

On International Financial Spillovers to Frontier Markets*

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Abstract

We explore the degree to which stock index returns and conditional volatility of 21 frontier markets were affected by fluctuations on the American stock market between December 1st 2005 and January 15th 2010. We find weak, positive return spillovers from US to 17 frontier markets. For four countries, Jordan, Lebanon, Nigeria, and Kenya, we find weak negative return spillovers from the US, implying possible diversification opportunities. For thirteen markets the influence of past local shocks is greater than the influence of current shocks from the US, and for sixteen markets local past volatility has stronger impact than volatility from the US.

Key phrases: Frontier markets; Emerging markets; spillovers; contagion; time-varying volatility

JEL codes: F36, G15, C58

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1. Introduction

The main issue investigated in this article is the extent to which contemporaneous returns and conditional volatility of 21 frontier markets were affected by the fluctuations in returns and conditional volatility on the American stock market during the period between December 1st, 2005 and January 15th, 2010.

The World Bank defines emerging markets as markets for which GDP per capita falls below a certain time-dependent hurdle. Frontier markets are defined as emerging markets that are investable, but have lower capitalization and market liquidity compared to the more developed emerging markets.

Financial spillovers exist due to real economic and financial ties between world economies. As a result of the existence of such ties, new information arising in one country affects not only local returns and volatility, but also the returns and volatility of assets traded on other markets. The impact of a change in returns of one stock market on the returns of another stock market is defined as returns spillovers, and the impact of a change in returns volatility of one stock market on the returns volatility of another stock market is defined as volatility spillovers. The new information may be absorbed immediately by other markets, or with a delay, depending on the presence and number of informed investors, information asymmetry, level of market liquidity, existence of feedback traders and herding behavior, high transaction costs and other potential market specific factors. The magnitude and speed of spillovers provide valuable insight into the nature and swiftness of dissemination of such new information among countries. The size of spillovers reflects how global investors feel about news, as well as their appraisal of its impact on asset prices across markets.

In order to travel across borders, information needs transmission channels. In the short run, asset price changes are the primary channel for transmission of financial shocks across borders. Owing to the dependence of frontier markets on common bank creditors and cross market portfolio re-balancing by investment funds, financial markets and institutions have been shown to act as a major tool for cross-border shock transmission (Kodres and Pritsker (2002), Calvo (1999), Pritsker (2001)). Detailed review of spillover transmission channels is offered by Pritsker (2001), and Kaminsky and Reinhart (2002).

The great majority of theoretical and empirical work has so far been concentrated on exploring spillovers among the mature and more developed emerging markets. However, the growing size and importance of frontier markets naturally draw considerable interest from investors, policy makers, and academics alike. In this study we extend the existing literature by analyzing the extent to which small markets are vulnerable to shocks from the USA, as represented by the returns and volatility spillovers from the US market to 21 frontier stock markets.

The exposure of the smallest developing markets to financial shocks from US is a matter of substantial concern for international investors. Frontier markets are often

considered very risky. That however, might not stem from those markets not being fundamentally sound; it might just be that investors do not know much about them. This study may provide financiers with further information about potential investment and portfolio diversification opportunities in those 21 small economies. Direct investment, project risk evaluation, cost of capital calculation, asset pricing and allocation, in addition to the development of hedging techniques can potentially benefit from this article as well.

Policy makers may take advantage of this study since understanding inter-market connections could provide for more informed decisions, improve macroeconomic management, as well as advance their ability to time, predict, and evaluate susceptibility of a country to shocks from abroad. Improved assessment of the nature and origin of a financial shock and possible subsequent economic downturn may facilitate the adaptation of more appropriate anti-crisis techniques and thus alleviate, or at least shorten, the suffering of those most affected by the deterioration of economic conditions.

Exploration of potential inter-market linkages may also aid academics in shedding more light on the outcome of market liberalization on capital flows and mobility. Enhanced awareness of market co-movement may expand their understanding of the significance of the structure and potential effects of free cash flows as well as any subsequent restrictions. Furthermore, this study may assist academics in forecasting and evaluating the reaction of international financial markets to global and local shocks, as well as in achieving deeper understanding of the shock transmission mechanisms.

Last but not least, when analyzing these economies, we should not be confused with the meaning of the word small: it refers only to the per capita income, not to the number of people living in those economies. The population of Argentina alone is close to 40 million, Romanian population is over 20 million, and in any one of those small economies live people struggling to survive every day. This paper will try to answer the question of how quickly, and how badly were those markets affected by the recent economic downturn and may even provide some insights about future macroeconomic policy course.

The evidence presented in this article suggests that spillovers from USA to frontier markets are rather weak, albeit statistically significant. One possible implication is that the global economic downturn worked its way in these countries through a different transmission channel, or that the economic deterioration in those frontier markets is due mainly to an idiosyncratic country specific shock. Furthermore, our results put forward the notion that it is not the lagged US market returns that have influence, rather it is the expected US market returns that have impact on frontier market returns. The inference is that despite different opening hours, non synchronous trading, stale orders, information asymmetry and other possible small market inefficiencies, the frontier markets absorb news from the USA almost immediately at the time of the news release. This

leads us to the conjecture that frontier market might not at all be inefficient, rather, their real and financial sectors might be resilient to influence from the US. From the perspective of a global financier, this finding means that there might exist some diversification benefits from investing in these developing economies. From the perspective of a developing country policy maker it means that a potential increase in capital flows from the US does not necessarily increase local market volatility even in times when the US economy is deteriorating.

In section 2 of this article we proceed with relevant literature review on financial spillovers; in section 3 we present the data and offer some descriptive statistics; section 4 develops the empirical models; in section 5 we report and discuss our results; section 6 concludes.

