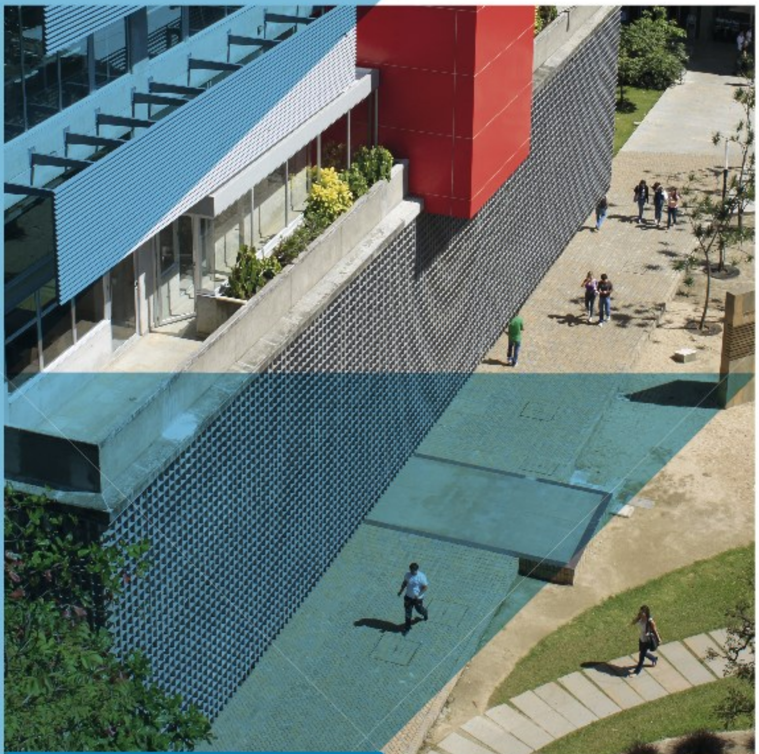

UNIVERSIDAD EAFIT
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Escuela de Economía y Finanzas

Documentos de trabajo

Economía y Finanzas

Centro de Investigación Económicas y Financieras

No. 18-17
2018

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December 2016

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This research was funded by a Universidad EAFIT grant. We acknowledge useful suggestions from Andrés Ramirez. We are also grateful to Adriana Cardenas, from for providing the data of Bolsa de Valores de Colombia, and Paula A.Yepes-Henao for early research assistantship.

Are foreigners the vectors of Contagion? A study of six emerging markets

Abstract

We investigate for the role of Foreigners, Local Institutions and Local individuals in days of Contagion in a set of six emerging markets from 2007 to 2016. We propose a new and intuitive continuous measure of Contagion based on the probability of a coincidence of daily negative returns in both the S&P500 and the local index, in excess of what can be explained by fundamentals. Using a VAR setting, we find that Foreigners sells induce Contagion, and that they keep selling in the following days. We also find evidence of Foreigners acting as the transmitters of large drops in the US stock market to emerging ones. Institutions also contribute to Contagion days with net sales, but they become net buyers from the day after. Finally, individuals are net buyers in Contagion days.

JEL: G14, G15, D82

Keywords: Contagion, Foreign flows, Institutional investors, Individual investors, Emerging Markets.

1. Introduction

Contagion is one of the most recurred topics of research in international finance. Interest on this topic has spurred from time to time, particularly after gloom worldwide financial episodes such as the Asian crisis in 1997, the Russian crisis in 1998 and more recently the Subprime crisis in 2008 and Sovereign debt crisis of the Euro Zone 2009-2011. Unlike crises in the late 90's, the last two originated in develop countries. In particular the Subprime crisis can be considered like a truly global event that affected most financial markets and industry sectors (Bekaert, Ehrmann, Fratzscher, & Mehl, 2014). In that sense, the latest episodes of Contagion can be considered exogenous to emerging markets. As in any contagious disease, we want to better understand the mechanism of transmission.

We use the most commonly agreed definition of Contagion: excessive comovement between markets beyond what can be explained by fundamentals (Bekaert et al., 2014; Boyson, Stahel, & Stulz, 2010; Choe, Kho, & Stulz, 2004; Markwat, Kole, & van Dijk, 2009). However, there are several technical difficulties in precisely measuring Contagion. For example, Forbes & Rigobon (2002) point that increasing market comovement is not necessarily Contagion when properly accounting for heteroscedasticity. Following Choe, Kho, & Stulz (2004) and Mierau & Mink, (2013) we avoid taking part in the polemic by assuming that Contagion do happen in the first place, whenever large unexplained negative returns in an emerging market coincide with large negative returns in the world market return.

Contagion is an obvious important concern from a portfolio diversification point of view. If low correlations between markets disappear when needed the most, this has to be taken into account in dynamic investment strategies and risk hedging. Mean variance optimization is radically changed when considered the implications of the existence of Contagion, as in the model of Aït-Sahalia & Hurd (2015).

Contagion is also a relevant topic in discussions of Financial Integration. While benefits of Financial Integration have been well documented in the literature, it clearly exposes emerging markets to increasing vulnerability to worldwide financial crises. Moreover, since foreigners have been traditionally regarded as the drivers of Contagion in emerging markets, seems justified that in the aftermath of worldwide financial turmoil regulators and policy makers discusses or implement capital barriers to the free flow of portfolio flows.

However, the evidence on the role of foreign flows in Contagion transmission is tenuous at best. Studies like Griffin, Nardari, & Stulz, (2004), Richards, (2005) and Froot, O´Connell & Seasholes, (2001), report evidence that foreign flows to emerging markets are responsive to worldwide international returns, in the same direction. This is suggestive that foreigners might play an important part in Contagion transmission, but it's neither a direct prove of their role in critical times, nor rules out the possible involvement of other types of investors. We intend to fill this void in the literature.

We contribute to the international finance literature by studying the role of three types of investor in the transmission of Contagion to an Emerging Market. For that, we join two strands of the international finance literature: the research on Contagion and the studies of foreign flows on emerging markets. In particular, we observe aggregate net buys of foreigners, local institutions and individuals for 4 emerging markets (Colombia, Kospi, Kosdaq, Thailand), and only foreigners for other 2 markets (Indonesia and Taiwan) from 2007 to 2016. Following the approach of Bae, et al., (2003), we propose a simple measure of the probability of Contagion based on the coincidence of negative returns between the US stock market and each emerging market, in excess of what can be explained by fundamentals. As for fundamentals we consider a set of country specific and global factors, known drivers of stock market returns, and some of them of foreign flows.

We start by updating the results of Griffin, Nardari, & Stulz, (2004) and Richards (2005) on the dynamics of international returns, local returns and foreign net flows for the 6 emerging markets, using a standard 3-VAR, and finding them, consistent with previous findings, for the most part. Specifically, foreign and institutional net buys move prices, while individuals tend to be more reversal traders. We then include the Contagion measure with the available net flow variables in a structural 4-VAR model, to test for the contemporaneous effect of net buys in the Contagion measure. As a robustness test, in a standard 4-VAR we also test for one-day ahead effects of Contagion on net flows. We find that foreigners induce Contagion, a result statistically significant in the 6 sampled emerging markets. Institutions appear also as Contagion drivers in 3 markets (out of 4 with available data), with a contemporaneous average effect greater than for foreigners, but with a smaller persistence in the time. In turn, Individuals appear to have a more mitigating effect, acting as "buyers of last resort" in Contagion days and shortly after, in all 4 markets for which their data is available.

Furthermore, the role of foreigners, as Contagion vectors is rounded off by the evidence of transmission of international returns on local returns via foreign net sales, using a 3-VAR model. Finally, in a 4-VAR model we study the reaction of each type of investor to Contagion events, finding that foreign flows do contribute to the continuation of Contagion days, in all six markets, whereas local Individuals and Institutions tend to mitigate, acting as net buyers, in most cases.

Although necessarily limited by the availability of data, the sample of emerging markets include a variety of markets with different sizes and stages of development. By 2007, according to the World Federation of Exchanges (2016), Korea was the third largest emerging stock market, just below China and India, Taiwan the sixth, Thailand and Indonesia were placed the third quartile of size, and Colombia in the lowest, only larger than Peru and Hungary. Besides, while all the five countries studies are counted as Emerging Markets by MSCI at 2016, FTSE (2016) classifies Korea as developed market, Taiwan and Thailand as advanced emerging, and the other two, Colombia and Indonesia as Secondary Emerging Markets.

The data on the four Asian markets come from Bloomberg at daily frequency, allowing for a close analysis of the dynamics between flows, returns and Contagion episodes. Databases of foreign net flows available for a larger sample of emerging markets are ill fitted to study Contagion due to their monthly frequency. New to this literature, we also make use of a proprietary database from the Colombia Stock Exchange. Colombia serves as an out-of-sample test of the results of the literature, mostly focused in Asian Emerging Markets. A more comprehensive study of Contagion should include Latin American markets, not just Asians, that seems to react differently. Studying the period 1996 to 2000, Bae, Karolyi, & Stulz (2003) find that Contagion of large negative returns is stronger in Latin America than in Asia. In a more recent period, 1999-2009, Samarakoon (2011) finds evidence Contagion from US to Latin American, unlike in other regions.

The contribution of this paper to the Contagion literature is twofold. First, and most important, we provide a direct test of the role of foreign investors are the drivers of Contagion. All since the Asian crisis times, Foreigners have been the usual suspect of turmoil in emerging markets (Stiglitz, 1999, 2000). Several theoretical models pose that foreigners act as such that. According to Stiglitz (1998), developing markets, given their limited structure and depth, are particularly vulnerable to variability of foreign flows. Evidence on negative foreign flows increasing volatility has been reported in Japan (Hamao & Mei, 2001) and Indonesia and Thailand (Wang, 2007). In contrast, studies as (Choe, Kho, & Stulz, 1999) in Korea, 1997, have found only weak or no evidence at all of foreign flows acting as the destabilizers. Empirical evidence also suggest that foreign flows might be an important part of sell pressure in times of financial distress. Early papers provided evidence of a momentum, trend chasing or positive feedback trading behavior of Foreigners in Emerging Markets (Froot et al., 2001). In turn Griffin, Nardari, & Stulz, (2004) propose a theoretical model where investors from a large market enter (leave) a smaller stock market following positive (negative) returns of either one. Moreover, they report evidence, using data of 9 developing countries, that negative US returns Granger cause negative foreign flows that in turn push down prices in the emerging market ("price pressure"). It follows that in times of financial distress, foreign flows are likely drivers of negative returns from developed markets to emerging ones[1].

Second, we also test for the possible role of two other type of investors, local institutions and local individuals. Whether Local institutions drive or mitigate of Contagion episodes is ambiguous. As described above for foreign investors, to the extent that a given institution portfolio has international exposure it might be driven to sell local positions for rebalancing in response to losses in the international markets. For example, Manconi, Massa, & Yasuda (2012) reports evidence that the liquidity constrains by institutional investors contribute to propagate shocks from securitized to corporate bonds in the context of the subprime crisis. However, some evidence has reported that institutions tend to be more sophisticated investors with better long-term performance than both foreigners and individuals. Such evidence has been presented for Taiwan (Barber, Lee, Liu, & Odean, 2009) and Colombia (Agudelo, Byder and Yepes, 2015). This makes feasible that institutions, particularly long-term oriented, act as net buyers in Contagion episodes, playing the role of "opportunistic buyers", buying at low prices and contribution to a better overall performance, while at the same time provide liquidity when need it the most. For example, in the study of gross capital flows, in a related branch of the international finance literature, Adler et al., (2016), find that domestic investors have a stabilizing role, compensating the response of foreign flows to negative global shocks.

