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Financial Contagion and Attention Allocation*

Jordi Mondria and Climent Quintana-Domeque**

Abstract

This paper explains financial contagion between two stock markets with uncorrelated fundamentals by fluctuations in international investors' attention allocation. We model the process of attention allocation that underlies portfolio investment in international markets using investors who face information processing constraints. Investors optimally allocate more attention to a region hit by a financial crisis, to the detriment of other markets. The resulting endogenous increase in uncertainty causes a reduction in the capacity to bear risks by international investors that induces them to liquidate their positions in all risky assets. Hence, there is a collapse in stock prices around the world. We show that the degree of non-anticipation of a crisis is crucial for the existence of contagion. Using data from the East Asian crisis and the number of news stories about Thailand in the Financial Times relative to news stories about Argentina, Brazil and Chile as a proxy for the relative attention allocated to the Asian stock market, we find evidence consistent with two key predictions of our model: first, the higher the volatility of the originator market, the more relative attention allocated to this market; and second, the more relative attention allocated to the originator market, the higher the volatility of the other markets. Our findings support the attention reallocation channel as a transmission mechanism of financial crises between regions during the period from January 1997 to July 1998.

Keywords: Financial Crisis, Asset Pricing, Portfolio Choice, Information Choice, News.

JEL classification: F30, D82, G12, G11.

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1 Introduction

The Asian crisis erupted in Thailand with the devaluation of the Thai baht on July 2, 1997, and in a few months, the crisis spread to Philippines, Malaysia, Indonesia, Hong Kong, Korea, Japan and Singapore. North and South American, European and African stock markets were affected after events in East Asia became headline news in American and British newspapers in mid-October. Before then, as noted by Forbes and Rigobon (2002), the press in these countries and international investors paid little attention to the earlier stock market movements in Thailand and Indonesia. This may suggest that financial contagion between regions took place when international investors started paying attention to South East Asian events. Indeed, such a possibility is consistent with recent empirical studies on limited attention in financial market settings. Huberman and Regev (2001), Hou and Moskowitz (2005), Hong, Torous and Valkanov (2007), Barber and Odean (2008), DellaVigna and Pollet (2007, 2008) provide evidence of delays in the response of asset prices to information that is publicly available until investors allocate attention to this information. In this paper, we explain financial contagion by fluctuations in the attention allocation of international investors.

Previous theoretical work, motivated by the existence of financial contagion between regions, has sought to study financial contagion across stock markets. In Kodres and Pritsker (2002), contagion occurs among stock markets that are indirectly linked through cross market-hedging when investors have a globally diversified financial portfolio. In Calvo and Mendoza (2000), globalization generates rational herding by decreasing the incentives of investors to process costly information. Kyle and Xiong (2001) study contagion in a model where there is an increase in risk aversion due to a wealth effect from the financial intermediaries. Yuan (2005) develops a rational expectations model of asset prices, where contagion arises from the interaction between asymmetric information and borrowing constraints. In Pasquariello (2007), heterogeneously informed investors generate excess comovement through strategic trading. Recent articles by Pavlova and Rigobon (2007), Cochrane, Longstaff and Santa-Clara (2008), Coeurdacier and Guibaud (2009) and Martin (2009) use multiple-tree frameworks to study asset price dynamics.[1]

Although the complementary transmission channels mentioned above are important for shedding light on contagion, this paper proposes a new financial transmission mechanism, namely attention allocation, where, provided investors have a limited capacity to process information, contagion between two international stock markets with uncorrelated fundamentals arises even in the absence of correlated information shocks, correlated liquidity shocks, direct or indirect macroeconomic links and borrowing constraints.

Attention is one of the most intensively research topics in the area of psychology. There is a large volume of evidence that shows that the human brain has a limited capacity to process information and to perform multiple simultaneous tasks, see Pashler and Johnston (1998). Kahneman (1973) argues that attention is a cognitive resource in short supply. Limited attention implies that investors must choose how to allocate their information resources across tasks. Hence, selectively concentrating information resources in one task implies a substitution of cognitive attention to other tasks.