2. Literature Review

Interdependency and correlations among world financial markets have been investigated since the mid 1960s, however, this area of international finance gained most of its popularity after the stock market crash of 1987 with King and Wadhvani (1990) establishing the unidirectional impact of the US stock returns on other markets, Hamao, Masulis, and Ng (1990) confirming the unidirectional impact of US market return volatility, and Eun and Shim (1989) examining the interdependency across nine stock markets. Harvey (1995) found that adding emerging market assets to a portfolio significantly enhances its opportunity set. He showed that the exposure of emerging markets to common factors is low and that it is more likely that local variables have stronger influence than do global variables. Aggarwal, Inclan, and Leal (1999) support the last claim, reporting that important local events in each country, rather than global factors, tend to be associated with sudden changes in volatility. Bekaert and Harvey (1997) ascertain that capital market liberalization increases return spillovers across markets but does not affect market volatility, while Tanizaki and Hamori (2009) determine that market volatility is increasing in the amount of information available. From asset allocation point of view, increasing spillover effects are generally associated with an increase in cross market correlations and thus reduced opportunities for cross border portfolio diversification (Bekaert, Harvey (2000), (2003)).

The literature on financial spillovers received a significant boost after the 1997 Asian crisis. Sola, Spagnolo, and Spagnolo (2001) find unidirectional volatility spillovers from Thailand, the country where the crisis originated, to most of the countries in the region. Caporale, Cippollini, and Spagnolo (2003) confirm unidirectional spillovers in returns from the Thai stock market. Kim (2005) and Gebka and Serwa (2006) affirm the significant influence of the American market on the Asian markets at all times, and Gebka and Serwa (2007) find significant contemporaneous spillovers from the USA during the same period.

Egert and Kocenda (2009), as well as Fadhlaoui, Bellalh, Dherry, and Zonaouri (2009) find some evidence for short term spillovers, but no long term relations, between developed and emerging markets of Central and Eastern Europe. Yu and Hassan (2006) and Al-Kulaib, Najand, and Mashayekh (2009) find no spillovers from the USA to the Middle East, North African, and Gulf Cooperation Countries, while Chen, Firt, and Rui (2000) suggest high correlation of Latin American countries with world markets and thus limited potential for portfolio diversification.

Psillaki, and Margaritis (2008) claim no long term relationship, but some short term interdependence between the USA stock market and the French and German stock markets. Pollard, Sapra, and Canarella (2007), on the other hand, find significant impact from both the USA market returns and volatility on the Canadian and Mexican markets. Beirne, Caporale, Schulze-Ghatta and Spagnolo (2008) suggest that mature markets influence the conditional variances in many emerging markets. Sgherri and Galesi (2009) clarify for 27 countries that asset prices are the main channel of transmission of financial shocks internationally in the short run.

3. Data

In this article we use daily MSCI Barra index closing prices to explore the returns on the US stock market and 21 frontier markets for the period from December 1st, 2005 to January 15th, 2010. The daily returns for each country are calculated as follows:

$$R_{it} = \ln(P_{it}/P_{i(t-1)})$$

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

We choose daily data since it will better account for the stock market dynamics and provides greater insight on cross-market interactions. The countries included are: Argentina, Bahrain, Bulgaria, Croatia, Estonia, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Mauritius, Nigeria, Oman, Pakistan, Qatar, Romania, Saudi Arabia, Slovenia, Sri Lanka, Tunisia, and United Arab Emirates. The countries and duration of the period under study are chosen such that the longest index series is available for the greatest number of countries. Lithuania, Serbia, Ukraine, Bangladesh, Trinidad and Tobago, Jamaica, Botswana and Ghana are also defined by the World Bank as frontier markets, but are not included in this study 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 inter-market relations. They are value-weighted and calculated with the 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 the US and 21 frontier markets are reported in Table 1.1. The statistics include annualized arithmetic and geometric means, median, maximum, and minimum geometric returns for each country, as well as skewness, excess kurtosis, Jarque-Bera, Ljung-Box (6), and Arch (6) test statistics. Annualized arithmetic mean returns range from 0.09% for Kazakhstan to -0.08% for UAE and -0.0003% for the US market. The annualized geometric mean returns range from 25.29% for Kazakhstan to -34.58% for UAE and -2.36 % for the USA. The annualized standard deviation of geometric returns ranges from 801.3% for Kazakhstan to 279.07% for Tunisia and 405.58% for the USA. The mean returns are low as anticipated, considering that the period under study incorporates the economic downturn of 2007-2009. The standard deviation is quite high for the frontier markets, as expected (Harvey (1995)). It could be resulting from various liquidity effects or heterogeneous information sets of investors. The standard deviation is quite high for the US returns as well, representing the turmoil on the US market. The null hypothesis for no skewness is rejected at 5% significance level for Kazakhstan, Kenya, Mauritius, and Sri Lanka; the values for skewness are positive for all four countries. All countries display high and significant excess kurtosis, possibly due to time variation of conditional variance, as well as significant non normality as represented by the Jarque-Bera test statistic. The returns for all countries are highly serially correlated at 6 lags. No statistically significant auto-correlation is exhibited by the returns from Argentina, Bahrain, Kuwait, Romania, and Saudi Arabia.

The summary statistics provided in Table 1.1 offer an insight that contrasts with the existing literature. The average returns and standard deviation for frontier markets are not much different than for the USA. One implication could be that these markets, however young, may not represent a considerable diversification opportunity for foreign investors. This could be due to the fact that these markets are economically and financially integrated with the US market. Another possibility is that the frontier market indices under study may be comprised mainly of internationally operating companies for which shocks from the US have greater impact than local market shocks. These indices may or may not truly represent the financial and economic sectors of the respective countries, in which case we can infer nothing about integration.

4. Methodology

In the Data section we have demonstrated the presence of substantial deviations from normality and considerable leptokurtosis in the country data series. One type of models that can capture these characteristics is the Arch type models. Arch type models were first introduced by Engle (1982) to account for the influence of changing volatility in time series. Engle (1982) represents the conditional variance as a linear function of lagged squared residuals. The basic specification for an Arch model has the form

$$R_t = a + u_t$$

$$u_t = h_t^{1/2} z_t$$

$$z_t \sim iidN(0, 1)$$

$$h_t = b_0 + b_1 u_{t-1}^2$$

Because only one lag of squared residual is incorporated, a model such as the above is called Arch(1).