[1] In a similar set of emerging markets Richards (2005) also reports evidence of push and pull factors, but argues that information extraction or behavioral reasons are behind the pull factor rather than portfolio rebalancing.

The expected role of retail traders in Contagion times is also uncertain. Individuals have been regarded as the archetypical noise traders, mostly liquidity providers, evidence of which has been reported in Taiwan (Lee, Liu, Roll, & Subrahmanyam, 2004) and Colombia (Agudelo et al., 2015; Yepes & Agudelo, 2016) In the context of Contagion, this could lead to two contrarian behaviors. In the one hand, individuals might have a role in transmitting Contagion, for example, by overreacting to negative international news or dropping local prices. On the other hand, they might well keep their liquidity providing role, acting as buyers of last resort, unaffected or unaware of falling international indexes.

To the extent of our knowledge, this is the first study to test for the role of different types of investors during Contagion episodes. The most related studies are those of Griffin, Nardari, & Stulz, (2004) and Richards (2005), that estimate the effect of international and local index returns in explaining foreign flows to a similar group of emerging markets with data up to January 2001 and September 2002, respectively. Besides, the last study, like the present one, estimates the same effects from net buys by local individuals and investors for a subsample of four markets. However, neither one explores those interactions in times of excessive turmoil in international markets.

The remaining of this article is organized as follows. Section 2 describes the databases used. Section 3, methodology, presents the proposed Contagion measure and explains the different VAR specifications. Section 4 presents and discusses the results on the roles of different types of investors in Contagion episodes, the transmission mechanism of foreigners, and the reaction of each type after Contagion days. Finally, section 5 concludes.

2. Data

This study focuses on five emerging countries, represented by their main indexes: Colombia (Colcap), Korea (Kospi, Kosdaq)[2], Thailand (SET50), Taiwan (TWSE), and Indonesia (JCI). Initially, we have three types of agents to consider in each market: Foreigners, Local Individual and Local Institutions. For Colombia, Korea and Thailand, we have daily net buys data for each of three types of agents. For Taiwan and Indonesia, we only have net buys from foreign investors.

[2] As in Richards (2005) we are able to study separately two set of stocks in Korea, those represented by KOSPI and Kosdaq. The KOSPI index is the most representative in Korea. Even so, Kosdaq as a technology index with a large market capitalization, which compares to the leading indexes in other emerging markets.

With the exception of Colombia, these series were extracted from Bloomberg, along with other daily market data, such as market capitalizations, market index prices, and other country-specific macro variables, from January 2007 to December 2015. For Colombia, we use a proprietary database, provided by the Colombian Stock Exchange (BVC), which contains the transactional activity by individual stock and type of investor on a daily basis, for the same sample period.[3]

Previous studies have used daily net purchase series for the same selected countries, with the exception of Colombia. Richards (2005), studying the trading behavior and price impact of the three type of agents, uses data for Kospi, Kosdaq, Taiwan and Thailand, in a period from 1998 to 2002. On the other hand, Griffin et.al, (2004) only use foreigners' net buys to explain if daily cross-border equity flows in emerging countries are pushed or pulled, in a period from 1996 to 2001. As detailed in Table 1, unlike these two studies, our data go from January 2007 to January 2016, for each of the countries under consideration. Thus, we are able to study the interaction of Contagion and net buys on a period that encompasses the Global Crisis, 2007-2009 and the Euro Zone Crisis, 2010-2011.

As usual in the literature we scaled the net buys by the previous-day market capitalization, which relates the net demand to the total supply of available shares in the market. Other studies have shown that without escalation, there are problems in comparing flows within the same country over different periods of time (Bekaert, Harvey, & Lumsdaine, 2002; Froot et al., 2001; J. M. Griffin, Harris, & Topaloglu, 2003). Besides, we windsorize the net buys in percentiles 1th and 99th, to control for abnormal values as suggested by Griffin et al., (2004) and Edison & Warnock, (2008).

Table 1 reports summary statistics for each net buy series. In all countries there is a positive and significant first order autocorrelation at the 5% level of daily flows, decreasing for the first five lags, consistent with what Froot et al., (2001) reports. This structure of autocorrelation in flows indicates a persistence in the investment activity for all types of investors. According to Richards, (2005), these results may be due to large purchases split on successive days. Institutional and

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[3] This database contains, in a stock-day basis, classified by type of investor, the purchases and sales, measured as number of transactions, traded volume (quantity of shares), and traded value (in local currency). Three major types of investors are identified: Foreigners, Local Individuals and Local Institutions. The latter classification is further refined in Brokerage Firms, Pension and Severance Funds, Family Offices, Mutual Funds, Insurance Companies, Trusts, Investment Companies, other type of funds and other financial institutions.

Foreign investors have a positive and significant correlation with each country's market index returns, consistent with price impact by those two agents. For their part, individual investors have a negative correlation with the local index. This contrarian style of trading of individuals as a group has been also reported by previous studies (Choe et al., 1999; Froot et al., 2001; J. M. Griffin et al., 2003; Grinblatt & Keloharju, 2000).

As shown in Table 1 as well, Foreigners' flows exhibit a positive and significant correlation with the S&P500 return, with the exception of Colombia, which is positive but not significant. This is consistent with push factors identified by Richards, (2005) and Griffin et al., (2004). It may suggest that a positive or negative shock in the S&P500 return could affect Foreigners' net buys in the same direction, as we will see later. On the contrary, Individuals as a group, tend to have net buys negatively and significantly correlated with the S&P500 return. Richards, (2005), who finds this same result argues that, in these markets, individual investors account for the largest share of trading and typically have contrarian responses to foreigners.

3. Methodology

3.1. Contagion measure

We are interesting in finding out the type of investor driving financial Contagion in an Emerging market. Several methods have been used in the literature to detect episodes of Contagion. Corsetti, Pericoli, & Sbracia, (2005) and Forbes & Rigobon, 2002) measure Contagion by estimating the heteroscedasticity-adjusted correlation between stock market returns. Bae et al. (2003), in turn, uses the coincidence between extreme returns across stock markets ("coexceedances"). Bekaert et al. (2005), use a factor model of equity returns with time-varying loadings to examine residual correlations. Finally, Rodriguez, (2007), uses switching-parameter copulas to analyze changes in dependence across stock markets, identifying Contagion states[4].

We adopt the spirit of Bae et al. (2003) approach. They criticizes the correlation framework that other researches have focused on early studies of Contagion that has rendered mixed results

[4] In a related point, Markwat et al., (2009) have used ordered logit regressions to model how stock market crashes depend on their past occurrence.

(Bekaert & Wu, 2000; Hartmann, Straetmans, & Vries, 2004; Kaminsky & Reinhart, 2000; Longin & Solnik, 2001). Instead they focus on large daily negative returns of a given emerging market coincident in time with markets in the same region, or with other regions. In their study Contagion across regions is defined as the fraction of the exceedance events in a particular region that is left unexplained by its own covariates but that is explained by the exceedances from another region. However, this methodology singles out very few days of Contagion for each country, and such a small sample would limit the detection of any relation between net buys and those episodes.

Instead, we propose a continuous Contagion measure bounded in the interval [0,1], based on the cumulative joint probability that a negative return in the S&P500 coincides, not by chance, with a negative return in the local index in excess of what´s explained by its fundamentals[5]. This measure follows Bae et al., (2003) and Markwat et al., (2009), in the need to rule out interdependence by controlling for fundamentals. The variable is defined as follows:

$$CONTAG_{i,t} = \max(0, 1 - 2 * Prob[x \leq S_t]) * \max(0, 1 - 2 * Prob[x \leq R_{i,t}]) \qquad [1]$$

Where $CONTAG_{i,t}$ is the Contagion variable for each country "i" in day "t", and S_t is the standardized S&P500 return in the current day "t".[6] $R_{i,t}$ are the standardized residuals for each country "i" of the next regression:

$$Loc\_Rend_{i,t} = \beta_0 + R_{US,t}\beta_1 + \sum_{j=1}^{N} X_{ji,t}\,\beta_j \qquad [2]$$

Where Loc_Rend_t is the local index return for each country "i" in the current day "t"; and $R_{US,t}$ refers to the S&P returns[7]. $X_{ji,t}$ corresponds to a vector of fundamental variable "j", for the country "i".[8]. Assuming a zero mean for both series of standardized returns S_t and $R_{i,t}$ $CONTAG_{i,t}$ will be zero if either return is positive in a given day "t". Provided that both are negative, the larger the negative return in either series, the larger the value of $CONTAG_{i,t}$, always bounded by one. This

[5] Returns are initially assumed normally distributed. The measure is also recalculated assuming the empirical distribution and we obtained qualitatively the same results.
[6] As usual, for Asian stock markets S_t is lagged one day, since they open just a few hours after the US market closes.
[7] As mentioned above, for Asian markets S&P returns are lagged one day.
[8] As fundamental variables, we included the returns on related markets (measured as the daily log difference change in the price index), the change on a short-term interest rate, the yields of some generic bonds, the depreciation of the exchange rate of the dollar, and the change of the country CDS. See details in Appendix A.

way the proposed Contagion measure is higher the less likely both returns are negative by chance, according with the spirit of the detection by coexceedance in Bae et al., (2003).

Figure 1 plots the daily Contagion measure for each country, along with the VIX index (as a proxy for global conditional volatility), and the local stock market index. Generally, in each country, the episodes of high Contagion measure tend to coincide with falls in the local index and higher levels of the VIX. For example, on October 30, 2008, in the middle of the subprime crisis, the VIX reaches its historical maximum (59.89 points), and we obtain some of the highest Contagion measures for all countries, along with a strong drop in local indices. A year later, on October 10, 2009, when the price of oil falls by about 25%, the Contagion measure rises, and local indices fall. More recently, we observe a similar behavior of the Contagion measure and the local indexes, on August 21, 2015, along with news of the fall of China´s imports of commodities by 15%.[9] As expected Contagion peaks appear to be concurrent with periods of worldwide financial uncertainty, as measured by the VIX. Besides, the Figure 1 exhibit clusters of the Contagion measure on each country, for example at the end of 2008, at the end of 2011 and in the middle of 2015. This suggests that Contagion is a persistent phenomenon in the financial markets.[10]

In turn, table 2 presents the Contagion measure descriptive statistics for each country. Although it appears from the graph that Contagion is detected for most of the days, we can see that the percentage of the days with a non-zero measure is greater than 0, by construction, is around 25% of the total number of days. In addition, the mean of the variable conditional of strictly positive values, is 18% and well above the median in each country, implying a right skewed distribution. Moreover, the percentage of days where the Contagion measure is greater than 0.5 is less than 3% for all countries. This gives us an idea that we are not overestimating the probability of Contagion, a phenomenon that is assumed to happen infrequently. Finally, as we had previously suggested, there is a positive correlation between the measure of Contagion and VIX.

