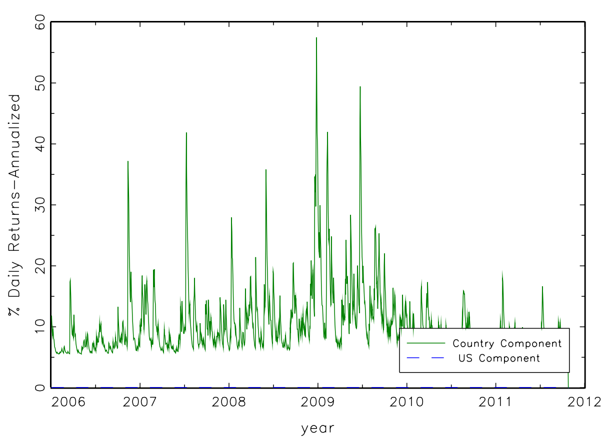
Panel 9: Kuwait



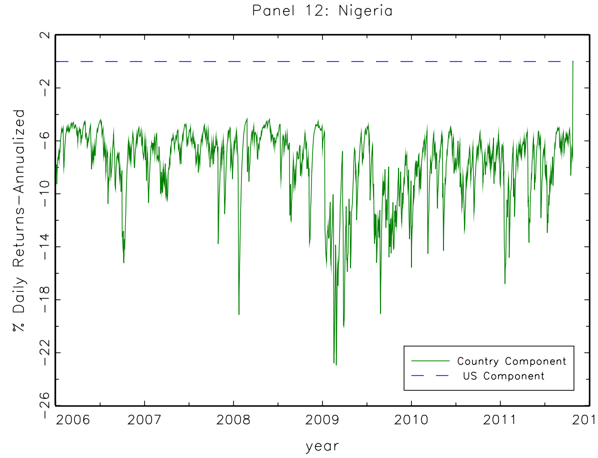
Panel 10: Lebanon



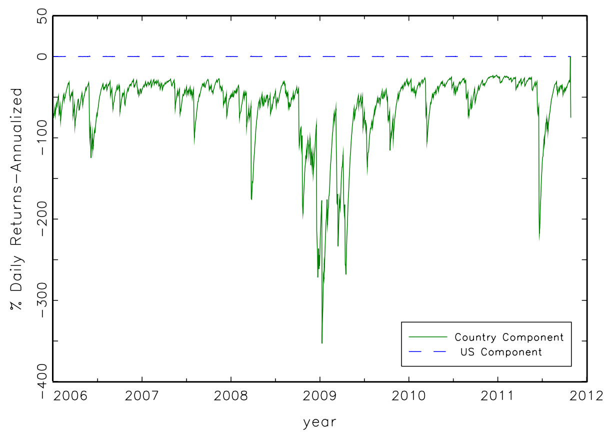
Panel 11: Mauritius



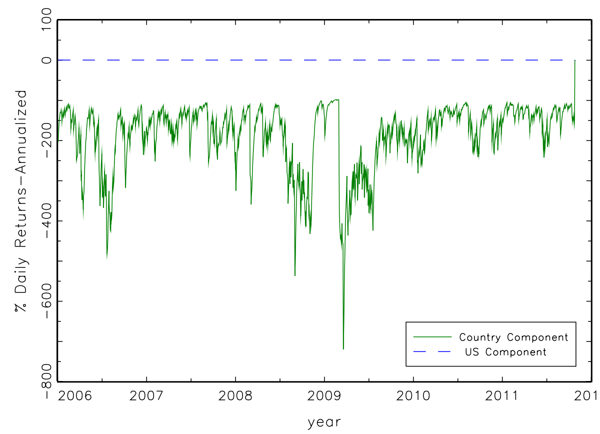
Panel 12: Nigeria



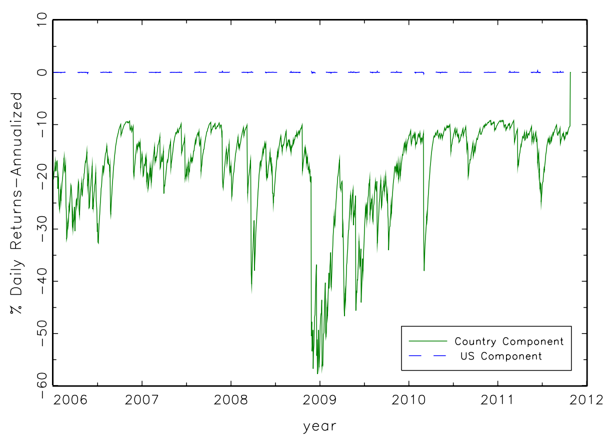
Panel 13: Oman



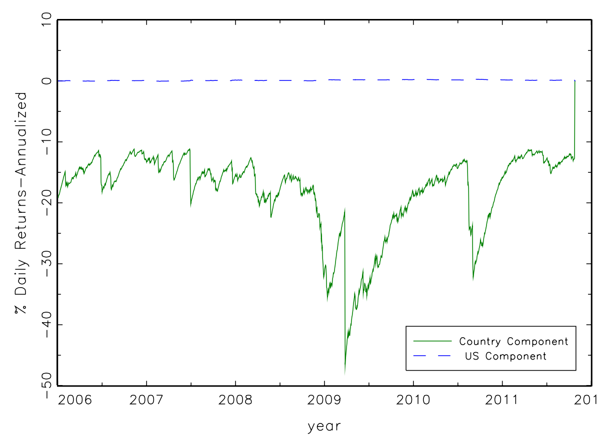
Panel 14: Pakistan



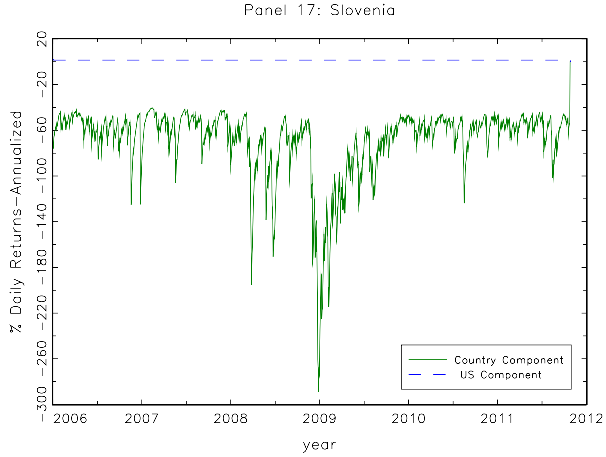
Panel 15: Qatar



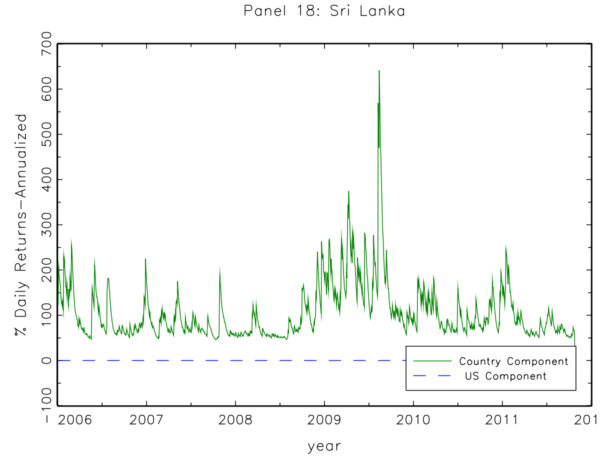