Bollerslev (1986) modified the Arch model by allowing lagged values of the conditional variance to be incorporated in the conditional variance equation. A basic GARCH (p,q) model describes the conditional variance as

$$R_t = a + u_t$$

$$u_t = h_t^{1/2} z_t$$

$$z_t \sim iidN(0, 1)$$

$$h_t = c_0 + \sum_{i=1}^p c_i u_{t-i}^2 + \sum_{i=1}^q b_i h_{t-i}$$

In order to avoid negative conditional variance the parameters of the variance equation must be non-negative, $c_0 > 0$, $c_i \geq 0$, $b_i \geq 0$.

GARCH models are shown to better account for fat tails and volatility clustering resulting from time variation in conditional volatility. It has also been found that GARCH (1,1) specification is the most appropriate for capturing these effects (Bollerslev (1986), Enders (2001), Hamilton (1994)).

In this paper we utilize two separate models to describe the evolution of returns in emerging markets. First, we utilize univariate GARCH (1,1) model to specify market returns as a function of own past values; then we specify a bivariate model that accounts for the impact of returns and volatility from the US market.

4.1 UNIVARIATE MODEL

The univariate model is defined as follows:

$$R_t^j = b_0 + \sum_{i=1}^{12} b_i R_{t-i}^j + u_t^j$$

$$u_t^j = \sqrt{h_t^j} z_t$$

$$z_t \sim iidN(0, 1)$$

$$h_t^j = a_0 + a_1 u_{t-1}^{j2} + a_2 h_{t-1}^j$$

R_t^j — log index return for country j.

b_0 — the portion of the returns explained by factors other than shocks and past returns.

b_i —parameter representing the impact of own country lagged returns on current returns.

u_t^j —represents the unexplained portion of the country returns.

h_t^j —conditional variance for country j. It is interpreted as a proxy for market sentiment towards news originating within the country.

a_0 —GARCH regression constant; represents the portion of the conditional volatility explained by factors other than the lagged excess returns and lagged conditional volatility. It is the portion of the market sentiment that is due neither to market sentiment towards news in the past, nor to excess returns.

a_1 —parameter representing the impact of lagged excess returns.

a_2 —parameter representing the impact of market sentiment towards past news originating within the country .

The above specification is estimated for returns from all 21 frontier markets, as well as the United States. The number of lagged returns included in the best-fitting model is determined using the Schwarz-Bayesian Criterion (SBC).

Appendix 1 presents details on the estimated factor loadings of the univariate models for each country and Table 1.2 reports a summary of the best-fitting models; discussion is offered in section 5.1.

4.2 BIVARIATE MODEL

In this section we upgrade the best-fitting univariate model to a bivariate model in order to account for the effect of the USA returns and conditional volatility on the market returns of individual countries. The bivariate model is defined as follows:

$$R_t^j = b_0 + \sum_{i=1}^{12} b_i R_{t-i}^j + \sum_{i=0}^{12} c_i R_{t-i}^{\text{US}} + u_t^j$$

$$u_t^j = \sqrt{h_t^j} z_t$$

$$z_t \sim iidN(0, 1)$$

$$h_t^j = a_0 + a_1 u_{t-1}^{j2} + a_2 h_{t-1}^j + a_3 h_t^{\text{US}} + a_4 h_{t-1}^{\text{US}}$$

where the variables and parameters additional to the univariate model are defined as follows:

R_{t-i}^{US} —log index returns for the US market representing shocks originating from the USA. When $i = 0$ we consider shocks on the US market that occur on the same day as the returns of the country under study. When $i > 0$, we consider past shocks to the US market.

c_i —parameter represents return spillovers from the US market to the market of the country under study. When $i = 0$, c_0 represents the impact on returns of contemporaneous US shocks, and when $i > 0$, c_i represents the impact on returns of past US shocks.

h_t^{US} —conditional variance for the USA market. It is interpreted as a proxy for market sentiment of traders on the USA market towards news originating in the USA and is derived from the univariate model of US market returns.

a_3 & a_4 parameters representing the impact of market sentiment of US investors towards contemporaneous news originating in the USA on the sentiment of the individual frontier country investors.

We choose to consider a GARCH model without any asymmetry, although the asymmetric impact on financial series volatility of negative news has long been studied (Glosten, Jagannathan, Runkle (1993)). For emerging markets, however, no asymmetry effects have been shown and any potential asymmetry is assumed to enter through the idiosyncratic shock u_t^j (Bekaert, Harvey, and Ng(2005)).

The above specification is estimated for returns from all 21 frontier markets. The number of lagged US returns included in the best-fitting bivariate model is determined using the Schwarz-Bayesian Criterion (SBC).

Appendix 2 presents details on the estimated factor loadings of the bivariate models for each country and Table 1.3 reports a summary of the best-fitting models; discussion

is offered in section 5.2.

4.3 HYPOTHESIS TESTING

In this text we investigate whether the country's own lag market return effects b_i and the US current and lagged market return effects c_i have any statistical significance. This is done by using LR test to explore the null hypothesis of whether $b_i = 0$ and $c_i = 0$, where the number of lags i of local and US returns is determined using the SBC. Further, we apply the LR test to examine the impact of the volatility spillover effects a_3 , and a_4 ; the hypotheses tested are $a_3 = 0$ and $a_4 = 0$. We also study the possibility for homoscedasticity of the error term; we do that by applying the LR test to the null hypothesis: $a_1 = a_2 = a_3 = a_4 = 0$. At the 5% significance level and the null for homoscedasticity is rejected in favor of the Garch specification.

The test statistics derived from the significance tests performed on the best-fitting bivariate models are presented in Table 1.4 and a summary is reported in Table 1.5.

5. Empirical Results

5.1 UNIVARIATE MODEL

Appendix 1 presents detailed results from the estimation of univariate models for the US and each of the 21 frontier markets. For each country we investigate 12 models, where each model is specified based on a different number of included own country lagged returns. The number of lagged returns under consideration ranges from 1 to 12, and the best-fitting model is determined using the Schwarz-Bayesian Criterion (SBC). A summary of the coefficients from the estimation the best-fitting univariate models for all countries is presented in Table 1.2

According to the Schwarz-Bayesian criterion (SBC), for the US and 20 out of the 21 frontier markets, with Kenya being the only exception, the best-fitting univariate model is one that includes only one period lagged home returns, and is defined as follows:

$$R_t^j = b_0 + b_1 R_{t-1}^j + u_t^j$$

$$u_t^j = \sqrt{h_t^j} z_t$$

$$z_t \sim iidN(0, 1)$$

$$h_t^j = a_0 + a_1 u_{t-1}^{j2} + a_2 h_{t-1}^j$$

One possible implication that can be inferred from this finding is that the influence of shocks from home is no more persistent for the frontier markets than for the USA

market.