3.2. VAR models

[9] Other peaks on the Contagion measures and the VIX can be observed in the following months: September 2009 (follow-up of the effects of the subprime crisis), November 2011 (crisis in the Eurozone), June 2012 (effects of Greece's debt), among others.

[10] In omitted correlograms a significant correlation structure can be evidenced up to lag 5 for the Contagion measure, which suggests that Contagion is at least persistent in the next five days.

We want to measure the contemporary effect of net buys on the Contagion variable, controlling by past measures of the variable, and local and international market returns. To achieve this goal, we use the standard tool of autoregressive vector models (VARs), previously used in similar studies (Griffin et al., (2004);Richards, (2005)). The base 4VAR is estimated independently for each emerging country "*j*" at daily frequency as follows:

$$Z_{ij,t} = B_{ij0} + B_{ij1}Z_{ij,t-1} + B_{ij2}Z_{ij,t-2} + \cdots + B_{ij5}Z_{ij,t-5} + \varepsilon_{ij,t} \qquad [2]$$

$$Z_{ij,t} = \begin{pmatrix} R_{US,t} \\ NET\_BUY_{ij,t} \\ CONTAG_{i,t} \\ Loc\_Rend_{i,t} \end{pmatrix} \qquad [3]$$

Where $R_{US,t}$ is the S&P500 return in day "*t*"[11]; $NET\_BUY_{ij,t}$ is the net buy as percentage of market capitalization of the type of investor "*j*" and $CONTAG_{i,t}$ and $Loc\_Rend_{i,t}$ are the Contagion variable and the local index return for the emerging market "*i*", respectively. With 4 emerging markets with data for net buy of three types of investors, and two with only foreigners, we have 14 4-VAR models.

We use the Hannan-Quinn and Schwartz-Bayes information criteria to define the optimal lag for all VAR equations. Appendix B shows the results obtained for each model, ranging from an optimal lag of 1 to 4. Taking those results into account, and considering that the degrees of freedom are not a constraint given the amount of data, we have selected five lags. In this, we follow Griffin et al., (2004) and Richards, (2005).

The main result of the VAR models, the impulse response analysis of orthogonalized shocks, requires a Cholesky decomposition, to define an exogeneity order between the variables, which assumes a direction on contemporaneous causality. The return to the US market, is naturally assumed to be the most exogenous variable of the VAR. Besides, according to Hasbrouck (1991), which has been cited by Richards, (2005), contemporaneous causality runs from net buys from investors to prices, but not vice versa. Under this standard assumption, the daily net buys of each investor is the second variable in exogeneity order. Since the Contagion measure for each market has been constructed from the S&P500 and each local index returns, the exogeneity order between

[11] One-day lagged for Asian markets equations, given the effects on transaction hours, explained above.

this measure and local returns is not as clear. For this, we use the variance decomposition of each of these series, changing the Cholesky ordering and conducting the comparison up to twenty lags. In 11 of 14 cases, the Contagion measure turns out more exogenous than local returns.[12]

4. Results

4.1. Who drives Contagion?

We are interested in finding those agents whose net sales increase the probability of a Contagion episode; namely, the Contagion drivers. For this, we observe the response of the Contagion measure to an innovation in net buys, using an impulse response analysis of structural 4- VAR, as expressed in the equation [2][13].

Initially, we study the response of the Contagion measure to a shock in net buys, by type of investor and country with the cumulative impulse response function. As seen in Figure 2, the contemporaneous response of the Contagion measure to a positive shock in the foreigners' net buys, for all markets, is negative and significant. Thus, a shock of foreigners' net sales of 1%, increases the same day probability of Contagion in each of the countries, by an average magnitude between 0.5% and 1.5%. In addition to this direct and immediate effect, the cumulative effect is negative and significant up to a period of 20 days for all countries except Colombia, where is only significant from day 5 onwards. These results suggest that foreign investors act as Contagion drivers for all six emerging markets. Besides, the effect of the shock of Foreign net sales appears persistent in the short-term, since the cumulative effect is still significant up to 20 days for every market.

Figure 3, presents the impulse response function of Contagion measure from a 1% innovation in Institutional investors net buys, for the four markets where this data is available (Colombia,

[12] The only exception is Korea (Kosdaq), for all three investors, where the local return variable is more exogenous than the Contagion measure. Even so, for this market all the Impulse response functions in the Results sections were performed for both exogeneity orders, rendering qualitatively the same results

[13] In order to place restrictions on the contemporaneous correlations between the equation's disturbances, the four variables are assumed to form a recursive dynamic structural model where each variable only depends upon those above it in the vector $Z_{ij,t}$ defined in equation [2]. Also, we have selected the lag order of 5 for the VAR according to the criteria of Akaike and Hannan-Quinn for all countries. For that appropriate order, we have checked for autocorrelation in the disturbances (using a LM test for residual autocorrelation), and for the stability conditions (the roots of the autoregressive polynomial must be within the unit circle), needed to compute impulse response functions.

Kospi, Kosdaq and Thailand). The immediate response of the Contagion measure is negative and significant for Kospi, Kosdaq and Thailand, with an average response between -1% and -2%, and not significantly different from zero for Colombia. Now, for both Korean markets and Thailand, the cumulative response is negative and significant until day 4. Therefore, we can say that for these three markets that Institutional agents also appear as Contagion drivers, as an increase in net sales drives up the probability of Contagion, with a contemporaneous average effect greater than for foreigners, but with a cumulative effect that dissipates in a few days unlike the one for foreigners.

Finally, the net buys effect of local individual investors can be found in Figure 4. For the three countries: Colombia, Korea (Kospi and Kosdaq), and Thailand, a positive 1% innovation in the net buys of this type of agent, causes a positive and significant immediate response in the Contagion measure, between 0.5 and 2%. That is to say, in a day of Contagion, a 1% increase in the local individual's net sales, significantly decreases the Contagion probability. The cumulative effect is not significant for Colombia, but it is for Korea (in both indices) and Thailand. In this way, we can say that local individual investors in these three emerging countries, do not increase the Contagion effect in a contemporaneous way.

The structural VAR, we have just discussed, assumes necessarily an exogeneity order. Although this assumption has been made in the empirical literature and can be supported by means of variance decomposition analysis, it's important to verify that the results don't depend on it, using a more robust causality measure that goes over this limitation. For that, Table 3 presents the p-values of a Granger test, run after the same structural VAR, testing whether each type of investor flows Granger-cause to the Contagion measure up to five days ahead.[14]

With the exception of Colombia and Indonesia, we find that Foreigners' flows Granger-cause the Contagion measure, which mostly confirm the results of Figure 2. The corresponding results for the other two types of investors, in the four markets with data available, are somewhat weaker. Only for Kosdaq, Institutional investors' net buys Granger-cause the Contagion variable. In turn, just for Colombia and Kosdaq, Individuals' net buys Granger-cause the Contagion measure. However, let's emphasize that the Granger-test doesn't directly detect same-day causality. To the extent that flows contemporaneously cause Contagion, and this effect only weakly

[14] The null hypothesis of the Granger test is: flows do not Granger-cause The Contagion measure. We also performed the test up to 8 days ahead, obtaining qualitatively the same results.

spills over on following days, it’s expected that the Granger-test finds weaker results than the Impulse response function.

In summary, we find that foreigners induce Contagion in all six emerging markets, as an increase in their net sales drives up the probability of Contagion. Individuals have a more mitigating effect in all 4 markets for which this data is available, given that their net sales do not increase and even reduce the probability of Contagion. Institutions appear also as Contagion drivers in 3 markets (Kospi, Kosdaq and Thailand), although the statistical significance is weaker and the overall effect is less permanent than for foreigners.

4.2. Foreigners investors as Contagion drivers

In the above results, foreign investors appear as the drivers of financial Contagion in the set of emerging markets studied. Since our working definition of Contagion is based on the coincidence of large negative returns in international stock markets with a given emerging market, beyond what fundamentals can account for, we need to provide evidence that foreigners in such market do sell in times of large global market drops. The previous literature suggests this link. Several studies explain international flows dynamics, as the result of conditions in developed markets (push factors), or in local markets (pull factors).[15] Richards, (2005), finds that in most markets, foreign flows show a positive relation with respect to both local and S&P500 returns, in addition to significantly impacting prices in local markets. Griffin et al., (2004), finds that both the push and pull factors are important determinants, being stronger the first, and consistent with a model of portfolio-rebalancing. In addition, these investors' net buys have a significant contemporaneous effect on the local return, via price pressure rather than informed trading.

We want to test whether push factors trigger the foreign sells associated to Contagion in the sample, which runs from 2007 onwards and doesn’t overlap with the two studies above mentioned. That is, in a financial Contagion episode, if a fall in the S&P500 induces foreign investors to sell in emerging markets, and if these sales in turn contribute to a local market fall. To achieve this

[15] Some studies have found that push factors or the developed markets returns, especially United States, explain better in average the inflow and outflow of foreign flows in the emerging economies. (Froot et al., 2001; Griffin et al., 2004; Richards, 2005). Others, on the other hand, have obtained evidence in favor of local returns as the main determinants (Bohn & Tesar, 1996; Brennan & Cao, 1997).

goal, and following the spirit of the two papers mentioned above[16], we use an impulse response analysis in a structural VAR similar to [2], but excluding the Contagion measure.[17]

The figure 5, portrays the effect on foreign investors net buys (in percentage), from a 1% innovation in the S&P500 contemporaneous returns (one-day lagged for Asian markets), by country. With the exception of Colombia, the contemporaneous average response of foreign net buys is positive and significant for all countries. Similarly, in the next day, a 1% drop in the S&P500 causes a significant increase in the foreign investor's net sales. Within 20 days, for all countries, including Colombia, the cumulative effect remains positive and significant, which tends to stabilize for most markets, starting on day 5. Therefore, there is evidence in favor of the S&P500 return, a push factor, as important determinants of the foreign investors flows behavior in the emerging countries, finding consistency with Richards, (2005) and Griffin et al., (2004).

The contemporaneous and cumulative response of local indices returns, to a 1% positive impact in foreigners' net buys, is shown in Figure 6. The same-day effect is positive and significant for all markets. A 1% foreign net sale would induce an average drop that varies by country, between 0.16% for Colombia and 0.68% for Taiwan. Analyzing the cumulative response, the effect remains significant for all markets, up to 20 days, except for Colombia, where the effect ceases to be significant from the fifth day onwards. These results agree with those of Griffin et al., (2004), who concludes that this effect on local prices is due to price pressure, rather to informed trading, as mentioned above.

In conclusion, we confirm that push factors are drivers of foreign flows in emerging countries, like in the previous literature that studied an earlier period. A shock in the S&P500, significantly affects the foreign investors net buys, up to a period of 20 days. We also confirm that sells from foreigners significantly press down prices in the set of emerging markets. Taking these results together, they present evidence of a direct channel of Contagion spread. That is, in a Contagion

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[16] Both studies use the S&P500 as the main foreign index, a sample of countries similar to ours, and an impulse response analysis with orthogonalized shocks.