While psychologists acknowledge that individuals have a limited capacity to process information, standard asset pricing models assume investors are able to process all their available and relevant information. However, even the most sophisticated investors have limited information resources. As argued by Huang and Liu (2007), information is costly due to data collection (i.e., macroeconomic and earnings announcements) and investigation costs (i.e., meeting with industry experts). Information is also costly in terms of time and effort allocated to processing the vast amount of freely available information. Theoretical work in finance has explored the implications of limited attention on asset pricing and portfolio choice. Merton (1987) analyzes an asset-pricing model where investors only know about a subset of the available assets. Peng (2005) shows that limited attention generates delayed consump-

[1] On the empirical side, previous research trying to identify the channels that transmit crises across countries has been mainly devoted to financial contagion within a region, i.e., the channels that spread the Thai crisis to Philippines, Malaysia, Indonesia and Korea. Although some papers have suggested that bilateral and third party trade links are playing a central role in the propagation of shocks across countries such as in Eichengreen, Rose and Wyplosz (1996), and Glick and Rose (1999), there is a growing consensus that points towards financial linkages as the main channel of financial contagion as noted by Kaminsky and Reinhart (2000), and Kaminsky, Reinhart and Vegh (2003). Van Rijckeghem and Weder (2001), Hernandez and Valdes (2001), and Kaminsky and Reinhart (2000) provide empirical evidence of contagion within regions by the existence of a single common creditor.

tion behavior and has implications on the cross-sectional differences in price informativeness. Peng and Xiong (2006) develops a model where limited attention leads to category learning and cross-sectional return predictability. Huang and Liu (2007) shows that costly information acquisition implies a trading strategy that is myopic with respect to future news frequency and news accuracy and may lead investors to overinvestment or underinvestment. Bacchetta and van Wincoop (2010) analyzes a two-country model in which limited information resources explains the forward discount puzzle and delayed overshooting.

This paper presents a model that offers a new mechanism, attention allocation, through which financial crises are transmitted within and between regions. We define financial contagion as an increase in uncertainty and a price drop in one market as a consequence of a financial crisis in another market with uncorrelated fundamentals. The model of contagion presented in this paper is a multiple asset, noisy rational expectations model with investors who face information processing constraints and builds on Admati (1985), Peng and Xiong (2006) and Mondria (2010).[2] The framework consists of two risky assets with uncorrelated fundamentals, which are interpreted as the national stock market indexes of two countries or regions. There is a continuum of agents who face information processing constraints. Each agent tries to obtain information about both stock markets in order to reduce the uncertainty of her optimal portfolio. However, investors have limited resources to process information, which they need to allocate between the two risky assets. The attention allocation decision consists of optimally allocating the limited information resources between the two markets. The more information is allocated to one market, the higher the precision of the private information about that particular market. After allocating their attention, investors incorporate the information from their private signal and prices through Bayesian updating to form their posterior beliefs about the asset payoffs and choose their optimal asset holdings.

In times of financial crises, the amount of daily news, rumors and investor concerns increases dramatically. In our model, investors optimally allocate more attention to the region

[2] Mondria (2010) solves a model with rationally inattentive agents, finds that agents choose to learn about a linear combination of asset payoffs, and explains price comovement/covariance between asset markets with uncorrelated fundamentals. In this paper, we solve a model where agents face a linear information processing constraint and focus on the transmission of financial crises between markets with uncorrelated fundamentals.

hit by a financial crisis, to the detriment of other markets, i.e., investors optimally process more information about the shaken stock market. Hence, the other emerging markets are perceived as more risky since less information is processed about them. The resulting endogenous decrease in the capacity of bearing risks by international investors induces them to liquidate their positions in all risky assets. As a consequence, there is a reduction of market liquidity that generates a rise in the risk premium, an increase in the perceived volatility and a collapse of asset prices in other emerging markets with uncorrelated fundamentals.

We provide some empirical evidence of attention reallocation as a mechanism through which financial crises are transmitted between regions. Using data from the East Asian crisis and the number of news stories about Thailand in the Financial Times relative to news stories about Argentina, Brazil and Chile as a proxy for the relative attention allocated to the Asian stock market, we find evidence consistent with two *key* predictions of our model: first, the higher the *volatility* of the *originator market*, the more *relative attention* allocated to this market; and, second, the more *relative attention* allocated to the originator market, the higher the *volatility* of the *other markets*. Our findings support the attention reallocation channel as a transmission mechanism of financial crises between regions during the period from January 1997 to July 1998. Our empirical analysis complements empirical studies in the area of financial crises and contagion, such as Boyer, Kumagai and Yuan (2006), who show that stock market crises are spread globally through asset holdings of international investors. In addition, our findings are consistent with those by Corwin and Coughenour (2008), who find that when NYSE specialists increase the attention allocated to their most active stocks, there is an increase in the bid-ask spread of their remaining assigned stocks.

Kaminsky, Reinhart and Vegh (2003) and Rigobon and Wei (2009) provided empirical evidence that anticipated financial crises as in Argentina on December 2001 generate less severe financial contagion than unanticipated crises as in Thailand 1997. The model presented in our paper is the first one, to the best of our knowledge, that points towards the degree of (non)anticipation of a financial crisis as the explanation of why some financial crises cause severe financial contagion and why others do not. If a financial crisis suddenly hits a country, investors are taken by surprise, and they are only able to reallocate their limited information processing resources, which causes financial contagion. However, if investors anticipate a future financial crisis, they will increase their limited resources to process information so that when a financial crisis arises, less attention needs to be reallocated and financial contagion is less severe.