For Kenya, the best-fitting univariate model is

$$R_t^j = b_0 + b_1 R_{t-1}^j + b_2 R_{t-2}^j + u_t^j$$

with the other equations as described above.

Table 1.2 suggests magnitude of the regression constant b_0 greater than 0.1 for more than half of the countries. The presence of a significant positive constant means the unconditional expected returns are positive. This suggests optimistic outlook of investors about the future. The constant captures latent factors determining the mean of the returns, as well as unobservable variables affecting the returns, but omitted in our model. The existence of such factors may be due to potential unavailability of data other than lagged returns, or poor quality of the available data. Potential latent factors could be political instability, government regulations, corruption, international compatibility of accounting standards, as well as different regional factors.

For several countries, Table 1.2 reports lower magnitude of the constant, relative to their peers. The relatively low magnitude of the constant implies low, or even negative mean returns for these countries, low or negative expected returns, and thus relatively pessimistic prospects about the future. The low magnitude may also imply that there is more data available for these countries, as well as better quality of the data, which is fully captured by the index returns. One implication of such possibility could be that markets in these countries are more efficient, which results in the weaker presence of latent factors and unobservable variables. Another possibility is that while home markets as a whole may be unable to incorporate all relevant information, the returns of the companies having most weight in the MSCI index are resilient to local factors other than past returns. This could be because the companies in question operate mostly internationally, there is more and better quality data available for them, or they are large enough to not be affected by home market processes.

According to Table 1.2, for most of the countries the influence of past returns b_i is below 0.1. For eight countries, the impact of past returns is greater than 0.1. The greater the impact of past returns, the longer it takes for those markets to evaluate the full effect of past shocks. One possibility is that the economies of these countries are not that well diversified, and a shock to one sector trickles to other sectors and that trickle takes time to be evaluated.

The magnitude of the variance constant a_0 for most of the countries is between zero and one, as presented in Table 1.2. For the USA the value of the variance constant is 0.086, which is the lowest for all countries. Since the US market has been shown to be efficient in incorporating information (Fama (1998)), the effect of any unobservable variables or latent factors is absorbed immediately through a change in returns. For

the frontier markets, the lowest constant value is for Kenyan returns: 0.098. For four markets the magnitude of the constant is greater than one. Those markets are Argentina (1.711), Lebanon (2.5), Mauritius (1.549), and Pakistan (1.4).

Table 1.2 further indicates the influence of one period lagged events on current market sentiment a_1 is between 0.5 and 1, for almost all countries, including the US (0.919). Considering that the period under study incorporates periods of great market turbulence and uncertainty, it seems reasonable to assume that the impact of any past news is being continuously reassessed. A high coefficient of impact may imply not only abundance of information, but also abundance of important information, such as announcement of structural reforms, or lack there of, announcements of new government policies or regulations, outdated statistical information. The only country with relatively low impact of past local news is Estonia (0.087). Considering that Estonia is a small, export oriented economy, it is realistic to believe that the index data is composed of predominantly export oriented companies, for which local information is relatively unimportant relative to global news and thus the coefficient of impact of past local news is relatively low.

5.2 BIVARIATE MODEL

Appendix 2 presents detailed results from the estimation of bivariate models for each of the 21 frontier markets and a summary of the results is presented in Table 1.3. For each country we investigate 13 models, where each model is specified based on a different number of included US lagged returns. The number of lagged returns under consideration ranges from 0 to 12, and the best-fitting model is determined using the Schwarz-Bayesian Criterion (SBC). According to the Schwarz-Bayesian criterion (SBC), for 16 out of the 21 frontier markets the best-fitting bivariate model is one that includes only contemporaneous US market returns and no US lagged returns. The model is specified as follows:

$$R_t^j = b_0 + b_1 R_{t-1}^j + c_o R_t^{us} + u_t^j$$

$$u_t^j = \sqrt{h_t^j} z_t$$

$$z_t \sim iidN(0, 1)$$

$$h_t^j = a_0 + a_1 u_{t-1}^{j2} + a_2 h_{t-1}^j + a_3 h_t^{us} + a_4 h_{t-1}^{us}$$

where h_t^{us} is derived from the uni-variate model for US returns.

For four countries, Bahrain, Kuwait, Oman, and Tunisia, Table 1.3 suggests the bivariate model contains one period US lagged returns, along with the contemporaneous

returns:

$$R_t^j = b_0 + b_1 R_{t-1}^j + c_0 R_t^{us} + c_1 R_{t-1}^{us} + u_t^j$$

with the other equations the same as above.

For the Kenyan market, the bivariate model contains two period lagged domestic returns and contemporaneous returns from the US. This model is as follows:

$$R_t^j = b_0 + b_1 R_{t-1}^j + b_2 R_{t-2}^j + c_0 R_t^{us} + u_t^j$$

with other equations as above.

Figures plotting the observed returns, as well as the returns predicted by the best-fitting bivariate model for each country are presented in Appendix 3. Each figure reveals the progression of the plotted variables over time and illustrates the degree to which the variance of the observed returns is explained by our best-fitting models.

5.3 DISCUSSION OF SPILLOVERS

The center piece of the bivariate model, summarized in Table 1.3, is the investigation of return and volatility spillovers from the US to the local markets as measured by the parameters c_0 , a_3 , and a_4 . The greatest return spillovers from the USA are to Argentina (0.957), Kazakhstan (0.237), and Romania (0.329). For majority of the countries the impact coefficients fall between 0.0 and 0.1, with 4 markets experiencing negative spillovers: Jordan (-0.021), Lebanon (-0.059), Nigeria (-0.027), and Kenya (-0.028) at lag one.