[17] In this model, flows have a contemporaneous effect on the local index return, but not vice versa. The basis for this order can be found in the section 3.2. The variables in the VARs are the S&P return (one-day lagged for Asian markets), net buys, and the return on the local market. We have also selected the same lag order of 5 for the VAR according to the criteria of Akaike and Hannan-Quinn for all countries and we have checked for autocorrelation in the disturbances (using a LM test for residual autocorrelation) and stability in the model (the roots of the autoregressive polynomial must be within the unit circle).

episode, a fall in the S&P500 induces net sales by foreigners in an emerging market, which in turn prompts a drop in the local index.[18]

4.3. Flows reaction after a Contagion Episode

Here, we explore the reaction of the net buys of different types to a Contagion episode, which may go beyond the normal reaction to a bear market. In addition, this helps us to explain the Contagion persistence, and its interaction with net flows over the following days. That is, a certain type of net sales may worsen Contagion in the following days, and this in turn induces more net sales. For this, we use the same methodology for impulse response analysis through orthogonalized shocks in a 4-VAR, such as equation [2]. This time, we want to analyze the cumulative effect in net buys from t+1 onward, driven by a 1% Contagion measure innovation.[19]

Figure 7 shows that for most countries in sample, after an increase of 1% in the Contagion probability, foreign investors still remain net sellers. For Colombia, Indonesia and Thailand, the foreign flows percentage cumulative response is negative and significant until the 5, 4 and 3 days, respectively. For Taiwan, the cumulative response is negative and marginally significant up to 20 days. Instead, for both Korean markets the effect in statistically insignificant. Since we are including local and S&P500 returns in this model, this negative foreign flows induced by Contagion are beyond what can be normally explained by the falling markets. Besides, the foreign sales in turn can generate more Contagion episodes in the following days, as shown in section 4.1. Therefore, we can say that foreign investors' sells do contribute to the persistence of Contagion in 4 out of 6 emerging markets.

Institutional investors, unlike foreigners, appear to have a stabilizing role. We had initially concluded that on a Contagion day, for both Korean markets and Thailand, Institutional agents are net sellers, whereas there is not significant evidence for Colombia. Now, Figure 8 shows that, after a Contagion day, these investors tend to reverse that behavior and become net buyers. Specifically,

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[18]As a further test of the push factors, we tested whether S&P500 returns Granger-cause to the Foreigners investors' net buys up to five days ahead. We use a VAR model similar to [2] but excluding the Contagion measure. According to the results, with the exception of Thailand and Kosdaq, S&P500 returns Granger-cause to the Foreigners investors' net buys. The results are available from the authors on request.

[19]In the exogeneity order assumed for the structural 4-VAR, the flows are more exogenous than the Contagion continuous measure. Therefore, the effect is seen from t+1, since the flows affect at the same time the measure, but not vice versa.

for Colombia, up to two days after an increase by 1% in the Contagion measure, cumulative net buys are positive and significant. For Kosdaq and Thailand, the effect is positive and becomes significant from day 4 and 3 onwards, respectively. Finally, for Kospi, the cumulative effect is positive and significant for 20 days. Meanwhile, as shown in Figure 9, individual investors do not have a clear role in any country.

Taking together this results with those of section 4.1 we find a differential and nuanced role for both local groups of investors. The evidence indicates that in Contagion episodes, Institutions are net sellers, like Foreigners, most surely aggravating the fall in the local index. However, in dare contrast with Foreigners, Institutions tend to become net buyers in the few days after, presumably supporting local prices.[20] In contrast, Individuals seem to act as the "buyers of last resort" in Contagion days, but don't have a define role as net buyers or sellers in the following days.

Conclusion

In this study we have tested the differential role of foreigners, local institutions and local individuals in days of Contagion. We have found that the behavior of foreigners corresponds with the role usually attributed for them: their sales increase the probability of Contagion, and they tend to keep selling after Contagion days. Local institution's sales also increase that probability, but their effect is lower and short-lived compared with the one of Foreigners in the same country. Moreover, Institutions tend to reverse their sales in the few following days, mitigating the effects of Contagion. Finally, Individuals are the net buyers in Contagion days, but this is a short-lived supporting role that appears not significant in the following days.

These findings are necessarily limited by the proposed Contagion measure. Future studies might try alternative definitions within the framework here proposed. Those new measures can incorporate, for example the heteroscedasticity of both international and local returns. We

[20] We confirm this with an impulse response analysis in a structural VAR similar to [2], but excluding the Contagion measure. We check the contemporaneous and cumulative response of local indexes, to a 1% positive impact in Institutions' net buys, for the 4 markets with available data. The results show that the same-day effect is positive and significant for all markets. A 1% institution net sale would induce an average drop that varies by country, between 0.1% for Colombia and 0.68% for Thailand. Analyzing the cumulative response, the effect remains significant for all markets, up to 20 days. The results are available from the authors on request.

acknowledge that the herein-proposed measure might overestimate Contagion, as it assumes a constant volatility in both series for the whole period.

Future research might study the same research question from at least two new perspectives. First, net buys around Contagion might be studied with the event study methodology. Although the event study methodology is well established in effects on returns and prices, we haven´t find many event studies focused on flows. This is necessarily a more demanding endeavor, since they have to deal with the persistence and predictability of net buys and their contemporaneous and lagged relations with local international returns. Second, the causality issues in a given Contagion day might be better settled with intraday data, which has been made available for some emerging markets.

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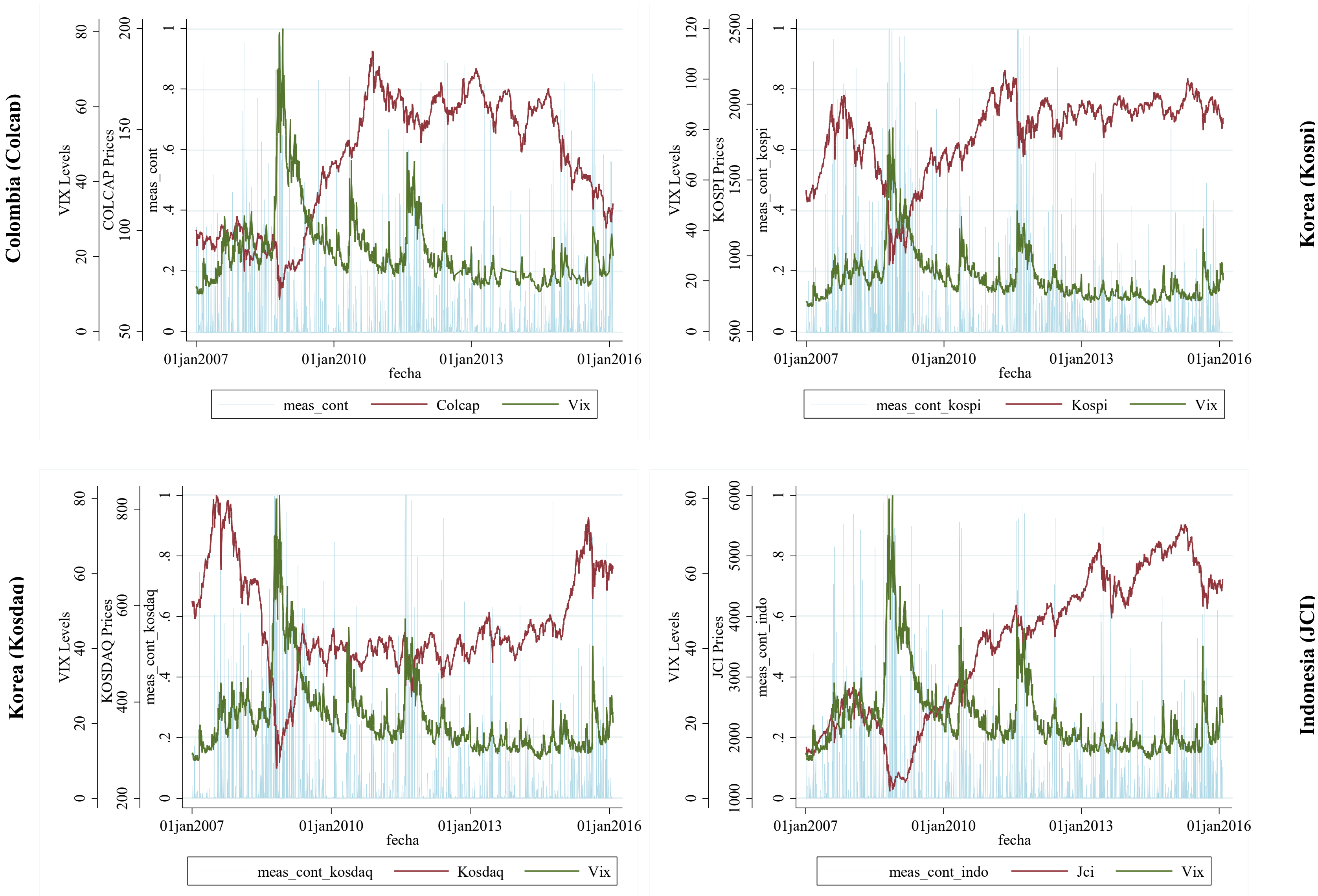
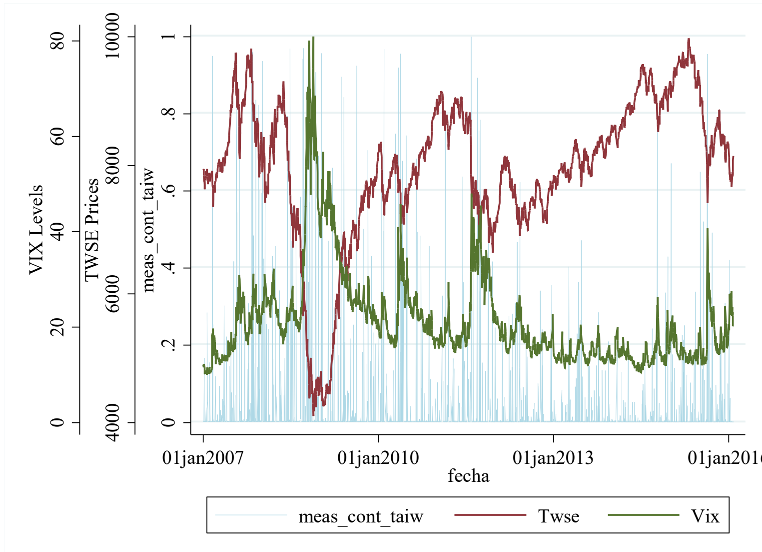
Figure 1. Contagion Measure, VIX levels and Local Indexes Prices



Taiwan (TWSE)



Thailand (SET50)

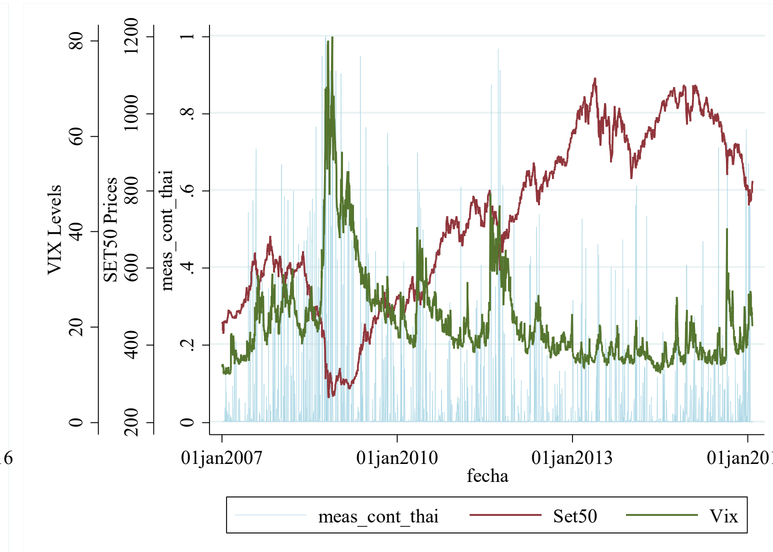


Figure 1 shows the Contagion measure time-series for six emerging markets (Colombia, Kospi, Kosdaq, Indonesia, Taiwan and Thailand), along with to the VIX level and the respective local index prices. Contagion measures are expressed in percentage, VIX is expressed in USD currency, and local indexes prices are expressed in the respective local currencies. The Contagion measure for each country is estimated from the standardized S&P500 return, and the standardized residuals of returns for each country, after controlling for a set of fundamentals, using daily data over 2007-2015; the methodology is described further in Section 3.1.