Panel 16: Romania

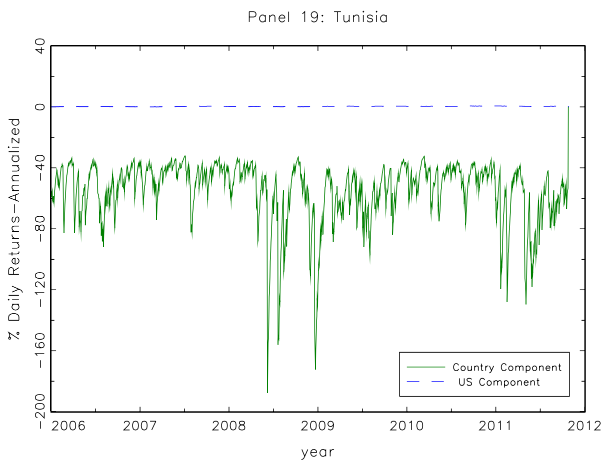


Panel 17: Slovenia

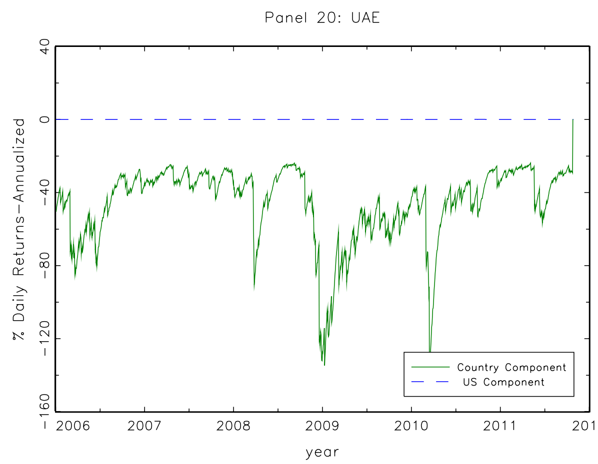


Panel 18: Sri Lanka





Panel 19: Tunisia
% Daily Returns-Annualized
40
0
-40
-80
-120
-160
-200
2006
2007
2008
2009
2010
2011
2012
year
Country Component
US Component



Panel 20: UAE
% Daily Returns-Annualized
40
0
-40
-80
-120
-160
2006
2007
2008
2009
2010
2011
2012
year
Country Component
US Component

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