For Argentina, Kazakhstan, and Romania the high impact coefficients may indicate deep economic inter-dependence between those countries and the US, rather than financial relations only. The economies of these four countries are predominantly export oriented and trade relations might be one reason for economic integration. If the trade export of those economies is predominantly to the USA, then they might not be well diversified and thus vulnerable to shocks from the American market. One implication is that in these four countries, international investors may find little or no scope for diversification. Not such is the situation with the markets experiencing negative impact from the US: Jordan, Lebanon, Nigeria, and Kenya. The negative relation between the US returns and returns in those countries implies low degree of inter-dependence between local economies and the US economy and thus presence of possible diversification opportunities from the standpoint of international portfolio managers. From a policy maker's point of view, those countries seem resilient to shocks from the US market. One implication is that downturn in USA should not be blamed for recession in those countries, and any economic slow down is more likely to be "home grown" rather than "imported" from US, at least not through this channel.

It is interesting to note that although the local and US market returns occur on the same date, the markets under study open before the US market and have little or no overlap in trading hours. Most of those markets open seven or more hours before the US

market opens, with the exception being Argentina opening one hour ahead, Nigeria and Tunisia five hours ahead, and Slovenia six hours ahead. One important implication of this finding is that it might not be the actual US returns that matter, but the expected US returns. Any announcements made in the USA after closing of the stock exchanges on day one, and before opening on day two, are absorbed by the US market on day two. Throughout the trading day on local frontier markets, investors observe those announcements, and incorporate them in their asset valuation immediately, while they only get incorporated in the US returns on the next trading day in the US, which in most cases starts just after closing of local markets. To better describe such a situation, we could say that it is the US overnight returns that affect the local markets, rather than the actual daily returns, where the overnight returns are defined as the change in price between closing on day one and opening on day two. The overnight returns form the expected returns, and are reflected in the US daily returns on the next day, so those returns seem to affect the local market returns despite the fact that local markets may close for the day before the US market opens. Similar discussion and more details on the international transmission of overnight returns can be found in Hamao, Masulis, and Ng (1994), Lin, Engle, and Ito (1994), and Baur and Jung (2006).

For thirteen of the twenty one frontier markets, Table 1.3 reports the impact coefficient of lagged home returns b_1 is greater than the impact coefficient of the current US returns c_0 . This implies that for the period under study for those markets, the average impact of domestic shocks is stronger than the average impact of shocks from the US market. This suggests that the economies of those countries may be less vulnerable to US market deterioration relative to their peers. The opposite is true for the remaining eight markets. For those, the average influence of shocks from the US is greater than the average influence of domestic shocks, and their economies may be more vulnerable to US market shocks relative to their peers.

The impact coefficients a_3 and a_4 representing volatility spillovers give us the scale of transmission of market sentiment from the US stock market to the local markets of the countries under study. In accordance with literature on emerging markets, Table 1.3 reports that volatility spillovers are weaker relative to return spillovers. Current period spillover parameter a_3 for most of the countries falls between 0.00 and 0.05. The low magnitude of impact coefficients imply weak, albeit statistically significant, cross-market transmission of market sentiment from the US market. The degree of transmission of market sentiment might also be indicative of the presence of feed back trading and herding behavior. The low parameter values imply very limited presence of those inefficiencies. Exception are Argentina (0.084), Bulgaria (0.158), Croatia (0.103), Mauritius (0.33), Romania (1.836), and Saudi Arabia (0.122). Similarly for one period lagged spillovers, majority of the countries fall in the range between 0.00 and 0.05. Exceptions are Bahrain (0.693), Bulgaria (0.112), Kenya (0.119), Lebanon (0.066), Nigeria (0.161),

Oman (0.686), Romania (0.436), and Saudi Arabia (0.28). For these markets, and especially for Romania, there is stronger indication for cross-border transmission of market sentiment and thus more prominent presence of herding behavior and feed back trading.

It is worth exploring whether the market sentiment of local market investors h_t^j is affected mostly by the current and lagged market sentiment of US investors h_t^{US} and h_{t-1}^{US} , or by the local investors' sentiment towards domestic lagged events h_{t-1}^j . For most of the countries, Table 1.3 indicates magnitude of the impact coefficient of lagged own market news a_1 between 0.5 and 1.0. This result implies that past local news and local market sentiment on average have stronger impact on local investors compared to both current and lagged news from the US market. For several countries like Kenya, Lebanon, Nigeria, Romania, and Saudi Arabia, the coefficient capturing the effect of local news on market sentiment is not significantly different from null. For these countries, the sentiment of US investors is more important than local factors. For five countries, the value of variance constant a_0 is quite high: 6.033 for Kenya, 8.194 for Lebanon, 6.081 for Nigeria, 9.675 for Romania, and 22.271 for Saudi Arabia. Implication is that for these frontier markets there is significant influence of international and domestic factors other than those included in the Garch specification. One possible explanation is that those economies are mostly export oriented and their exports are sensitive to a wide variety of international factors.

To summarize, for half of the countries, the influence of local shocks and market sentiment is stronger than the influence stemming from the US market. The interdependence of most of the frontier markets with the US market is weak, albeit significant. The weak interdependence can be attributed to fluctuations in the relative significance of market specific shocks versus shocks from the US. When shocks from US dominate domestic shocks, markets will move closer together and will appear more integrated. When domestic shocks dominate shocks from the US, the markets will move further apart and will appear more segmented. In addition, frontier markets could be underrepresented in global portfolios and thus be insulated from portfolio re-balancing. Last but not least, the US and frontier market indices may have significantly different structure which may further reduce the cross-border market co-movement. Furthermore, we find that local markets absorb information from US as soon as it appears which implies frontier markets are highly informationally efficient.

6. Conclusion

In this article we examine the degree to which the returns and conditional volatility of 21 frontier markets were affected by the fluctuations in returns and conditional volatility of the American stock market during the period between December 1st, 2005 and January 15th, 2010. Using Schwarz-Bayesian criterion we find that for seventeen countries the best-fitting model is one that includes only the contemporaneous US returns, and for four countries, the best-fitting model includes one period lagged US returns as well. We

find weak, albeit significant, mostly positive return spillovers from the US market. For four countries, Jordan, Lebanon, Nigeria, and Kenya, we find weak negative spillovers, implying possible diversification opportunities. For thirteen markets, the influence of past local shocks is greater than the influence of current shocks from the US, and for sixteen markets local past volatility has stronger impact than volatility from US.