Figure 2.

VAR Impulse Responses of the Contagion Measure to Innovations in Foreigners' Net Buys

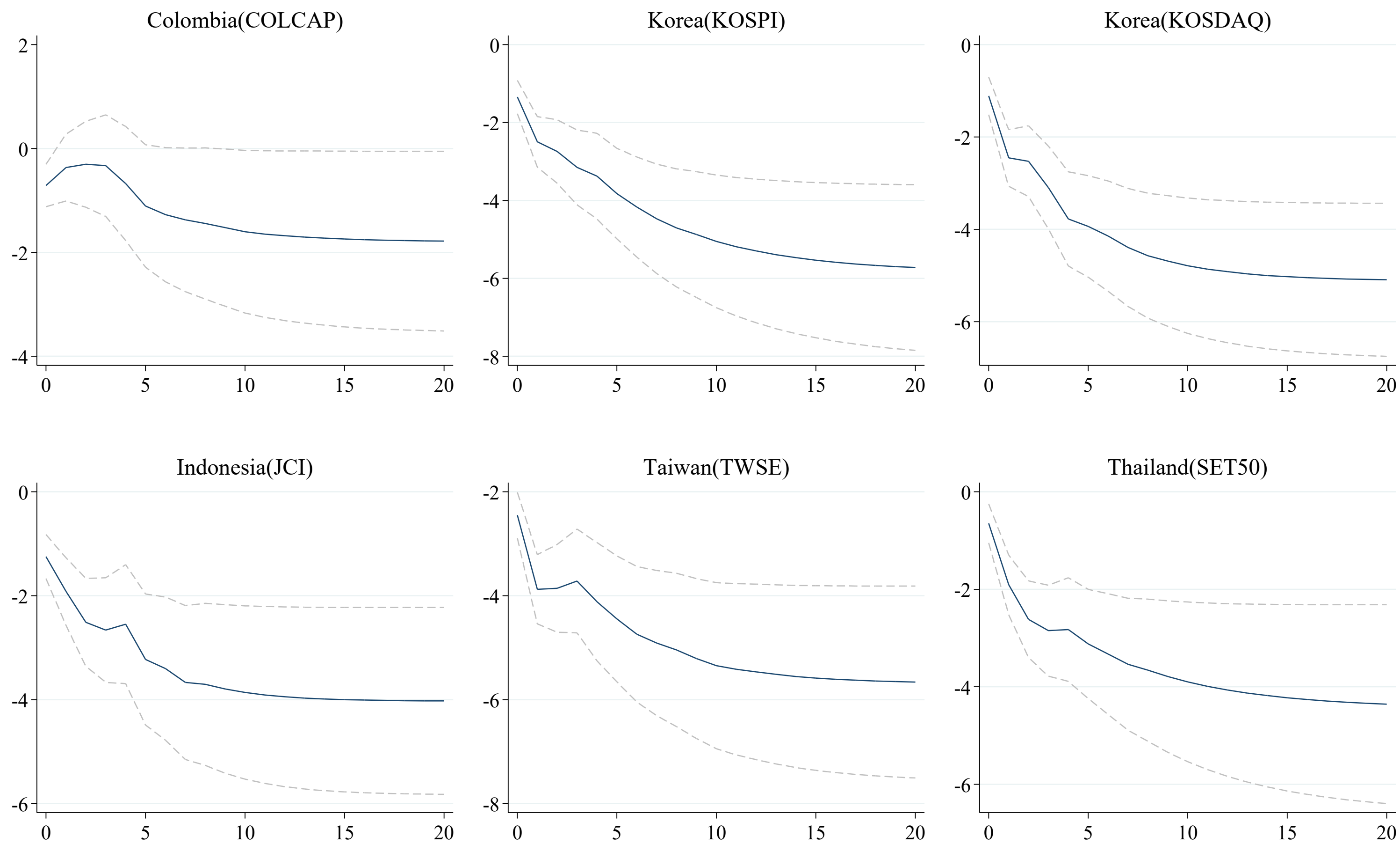


Figure 2 shows the cumulative response of the Contagion measure into six emerging markets (in percentage) to an innovation of one percentage point in Foreigners' net buys. The time scale on the horizontal axis is in days. The estimates are obtained from four-variable vector autoregression (VAR) systems, which are described further in Section 3.2., and are estimated using daily data over 2007-2015. Shocks are orthogonalized through a Cholesky factorization. The variables in the VARs are the S&P return (the lagged for Asian markets), net buys, the Contagion measure, and the return on the local market. For each impulse response function, we also report the 90% confidence intervals (dotted lines) based on asymptotic standard errors.

Figure 3.

VAR Impulse Responses of the Contagion Measure to Innovations in Institutions' Net Buys

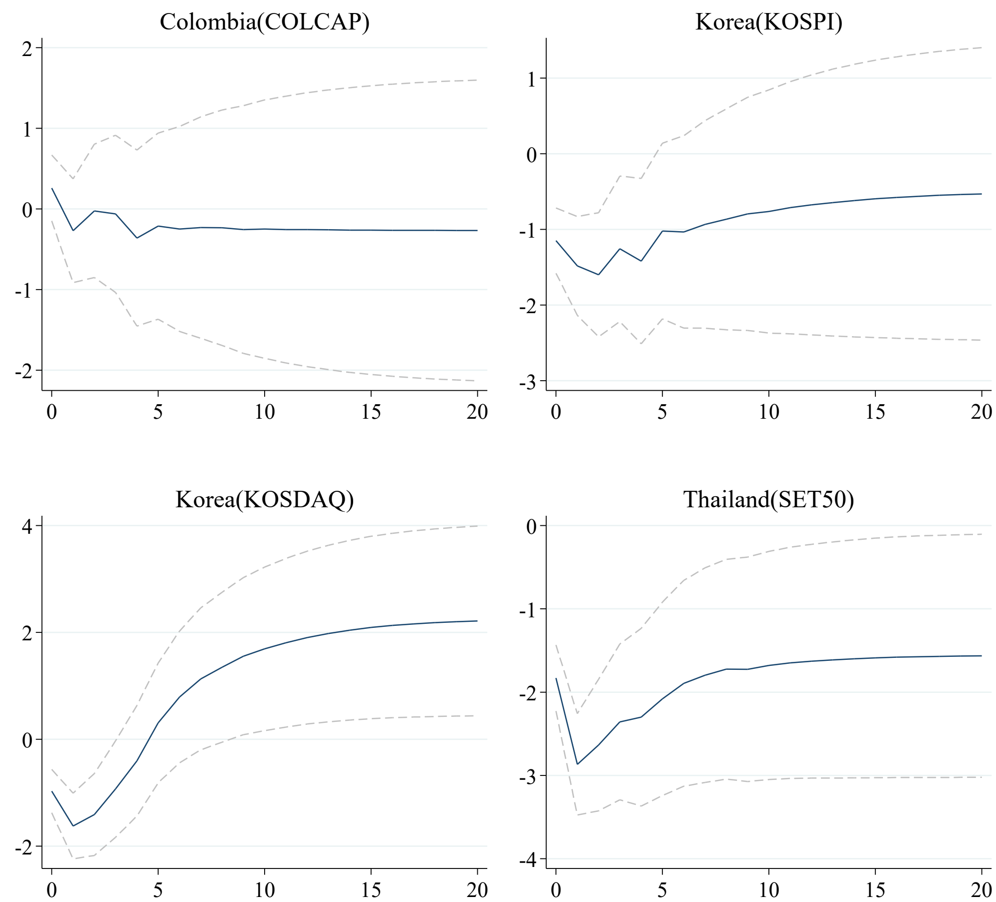


Figure 3 shows the cumulative response of the Contagion measure into six emerging markets (in percentage) to an innovation of one percentage point in Institutions' net buys. The time scale on the horizontal axis is in days. The estimates are obtained from four-variable vector autoregression (VAR) systems, which are described further in Section 3.2., and are estimated using daily data over 2007-2015. Shocks are orthogonalized through a Cholesky factorization. The variables in the VARs are the S&P return (the lagged for Asian markets), net buys, the Contagion measure, and the return on the local market. For each impulse response function, we also report the 90% confidence intervals (dotted lines) based on asymptotic standard errors.

Figure 4.

VAR Impulse Responses of the Contagion Measure to Innovations in Individuals' Net Buys

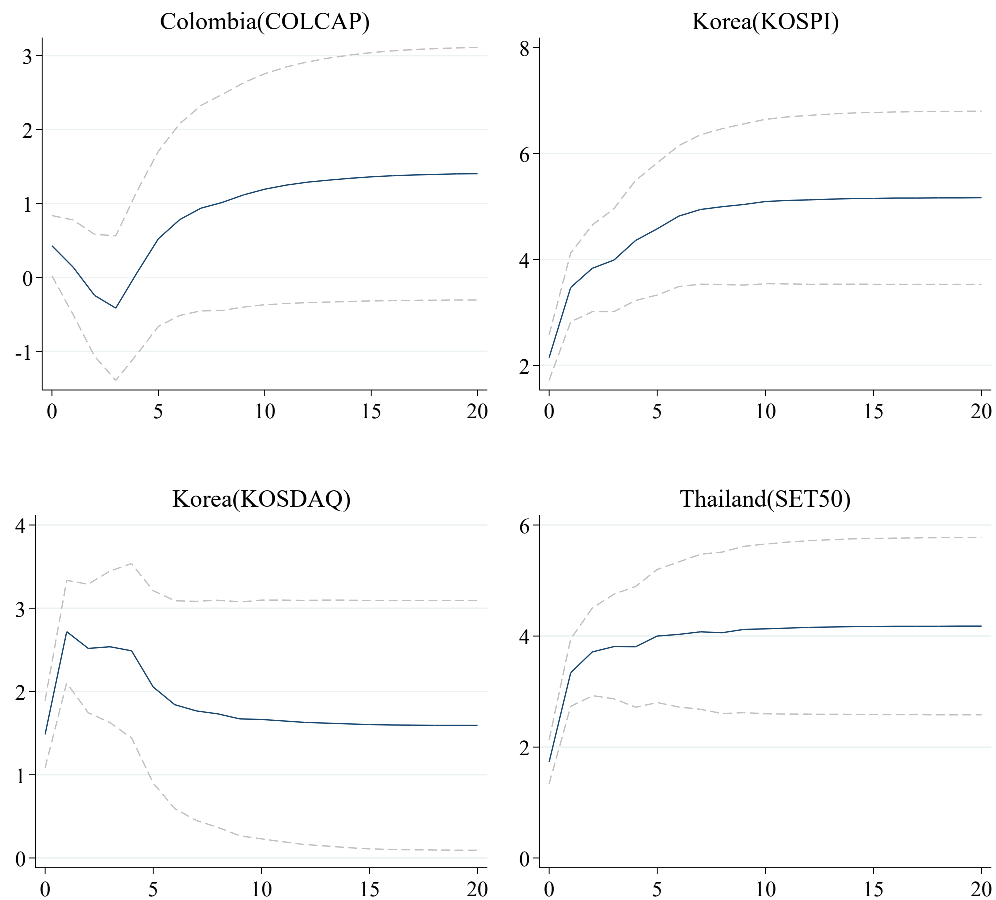


Figure 4 shows the cumulative response of the Contagion measure into six emerging markets (in percentage) to an innovation of one percentage point in Individuals' net buys. The time scale on the horizontal axis is in days. The estimates are obtained from four-variable vector autoregression (VAR) systems, which are described further in Section 3.2., and are estimated using daily data over 2007-2015. Shocks are orthogonalized through a Cholesky factorization. The variables in the VARs are the S&P return (the lagged for Asian markets), net buys, the Contagion measure, and the return on the local market. For each impulse response function, we also report the 90% confidence intervals (dotted lines) based on asymptotic standard errors.