The remainder of the paper is organized as follows. In Section 2, we describe the model. Section 3 presents the solution to the investor's optimization problem and explains how investors allocate their attention. Section 4 discusses the financial transmission channel that generates contagion between markets. Section 5 provides a theoretical explanation of why some crises generate financial contagion, while others only affect the country hit by the financial crisis. Section 6 presents an empirical analysis supporting the predictions of the model by studying financial contagion from Asia to Latin America during the period January 1997 - July 1998. Section 7 concludes.

2 Model Description

The model consists of two regions with a risky asset in each one of them. Each risky asset represents the stock market index of a separate region. There is a continuum of agents of measure one. Each agent has a limited capacity to analyze the asset payoffs.

Agents live four periods. In the first period, they receive an initial wealth, W_{i0}, and limited resources to process information, κ. In the second period, investors choose their attention allocation, which consists of allocating the limited information resources among stock markets. In the third period, each investor decides the optimal portfolio given the observation of a private signal, which depends on the amount of information processed about each stock market, and the price, which is public information. In the last period, agents consume the payoff of their portfolio.

Each agent invests her initial endowment in three different assets: a risk free asset that pays R units of the consumption good and two risky assets with uncorrelated fundamentals. The region 1 risky asset is traded in the first region stock market and pays $\tilde{r}_1 \sim N\left(\bar{r}_1, \sigma_{r1}^2\right)$

units of the consumption good. The region 2 risky asset is traded in the second region stock market and pays $\tilde{r}_2 \sim N\left(\bar{r}_2, \sigma_{r2}^2\right)$ units of the consumption good. Let $\bar{R}$ and Σ_R denote the mean vector and the diagonal covariance matrix of the vector $\tilde{R} = (\tilde{r}_1, \tilde{r}_2)'$. The numeraire in the market is the price of the bond and $\tilde{P} = (\tilde{p}_1, \tilde{p}_2)'$ is the price vector of the risky assets. The net supply of the risky asset j is given by the realization of a random variable $\tilde{z}_j \sim N\left(\bar{z}_j, \sigma_{zj}^2\right)$. Let $\bar{Z}$ and Σ_Z denote the mean vector and the diagonal covariance matrix of the vector of net supply $\tilde{Z} = (\tilde{z}_1, \tilde{z}_2)'$. This randomness can be viewed as the result of some trade of a nonspeculative nature (liquidity traders) or some trade from agents lacking perfect knowledge of the market structure (irrational traders). Asset supply randomness is necessary in order to avoid perfect revelation of private information through the price.

2.1 Investor's Optimization Problem

Investors, with a constant risk tolerance parameter ρ, maximize a CARA utility function

$$EU_i = E\left[-\exp\left(-\frac{W_i'}{\rho}\right)\right] \tag{1}$$

where W_i' is the wealth of agent i in the last period, subject to the following budget constraint

$$W_i' = W_{i0}R + X_i'(\tilde{R} - R\tilde{P}) \tag{2}$$

where W_{i0} is the initial wealth of agent i, $X_i = (x_{i1}, x_{i2})'$ is the asset holdings vector of agent i, $\tilde{R}$ is the vector of risky asset payoffs and $\tilde{P}$ is the price vector of the risky assets. The market clearing conditions are given by $\int_0^1 X_i di = \tilde{Z}$.

Investors devote information resources to process information about the vector of unknown asset payoffs $\tilde{R}$. Agent i receives a private signal about each risky asset $j = 1, 2$ given by

$$\tilde{Y}_i = \tilde{R} + \tilde{\varepsilon}_i \text{ where } \tilde{\varepsilon}_i \sim N(0, \Sigma_i)$$

where $\tilde{\varepsilon}_i$ is independent of $\tilde{R}$, $\tilde{\varepsilon}_i$ is independent of $\tilde{\varepsilon}_k$ for agent $i \neq k$ and $\Sigma_i = diag\left(\sigma_{i1}^2, \sigma_{i2}^2\right)$ is the diagonal covariance matrix of $\tilde{\varepsilon}_i$. Investors would like to obtain perfect information about the risky assets in order to reduce the uncertainty of their portfolio. However, they have limited resources to process information, κ, which they allocate among markets. Following Peng and Xiong (2006), we write the information processing constraint as

$$\kappa_{i1} + \kappa_{i2} \leq \kappa \text{ and } \kappa_{ij} \geq 0 \text{ for } j = 1, 2 \tag{3}$$