We find that frontier markets incorporate new information as soon as it arrives and for most of the countries local information is weighted heavier relative to information from the USA.

The research presented in this article may be extended using time-varying parameter techniques to better account for market dynamics and possible switching dominance overtime of domestic and US shocks. Other extensions could be the investigation of the effects of incomplete information and fat tails on market interdependence, as well as an empirical assessment of various shock transmission channels across frontier markets.

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Table 1.1: Distributional Characteristics of Annualized Daily Percentage Country Logarithmic Returns.

Country	Aritm.	Geometric	Median	Max	Min	St.Dev.	Skewness	Excess	Jarque-Bera	Ljung-Box	Arch
	Mean	Mean						Kurtosis		Q (6)	(6)
Argentina	0.0132	0.0402	0.0993	32.6988	-46.2513	6.3874	-0.7162	10.375	2532.538	10.211	9.908
Bahrain	-0.0709	-0.2817	0.0000	28.9765	-45.3414	4.0973	-1.969	27.112	26785.910	7.029	6.779
Bulgaria	-0.0425	-0.1962	0.1092	28.6710	-46.1532	5.4928	-1.656	15.502	7506.549	48.598	44.373
Croatia	0.0424	0.1266	0.0850	26.6783	-26.1957	4.5298	-0.139	8.566	1393.671	44.203	44.097
Estonia	-0.0285	-0.1407	-0.0845	31.5919	-25.2044	5.1833	0.067	7.717	999.328	15.594	15.548
Jordan	-0.0493	-0.1997	0.0000	19.9778	-24.5732	3.7938	-0.798	10.049	2343.659	16.740	16.012
Kazakhstan	0.0935	0.2529	6.6272	47.0791	-36.4983	8.0123	0.308 *	8.876	1566.270	14.933	14.857
Kenya	0.0140	0.0293	0.0143	24.9572	-25.4871	3.9877	0.389 *	11.818	3516.884	177.778	152.377
Kuwait	-0.0311	-0.1405	0.0000	22.0500	-29.9682	4.4587	-1.124	11.522	3486.069	11.221	11.358
Lebanon	0.0330	0.0905	6.9078	26.0267	-41.2237	4.6815	-0.144	14.974	6461.628	37.326	40.03
Mauritius	0.0648	0.2141	6.4973	27.3738	-21.9885	4.0508	0.161 *	11.364	3144.202	29.664	27.879
Nigeria	-0.0008	-0.0252	0.000	14.3145	-23.1930	4.0417	-0.339	6.227	487.871	386.863	312.699
Oman	-0.0045	-0.0399	0.000	27.1075	-44.4726	4.1464	-1.441	23.956	20080.11	24.028	29.007
Pakistan	-0.0196	-0.1056	0.0404	21.7455	-32.4033	4.9821	-0.573	5.709	388.471	60.615	49.038
Qatar	-0.0241	-0.1228	0.000	28.3712	-33.1923	5.0448	-0.633	10.79	2795.2385	15.020	16.169
Romania	0.0032	-0.0505	0.000	31.5860	-79.6922	6.7691	-1.622	21.999	16669.7203	7.505	7.222
Saudi Arabia	-0.0466	-0.2136	0.000	40.8917	-37.5188	5.6521	-0.97	13.0370	4689.7826	11.998	12.382
Slovenia	0.0276	0.0753	0.1253	23.8831	-24.8745	4.3279	-0.419	9.043	1670.1873	35.569	38.793
Sri Lanka	0.0149	0.0332	0.000	41.8982	-17.8501	3.9139	1.99 *	24.32	21110.1407	85.355	74.464
Tunisia	0.0436	0.1486	0.0411	22.7851	-18.0495	2.7907	0.11	10.719	2676.3479	19.266	19.886
UAE	-0.0813	-0.3458	0.000	46.9438	-43.5286	5.9894	-0.601	13.015	4565.6213	34.686	30.529
United States	-0.0003	-0.0236	0.1446	27.8273	-23.9746	4.0558	-0.242	12.003	3648.3631	35.8725	35.637

Note:

The test statistics are based on 1077 daily observations of country returns between December 1st, 2005 and January 15th, 2010 as given by MSCI Barra country indices. All country indices are in US currency. The distribution of the Jarque-Bera test statistics approximates $\chi^2(2)$, with 5.99 critical value at the 5% level. The Ljung-Box and Arch test statistics are based on 6 lags of the returns and are asymptotically distributed as $\chi^2(6)$ with critical value of 12.59 at the 5% level. The null hypothesis of no excess kurtosis is rejected for all countries and * indicates the null hypothesis for no skewness is rejected at 5% level.

Table 1.2. Summary of the best-fitting univariate models for the US and each of the 21 frontier markets.