Figure 5.

VAR Impulse Responses of Foreigners' Net Buys to Innovations in S&P500 return

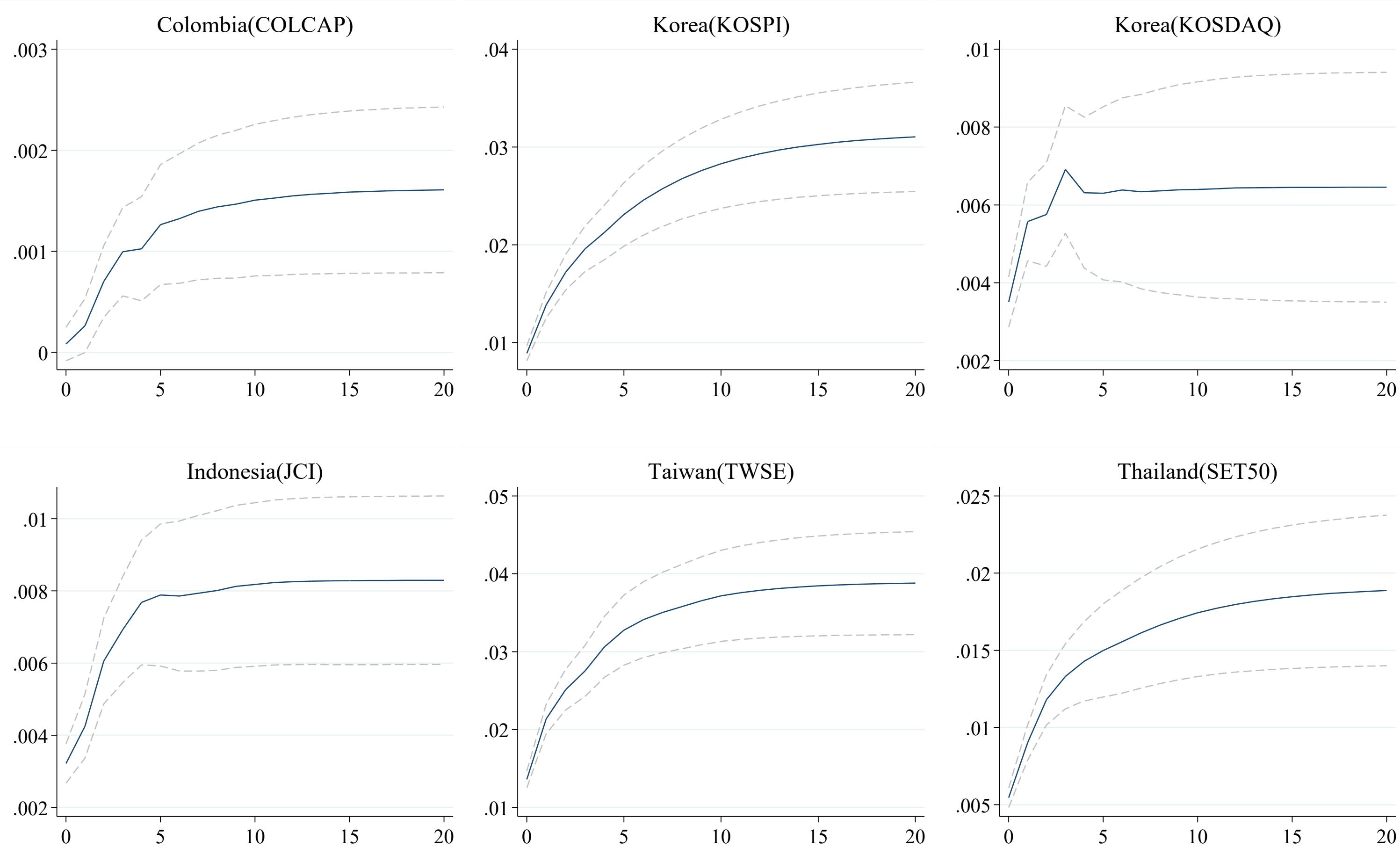


Figure 5 shows the cumulative response of Foreigner's net buys into six emerging markets (in percentage of market capitalization) to an innovation of one percentage point in S&P return. The time scale on the horizontal axis is in days. The estimates are obtained from three-variable vector autoregression (VAR) systems, which are described further in Section 4.2., and are estimated using daily data over 2007-2015. Shocks are orthogonalized through a Cholesky factorization. The variables in the VARs are the S&P return (the lagged for Asian markets), net buys, and the return on the local market. For each impulse response function, we also report the 90% confidence intervals (dotted lines) based on asymptotic standard errors.

Figure 6.

VAR Impulse Responses of Local Index Returns to Innovations in Foreigners' Net Buys

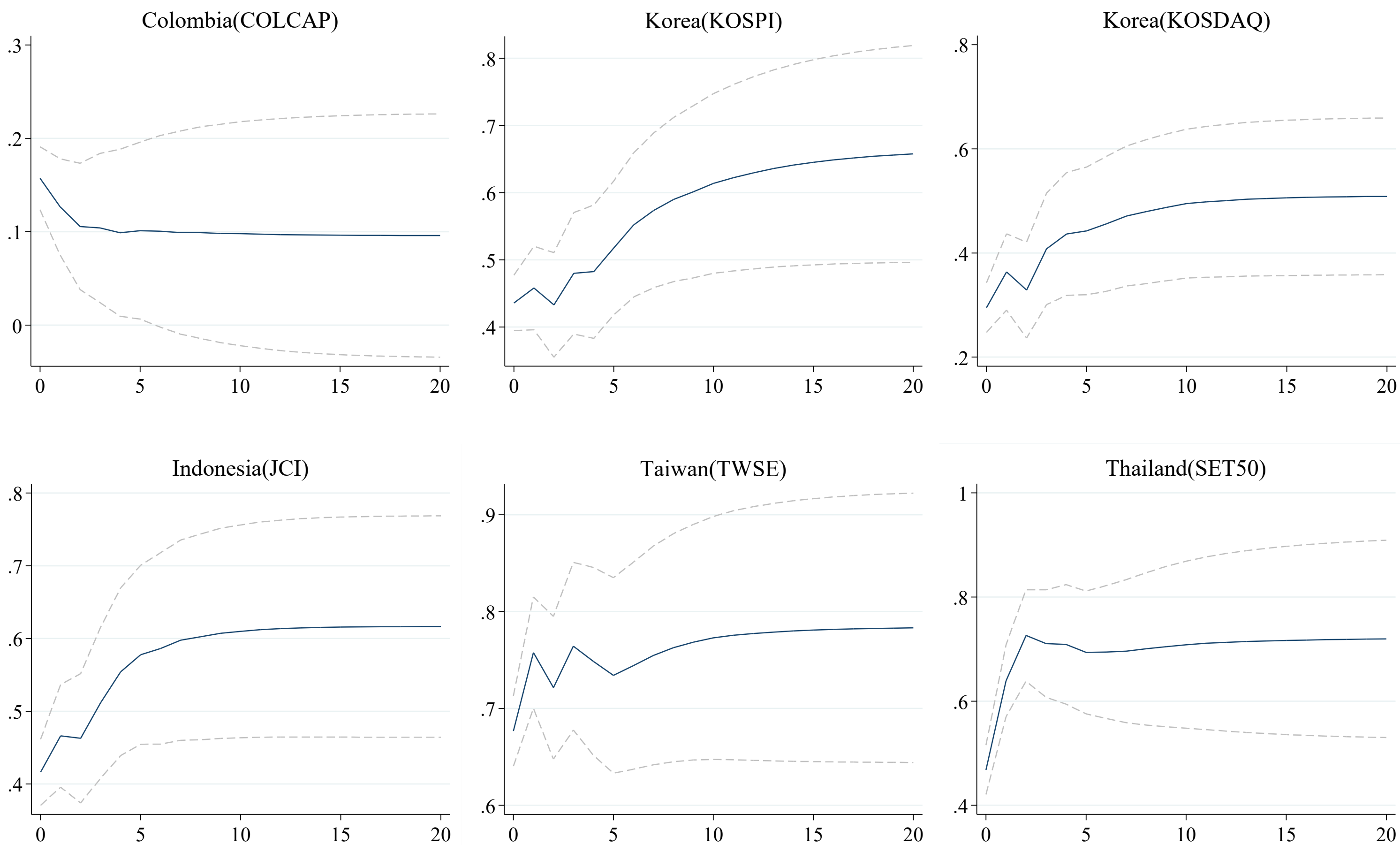


Figure 6 shows the cumulative response of local index returns into six emerging markets (in percentage) to an innovation of one percentage point in Foreigners' net buys. The time scale on the horizontal axis is in days. The estimates are obtained from three-variable vector autoregression (VAR) systems, which are described further in Section 4.2., and are estimated using daily data over 2007-2015. Shocks are orthogonalized through a Cholesky factorization. The variables in the VARs are the S&P return (the lagged for Asian markets), net buys, and the return on the local market. For each impulse response function, we also report the 90% confidence intervals (dotted lines) based on asymptotic standard errors.

Figure 7.