Univariate Model						
Country	b_0	b_1	b_2	a_0	a_1	a_a
Argentina	0.359 (0.14)	0.013 (0.03)		0.629 (0.11)	0.084 (0.02)	0.133 (0.02)
Bahrain	-0.11 (0.09)	0.09 (0.04)		0.629 (0.11)	0.843 (0.02)	0.126 (0.02)
Bulgaria	0.198 (0.11)	-0.084 (0.04)		0.318 (0.13)	0.887 (0.02)	0.109 (0.02)
Croatia	0.263 (0.11)	0.114 (0.03)		0.792 (0.31)	0.844 (0.05)	0.114 (0.03)
Estonia	-0.052 (0.1)	0.119 (0.03)		0.25 (0.09)	0.087 (0.02)	0.133 (0.02)
Jordan	-0.064 (0.09)	0.045 (0.03)		0.144 (0.05)	0.922 (0.01)	0.07 (0.01)
Kazakhstan	0.37 (0.17)	-0.024 (0.03)		0.597 (0.22)	0.91 (0.02)	0.076 (0.02)
Kenya	-0.003 (0.09)	0.27 (0.04)	0.085 (0.04)	0.098 (0.042)	0.913 (0.01)	0.089 (0.01)
Kuwait	0.133 (0.1)	0.063 (0.04)		0.166 (0.05)	0.933 (0.01)	0.06 (0.00)
Lebanon	0.006 (0.1)	0.121 (0.04)		2.505 (0.59)	0.593 (0.07)	0.361 (0.07)
Mauritius	0.23 (0.09)	0.215 (0.04)		1.549 (0.37)	0.644 (0.06)	0.321 (0.06)
Nigeria	0.023 (0.08)	0.447 (0.03)		0.613 (0.173)	0.77 (0.04)	0.19 (0.04)
Oman	0.121 (0.09)	0.099 (0.04)		0.294 (0.06)	0.878 (0.01)	0.111 (0.02)
Pakistan	0.248 (0.12)	0.091 (0.03)		1.4 (0.27)	0.742 (0.03)	0.2 (0.03)
Qatar	-0.018 (0.122)	0.098 (0.04)		0.798 (0.17)	0.868 (0.02)	0.104 (0.02)
Romania	0.237 (0.18)	0.04 (0.03)		0.21 (0.06)	0.976 (0.00)	0.02 (0.00)
S. Arabia	0.023 (0.13)	0.038 (0.04)		0.251 (0.08)	0.933 (0.01)	0.062 (0.01)
Slovenia	0.227 (0.1)	0.189 (0.03)		0.555 (0.35)	0.848 (0.07)	0.117 (0.05)
Sri Lanka	-0.04 (0.08)	0.237 (0.04)		0.278 (0.06)	0.826 (0.02)	0.18 (0.03)
Tunisia	0.145 (0.07)	0.064 (0.04)		0.454 (0.12)	0.776 (0.03)	0.189 (0.03)
UAE	-0.058 (0.134)	0.136 (0.04)		0.329 (0.1)	0.922 (0.01)	0.076 (0.01)
USA	0.124 (0.07)	-0.097 (0.03)		0.086 (0.02)	0.919 (0.01)	0.074 (0.01)

Note: The estimation is done via ML utilizing 1077 daily observations of country returns between December 1st, 2005 and January 15th,

2010 as given by MSCI Barra country indices.

Table 1.3: Summary of the best-fitting bivariate models for each of the 21 frontier markets.

Bivariate Model										
Country	b_0	b_1	b_2	c_0	c_1	a_0	a_1	a_2	a_3	a_4
Argentina	0.18 (0.12)	0.111 (0.03)		0.957 (0.05)		1.31 (0.44)	0.72 (0.07)	0.185 (0.04)	0.084 (0.314)	0.017 (0.31)
Bahrain	-0.115 (0.09)	0.101 (0.04)		0.017 (0.03)	0.076 (0.04)	3.126 (0.47)	0.000 (0.00)	0.123 (0.03)	0.000 (0.00)	0.693 (0.07)
Bulgaria	0.193 (0.11)	-0.065 (0.04)		0.085 (0.05)		0.67 (0.31)	0.728 (0.07)	0.112 (0.03)	0.158 (1.21)	0.112 (1.219)
Croatia	0.246 (0.11)	0.107 (0.04)		0.13 (0.04)		1.672 (0.54)	0.676 (0.09)	0.155 (0.05)	0.103 (0.05)	0.000 (0.00)
Estonia	-0.023 (0.1)	0.131 (0.03)		0.111 (0.04)		0.17 (0.12)	0.83 (0.03)	0.14 (0.02)	0.039 (0.65)	0.04 (0.65)
Jordan	-0.067 (0.09)	0.044 (0.03)		-0.02 (0.03)		0.144 (0.07)	0.91 (0.02)	0.073 (0.01)	0.009 (0.01)	0.000 (0.00)
Kazakhstan	0.349 (0.17)	-0.003 (0.03)		0.237 (0.06)		0.613 (0.23)	0.897 (0.02)	0.081 (0.02)	0.016 (0.00)	0.016 (0.00)
Kenya	-0.023 (0.09)	0.216 (0.03)	0.106 (0.03)	-0.028 (0.03)		6.039 (0.47)	0.000 (0.00)	0.409 (0.06)	0.001 (0.02)	0.119 (0.04)
Kuwait	-0.014 (0.11)	0.064 (0.04)		0.003 (0.04)	0.077 (0.04)	6.71 (0.64)	0.000 (0.00)	0.031 (0.02)	0.000 (0.00)	0.781 (0.08)
Lebanon	-0.36 (0.1)	-0.249 (0.03)		-0.059 (0.03)		8.194 (0.87)	0.000 (0.00)	1.088 (0.13)	0.000 (0.00)	0.066 (0.042)
Mauritius	0.249 (0.08)	0.213 (0.04)		0.037 (0.03)		2.095 (0.48)	0.196 (0.06)	0.512 (0.08)	0.33 (0.00)	0.008 (0.000)
Nigeria	0.022 (0.09)	0.49 (0.03)		-0.027 (0.03)		6.081 (0.57)	0.000 (0.00)	0.261 (0.05)	0.000 (0.00)	0.161 (0.05)
Oman	0.071 (0.09)	0.111 (0.04)		-0.004 (0.03)	0.141 (0.03)	3.216 (0.04)	0.000 (0.03)	0.081 (0.03)	0.000 (0.00)	0.686 (0.07)
Pakistan	0.248 (0.12)	0.092 (0.03)		0.019 (0.02)		1.394 (0.27)	0.743 (0.03)	0.197 (0.03)	0.000 (0.00)	0.000 (0.000)
Qatar	-0.049 (0.12)	0.098 (0.04)		0.003 (0.04)		0.762 (0.22)	0.838 (0.03)	0.103 (0.02)	0.01 (0.00)	0.05 (0.00)
Romania	0.171 (0.16)	0.07 (0.03)		0.329 (0.06)		9.675 (1.59)	0.000 (0.00)	0.114 (0.04)	1.836 (0.00)	0.431 (0.00)
S. Arabia	-0.117 (0.16)	0.04 (0.04)		0.086 (0.05)		2.271 (1.30)	0.001 (0.00)	0.072 (0.02)	0.122 (1.19)	0.28 (1.19)
Slovenia	0.208 (0.1)	0.198 (0.03)		0.096 (0.04)		1.479 (0.47)	0.575 (0.12)	0.13 (0.03)	0.174 (2.34)	0.056 (2.35)
Sri Lanka	-0.041 (0.08)	0.237 (0.04)		0.061 (0.03)		0.382 (0.11)	0.732 (0.05)	0.24 (0.05)	0.018 (0.19)	0.017 (0.19)
Tunisia	0.161 (0.08)	0.121 (0.04)		0.078 (0.02)	0.148 (0.02)	4.458 (0.39)	0.000 (0.00)	0.217 (0.05)	0.000 (0.00)	0.093 (0.03)
UAE	-0.056 (0.14)	0.137 (0.04)		0.01 (0.05)		0.351 (0.14)	0.902 (0.02)	0.082 (0.01)	0.016 (0.3)	0.018 (0.3)

Note:

The estimation is done via ML utilizing 1077 daily observations of country returns between December 1st, 2005 and January 15th, 2010 as given by MSCI Barra country indices. All country indices are in US currency.

Table 1.4: LR tests of the coefficients of the best-fitting model of country returns with spillovers

$H_0 :$		LR Test Statistics								
		$b_1 = 0$	$c_0 = 0$	$b_1 = c_0 = 0$	$a_1=0$	$a_2 = 0$	$a_3 = 0$	$a_4 = 0$	$a_1 = a_2 =$ $= a_3 = a_4 = 0$	$a_3 = a_4 = 0$
Country (j)	(i-max, k-max)									
Argentina	(1,0)	15.542	441.81	378.168	45.838	111.427	151.02	151.021	377.43	151.01
Bahrain	(1,1)	17.298	59.84	8.361	12.06	41.827	0.000	0.000	490.67	47.007
Croatia	(1,0)	6.45	17.72	15.49	9.829	65.825	145.408	137.52	274.80	11.7
Estonia	(1,0)	14.28	90.08	15.058	87.4	188.37	240.467	156.271	415.184	176.49
Jordan	(1,0)	1.775	131.9	6.53	131.31	164.18	277.79	236.84	308.99	254.78
Kazakhstan	(1,0)	0.007	222.99	43.426	210.28	318.16	275.26	210.289	419.04	2.59
Kenya	(2,0)	34.71	0.98	56.725	0.001	189.78	197.29	208.93	302.201	296.35
Kuwait	(1,1)	131.03	127.67	134.81	127.667	107.009	13.9128	13.913	413.16	11.74
Lebanon	(1,0)	20.727	4.817	24.035	231.38	175.19	0.000	3.693	194.68	3.69
Mauritius	(1,0)	25.654	68.24	25.819	61.41	167.823	155.321	380.89	380.89	155.321
Nigeria	(1,0)	70.09	0.987	70.627	141.529	69.32	24.623	22.75	152.57	27.15
Oman	(1,1)	94.101	84.22	110.95	84.205	98.039	0.000	27.357	546.074	31.65
Pakistan	(1,0)	7.075	159.12	164.158	158.159	306.26	158.74	167.93	329.607	120.159
Qatar	(1,0)	7.216	62.04	14.047	61.505	94.74	265.28	218.365	302.54	241.17
Romania	(1,0)	4.118	27.85	30.25	52.062	25.066	224.98	0.000	248.50	235.974
Saudi Arabia	(1,0)	433.71	433.923	434.24	433.596	45.866	61.087	63.19	99.118	62.99
Slovenia	(1,0)	102.705	74.62	105.613	69.86	29.55	187.87	199.37	422.66	21.19
Sri Lanka	(1,0)	419.88	405.52	425.45	402.99	301.43	462.115	343.95	520.03	11.34
Tunisia	(1,1)	275.33	266.84	176.33	262.76	139.11	30.08	26.03	178.93	7.405
UAE	(1,0)	424.52	386.46	424.63	386.22	196.28	315.98	294.64	331.04	302.81

Note:

The best-fitting model is $R_t^J = b_0 + \sum_{i=1}^{i-\max=2} b_i R_{t-1}^J + \sum_{k=0}^{k-\max=1} c_k R_{t-1}^{USA} + u_t^J, u_t^J = \sqrt{h_t^J} z_t, z_t \sim N(0, 1), h_t^J = a_0 + a_1 h_{t-1}^J + a_2 u_{t-1}^{2J} + a_3 h_t^{USA} + a_4 h_{t-1}^{USA}$. The testing technique used is LR, where the LR statistic is approximately chi-squared. The critical value with 1 degree of freedom and p-value=.05 is 3.84; with 2 degrees of freedom and p-value=.05 the critical value is 5.99; with 3 degrees of freedom and p-value=.05 the critical value is 7.82; and with 4 degrees of freedom and p-value=.05 the critical value is 9.49 .

Table 1.5: Summary of hypothesis test results

Country	Spillovers in Mean	Spillovers from Current Period US Volatility	Spillovers from one-period Lag US Volatility	Garch
Argentina	yes	yes	yes	yes
Bahrain	yes	no	no	yes
Bulgaria	yes	yes	yes	yes
Croatia	yes	yes	yes	yes
Estonia	yes	yes	yes	yes
Jordan	yes	yes	yes	yes
Kazakhstan	yes	yes	yes	yes
Kenya	yes	yes	yes	yes
Kuwait	yes	yes	yes	yes
Lebanon	yes	no	yes	yes
Mauritius	yes	yes	yes	yes
Nigeria	no	yes	yes	yes
Oman	yes	no	yes	yes
Pakistan	yes	yes	yes	yes
Qatar	yes	yes	yes	yes
Romania	yes	yes	no	yes
S. Arabia	yes	yes	yes	yes
Slovenia	yes	yes	yes	yes
Sri Lanka	yes	yes	yes	yes
Tunisia	yes	yes	yes	yes
UAE	yes	yes	yes	yes

Note:

Presence of garch effects, and return and volatility spillovers for each of the 21 frontier markets.