VAR Impulse Responses of Foreigners' Net Buys to Innovations in the Contagion Measure

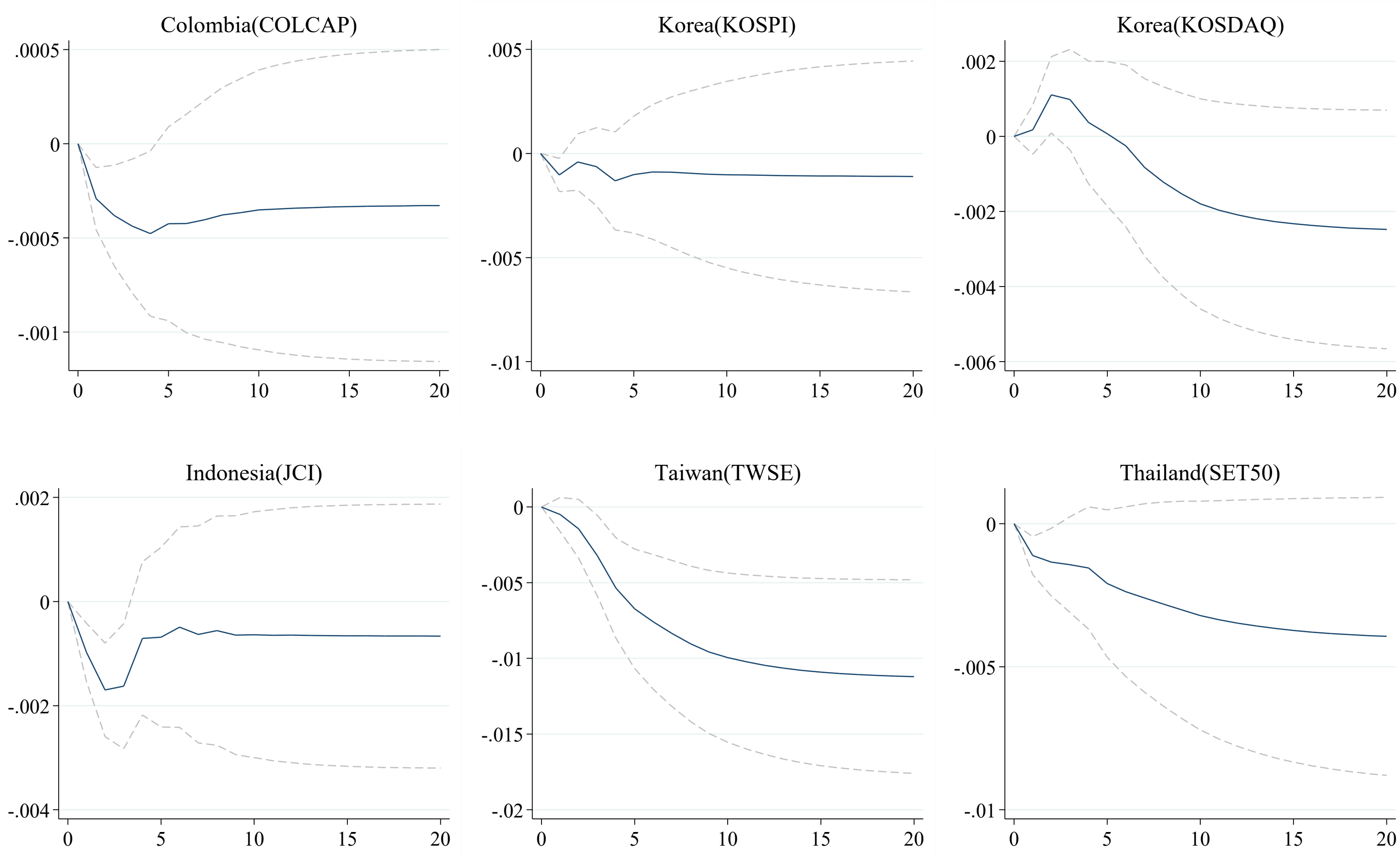


Figure 7 shows the cumulative response of Foreigners' net buys (in percentage of market capitalization) to an innovation of one percentage point in the Contagion measure. The time scale on the horizontal axis is in days. The estimates are obtained from four-variable vector autoregression (VAR) systems, which are described further in Section 3.2., and are estimated using daily data over 2007-2015. Shocks are orthogonalized through a Cholesky factorization. The variables in the VARs are the S&P return (the lagged for Asian markets), net buys, the Contagion measure, and the return on the local market. For each impulse response function, we also report the 90% confidence intervals (dotted lines) based on asymptotic standard errors.

Figure 8.

VAR Impulse Responses of Institutions' Net Buys to Innovations in the Contagion Measure

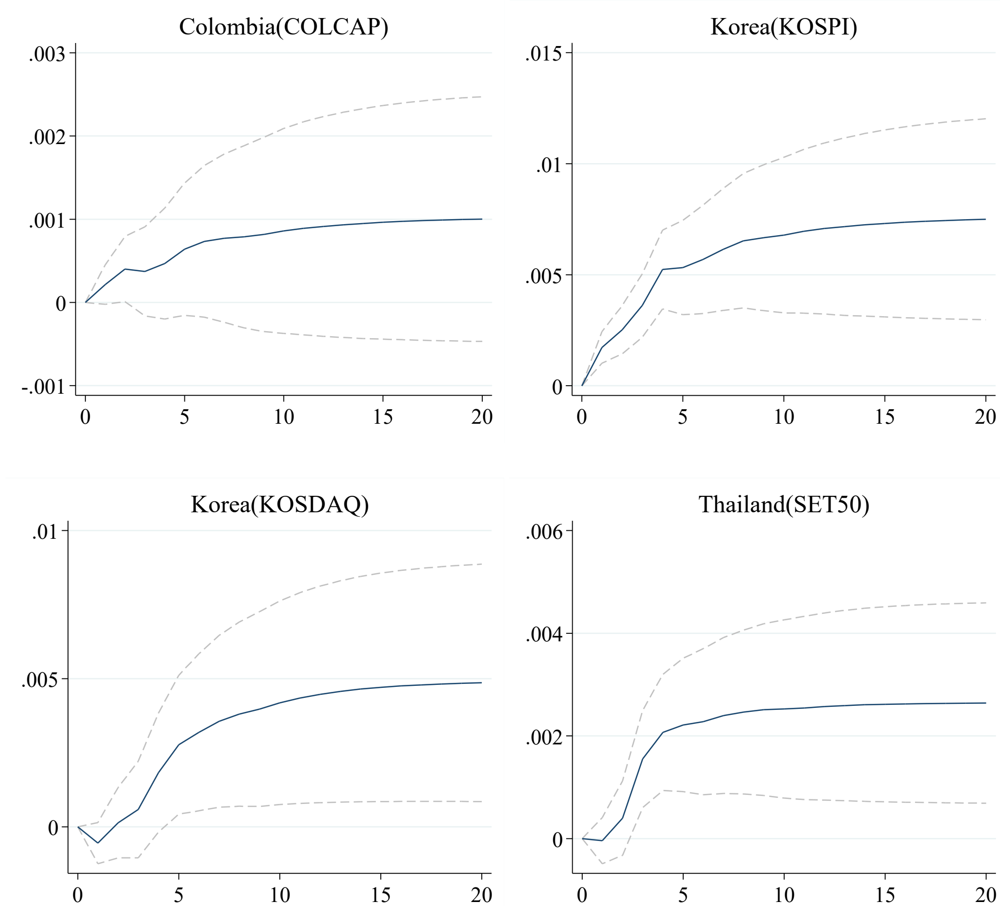


Figure 8 shows the cumulative response of Institutions' net buys (in percentage of market capitalization) to an innovation of one percentage point in the Contagion measure. The time scale on the horizontal axis is in days. The estimates are obtained from four-variable vector autoregression (VAR) systems, which are described further in Section 3.2., and are estimated using daily data over 2007-2015. Shocks are orthogonalized through a Cholesky factorization. The variables in the VARs are the S&P return (the lagged for Asian markets), net buys, the Contagion measure, and the return on the local market. For each impulse response function, we also report the 90% confidence intervals (dotted lines) based on asymptotic standard errors.

Figure 9.

VAR Impulse Responses of Individuals' Net Buys to Innovations in the Contagion Measure

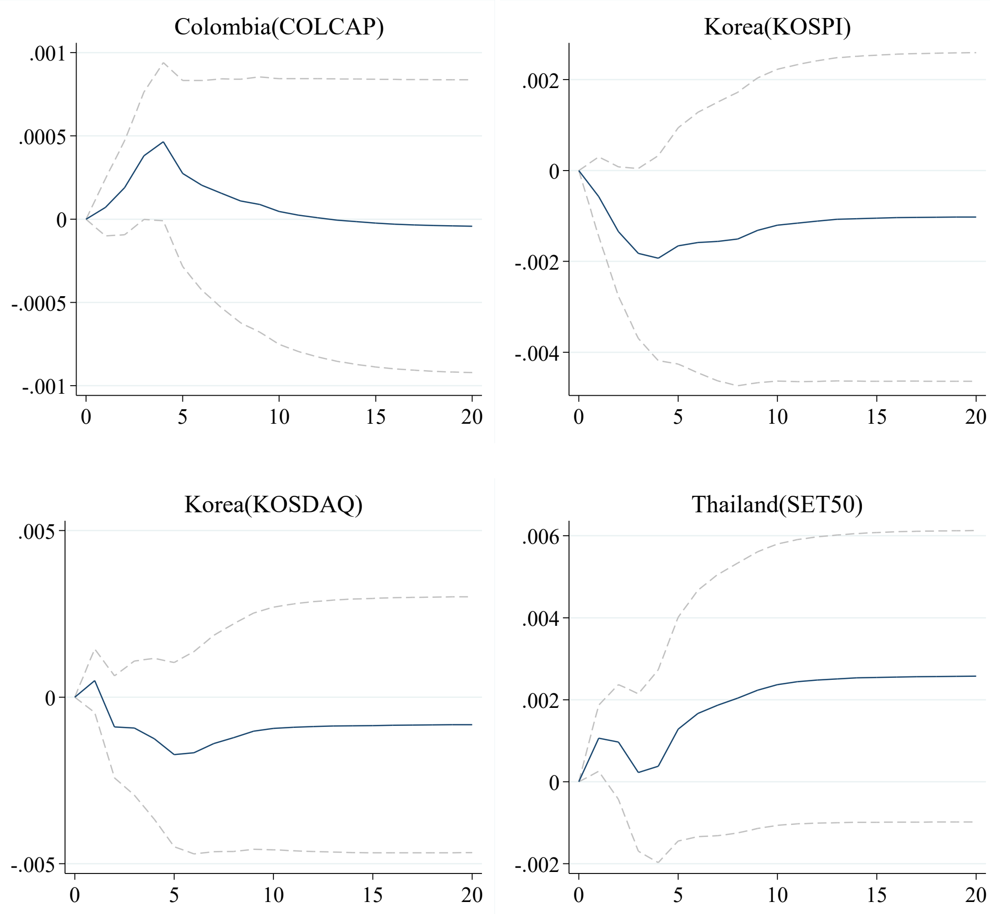


Figure 9 shows the cumulative response of Individuals' net buys (in percentage of market capitalization) to an innovation of one percentage point in the Contagion measure. The time scale on the horizontal axis is in days. The estimates are obtained from four-variable vector autoregression (VAR) systems, which are described further in Section 3.2., and are estimated using daily data over 2007-2015. Shocks are orthogonalized through a Cholesky factorization. The variables in the VARs are the S&P return (the lagged for Asian markets), net buys, the Contagion measure, and the return on the local market. For each impulse response function, we also report the 90% confidence intervals (dotted lines) based on asymptotic standard errors.

Table 1. Descriptive Data for Net Buys of Different Investor Groups

Country	Mean	Median	Std. Dev.	Autocorrelations Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Corr Local	Corr S&P500
Foreigners										
Colombia (Colcap)	0.0017%	0.0011%	0.0052%	0.3274*	0.2112*	0.1836*	0.1475*	0.1573*	0.1317*	0.0052
Korea (Kospi)	0.0001%	0.0002%	0.0268%	0.4706*	0.3398*	0.2774*	0.2236*	0.2303*	0.4159*	0.3573*
Korea (Kosdaq)	-0.0038%	-0.0038%	0.0204%	0.2559*	0.1928*	0.1607*	0.1370*	0.1185*	0.2580*	0.1603*
Indonesia (JCI)	0.0022%	0.0011%	0.0173%	0.3046*	0.1968*	0.1263*	0.1241*	0.0712*	0.3697*	0.2397*
Taiwan (TWSE)	0.0014%	0.0028%	0.0372%	0.4600*	0.2645*	0.2064*	0.1766*	0.1529*	0.6050*	0.3757*
Thailand (SET50)	-0.0014%	-0.0008%	0.0235%	0.5613*	0.4057*	0.3162*	0.2707*	0.2209*	0.3642*	0.2965*
Institutions										
Colombia (Colcap)	0.0006%	0.0004%	0.0077%	0.4127*	0.3007*	0.2399*	0.2380*	0.2211*	0.0936*	0.0277
Korea (Kospi)	0.0007%	0.0000%	0.0228%	0.2816*	0.2694*	0.2559*	0.2164*	0.1940*	0.2286*	-0.0671*
Korea (Kosdaq)	-0.0007%	-0.0004%	0.0230%	0.4362*	0.2578*	0.1444*	0.1352*	0.1439*	0.1557*	-0.1004*
Thailand (SET50)	0.0009%	0.0006%	0.0142%	0.3200*	0.1355*	0.0675*	0.0710*	0.0707*	0.4598*	0.2317*
Individuals										
Colombia (Colcap)	-0.0022%	-0.0018%	0.0054%	0.3715*	0.2417*	0.1758*	0.1354*	0.1346*	-0.2932*	-0.0910*
Korea (Kospi)	-0.0010%	0.0004%	0.0268%	0.3025*	0.1210*	0.0804*	0.0582*	0.0581*	-0.5894*	-0.2924*
Korea (Kosdaq)	0.0044%	0.0044%	0.0296%	0.2794*	0.1306*	0.0510*	0.0509*	0.0593*	-0.3019*	-0.0396
Thailand (SET50)	0.0004%	0.0002%	0.0259%	0.4322*	0.2068*	0.0888*	0.0608*	0.0604*	-0.5927*	-0.3972*

Table 1 reports the descriptive statistics for daily net buys for each country and type of investor. Net buys are defined as purchases less sales in local currency, scaled by the previous day market capitalization. We windsorize the net buys in percentiles 1th and 99th, to control for abnormal values. For all countries in the sample, the start date is January 3, 2007, and the final date is January 29, 2016. With the exception of Colombia, where the data were extracted from a proprietary database supplied by the BVC, the series of net buys were collected from Bloomberg. For each country and for each type of agent, the table shows the mean, median, standard deviation and the first five autocorrelation coefficients for each series. * Significance at the 5% level.

Table 2. Descriptive data of the Contagion Measures

Country	Nº Days	% Days/ >0	Mean / >0	Median / >0	% Days / >0.5	Corr VIX
Colombia (Colcap)	2224	23.02%	18.34%	8.69%	2.29%	0.1648
Korea (Kospi)	2254	25.02%	18.92%	8.93%	2.93%	0.2465
Korea (Kosdaq)	2254	23.03%	18.16%	7.56%	2.53%	0.2368
Indonesia (JCI)	2215	22.80%	19.28%	9.92%	2.66%	0.2203
Taiwan (TWSE)	2254	23.43%	18.74%	7.90%	2.71%	0.2082
Thailand (SET50)	2219	23.25%	18.11%	8.47%	2.66%	0.2404

This table shows the Contagion measure descriptive statistics for each country. In the first column we have the total number of days, followed by the percentage of data that are greater than zero. In the third and fourth columns, we present the mean and median of the data that are greater than 0. In the last two columns, we include the percentage of days in which the Contagion measure is greater than 0.5 and the correlation between the VIX (as a proxy of international volatility). The Contagion measure for each country is estimated from the standardized S&P500 return, and the standardized residuals for each country, using daily data over 2007-2015; the methodology is described further in Section 3.1.

Table 3. Granger Test of Net Flows by Country

Country	Foreigners	Institutions	Individuals
Colombia (Colcap)	0.207	0.187	0.014
Korea (Kospi)	0.011	0.836	0.12
Korea (Kosdaq)	0.001	0.002	0.048
Indonesia (JCI)	0.131	NA	NA
Taiwan (TWSE)	0.021	NA	NA
Thailand (SET50)	0.051	0.127	0.379

This table shows the Granger causality test p-values of net flows by country and type of investor, up to five days ahead. The null hypothesis is: flows do not Granger-cause Contagion measure. The VAR equations are the same of those expressed in the equation [2].

Appendix A

Table A1. Fundamentals Variables by Country

Country	Fundamentals Variables				
	Returns on related markets	**Interest rates**	**Country risk**	**International Volatility**	**Others**
Colombia (Colcap)	S&P500 Index (SPX Index), Ibovespa Brasil Sao Paulo Stock Exchange Index (IBOV Index), Mexican Stock Exchange Mexican Bolsa IPC Index (MEXBOL Index), S&P/BVL Peru General Index TR PEN (SPBLPGPT Index), Santiago Stock Exchange IPSA Index (IPSA Index), Buenos Aires Stock Exchange Merval Index (MERVAL Index), EURO STOXX 50 Price EUR (SX5E Index), Hong Kong Kong Hang Seng Index (HSI Index), Nikkei 225 (NKY Index), Shanghai Stock Exchange Composite Index (SHCOMP Index)	Colombia IBR Overnight Interbank Reference Rate (COOVIBR Index), Colombia Government Generic Bond 1 Year Yield (COGR1Y Index)	Colombia CDS 5 years (COLOM CDS USD SR 5Y D14)	Chicago Board Options Exchange SPX Volatility Index (VIX Index)	USDCOP Spot Exchange Rate - Price of 1 USD in COP (USDCOP Curncy), Generic 1st Crude Oil, WTI (CL1 COMB Comdty)
Korea (Kospi) Korea (Kosdaq)	S&P500 Index (SPX Index), Taiwan Stock Exchange Weighted Index (TWSE Index), Nikkei 225 (NKY Index), Hong Kong Hang Seng Index (HSI Index), Shanghai Stock Exchange Composite Index (SHCOMP Index), Straits Times Index (STI Index), Jakarta Stock Exchange Composite Index (JCI Index), Stock Exchange of Thailand SET 50 Index (SET50 Index)	KRW 3 Month Certificate of Deposit (KWCDC Curncy), KCMP South Korea Treasury Bond 2 Year (GVSK2YR Index), KCMP South Korea Treasury Bond 5 Year (GVSK5YR Index), KCMP South Korea Treasury Bond 10 Year (GVSK10YR Index)	South Korea CDS 5 years (KOREA CDS USD SR 5Y D14 Corp)	Chicago Board Options Exchange SPX Volatility Index (VIX Index)	USDKRW Spot Exchange Rate - Price of 1 USD in KRW (USDKRW Curncy), Generic 1st Crude Oil, WTI (CL1 COMB Comdty)

Indonesia (JCI)	S&P500 Index (SPX Index), Korea Stock Exchange KOSPI Index (Kospi Index), Taiwan Stock Exchange Weighted Index (TWSE Index), Nikkei 225 (NKY Index), Hong Kong Hang Seng Index (HSI Index), Shanghai Stock Exchange Composite Index (SHCOMP Index), Straits Times Index (STI Index), Stock Exchange of Thailand SET 50 Index (SET50 Index)	(JIIN3M Index), Indonesia Govt Bond Generic Bid Yield 2 Year (GIDN2YR Index), Indonesia Govt Bond Generic Bid Yield 5 Year (GIDN5YR Index), Indonesia Govt Bond Generic Bid Yield 10 Year (GIDN10YR Index)	Indonesia CDS 3 years (INDON CDS USD SR 3Y D14 Corp)	Chicago Board Options Exchange SPX Volatility Index (VIX Index)	USDIDR Spot Exchange Rate - Price of 1 USD in IDR (USDIDR Curncy), (CL1 COMB Comdty)
Taiwan (TWSE)	S&P500 Index (SPX Index), Korea Stock Exchange KOSPI Index (Kospi Index), Nikkei 225 (NKY Index), Hong Kong Hang Seng Index (HSI Index), Shanghai Stock Exchange Composite Index (SHCOMP Index), Straits Times Index (STI Index), Jakarta Stock Exchange Composite Index (JCI Index), Stock Exchange of Thailand SET 50 Index (SET50 Index)	Taiwan Interbank Money Center TAIBOR Fixing Rates 3 Month (TAIBOR3M Index), Generic Taiwan 2 Year Goverment Bond (GTTWD2Y Govt), Generic Taiwan 5 Year Goverment Bond (GTTWD5Y Govt), Generic Taiwan 10 Year Goverment Bond (GTTWD10Y Govt)		Chicago Board Options Exchange SPX Volatility Index (VIX Index)	USDTWD Spot Exchange Rate - Price of 1 USD in TWD (USDTWD Curncy, Generic 1st Crude Oil, WTI (CL1 COMB Comdty)
Thailand (SET50)	S&P500 Index (SPX Index), Korea Stock Exchange KOSPI Index (Kospi Index), Taiwan Stock Exchange Weighted Index (TWSE Index), Nikkei 225 (NKY Index), Hong Kong Hang Seng Index (HSI Index), Shanghai Stock Exchange Composite Index (SHCOMP Index), Straits Times Index (STI Index), Jakarta Stock Exchange Composite Index (JCI Index)	1 Month Thailand BIBOR Rates Classified by Banks (BOTH1M Index), Thailand Govt Bond 2 Year Note (GVTL2YR Index), Thailand Govt Bond 5 Year Note (GVTL5YR Index), Thailand Govt Bond 10 Year Note (GVTL10YR Index)	Thailand CDS 5 years (THAI CDS USD SR 5Y D14 Corp)	Chicago Board Options Exchange SPX Volatility Index (VIX Index)	USDTHB Spot Exchange Rate - Price of 1 USD in THB (USDTHB Curncy), Generic 1st Crude Oil, WTI (CL1 COMB Comdty)

Appendix B

Table B1. Optimal lag of VAR Equations: Information Criterion

Country	Hannan-Quinn	Schwartz-Bayes
Foreigners		
Colombia (Colcap)	2	1
Korea (Kospi)	2	2
Korea (Kosdaq)	3	2
Indonesia (JCI)	2	2
Taiwan (TWSE)	4	1
Thailand (SET50)	2	1
Institutions		
Colombia (Colcap)	2	1
Korea (Kospi)	4	2
Korea (Kosdaq)	2	2
Thailand (SET50)	3	2
Individuals		
Colombia (Colcap)	2	1
Korea (Kospi)	2	1
Korea (Kosdaq)	2	2
Thailand (SET50)	3	2

Table B1 presents the results of the information criteria for choosing the optimal lag for VAR equations. The estimates are obtained from four-variable vector autoregression (VAR) systems, which are described further in Section 3.2., and are estimated using daily data over 2007-2015. The variables in the VARs are the S&P return (one-day lagged for Asian markets), net buys, the contagion measure, and the return on the local market.