where κ_{i1} and κ_{i2} are the amount of information resources allocated to each stock market.[3] Investor i faces the following linear technology when processing information about the risky asset j

$$\sigma_{ij}^2 = \frac{\sigma_{rj}^2}{\kappa_{ij}}$$

The more information an investor i processes about an asset j, the lower is the variance of the error term in the private signal, σ_{ij}^2. The precision of a private signal is higher if more attention is allocated to that particular signal.[4] The information constraint in equation (3) imposes a limit in the reduction of the agent i's uncertainty about the payoff of the risky asset j. Investors' limited information resources determine the maximum amount of information they can process. The information processing resources have to be optimally divided between the two risky assets.[5] After deciding the amount of information to be processed about each stock market, investors incorporate the information from the private signal, $\tilde{Y}_i$, into their beliefs through Bayesian updating. Then, investors derive their posterior beliefs about the asset payoffs and decide their optimal asset holdings.

[3] As argued by Huang and Liu (2007), even the more sophisticated investors face information processing constraints due to data collection and investigation costs.

[4] Peng and Xiong (2006) assumed an increasing returns to scale technology to process information, which implies $\sigma_{ij}^2 = \frac{\sigma_{rj}^2}{(e^{\kappa_{ij}}-1)}$. However, as in Van Nieuwerburgh and Veldkamp (2010), we assume a linear technology that implies constant returns to scale.

[5] Peng (2005), Peng and Xiong (2006), Van Nieuwerburgh and Veldkamp (2010), Mackowiak and Wiederholt (2009) among others have also used similar information processing constraints. The main results of the paper are robust to the log-linear technology (rational inattention). For exposition and simplicity, we report only the results under a linear technology.

3 Solving the Model

The model is solved using backward induction. First, given an arbitrary attention allocation, each agent decides the optimal asset holdings. Second, given the optimal risky asset demand for each attention allocation, each agent decides the optimal attention allocation.

3.1 Optimal Asset Holdings

In the third period, each agent chooses the optimal risky asset demand taking as given any attention allocation. After observing the private signals and the asset prices, investors derive their posterior beliefs about the asset payoffs in order to choose their optimal asset holdings

$$X_i\left(\tilde{Y}_i, \tilde{P}\right) = \rho Var\left[\tilde{R} \mid \tilde{Y}_i, \tilde{P}\right]^{-1} E\left[\tilde{R} - R\tilde{P} \mid \tilde{Y}_i, \tilde{P}\right] \tag{4}$$

Following Admati (1985), the rational expectations equilibrium price is found by aggregating these asset demands and imposing the market clearing conditions.

Proposition 1 *There exists a unique linear rational expectations equilibrium price that depends on both market aggregates*

$$\tilde{P} = A_0 + A_1\tilde{R} - A_2\tilde{Z}, \text{ with } A_2 \text{ nonsingular} \tag{5}$$

Expressions for A_0, A_1 and A_2 are in the appendix. The conditional distribution of $\tilde{R}$ given a private signal $\tilde{Y}_i$ and the equilibrium price vector $\tilde{P}$ is a multivariate normal with covariance matrix

$$V_i = Var\left[\tilde{R} \mid \tilde{Y}_i, \tilde{P}\right] = \left(\Sigma_R^{-1} + \Pi\Sigma_Z^{-1}\Pi + \Sigma_i^{-1}\right)^{-1} \tag{6}$$

The optimal asset holdings by an investor i, who observes the state of the world with a private signal $\tilde{Y}_i$ and the equilibrium price vector $\tilde{P}$, are given by

$$X_i\left(\tilde{Y}_i, \tilde{P}\right) = G_{0i} + G_{1i}\tilde{Y}_i - G_{2i}\tilde{P} \tag{7}$$

Expressions for G_0, G_1 and G_2 are in the appendix.

A mean variance objective function implies a linear demand for risky assets, which does not depend on wealth. If agents only face the asset holdings decision given exogenous and independent private signals, then prices and asset holdings are independent of each other. Therefore, changes in one stock market have no effect in other stock markets and there is no asset price comovement since the matrices A_1 and A_2 in the equilibrium price equation (5) are diagonal.

3.2 Attention Allocation

In the second period, each agent i chooses the optimal allocation of information resources, κ_{i1} and κ_{i2}. Taking into account the optimal asset demand given by equation (4), investors maximize their objective function given by equation (1) subject to the information resources constraint given by equation (3). The following proposition shows the existence of a unique linear rational expectations equilibrium private signal and solves for the equilibrium values of the optimal allocation of information resources, κ_{i1} and κ_{i2}.

Proposition 2 *There exists a unique linear rational expectations equilibrium private signal. In this equilibrium, all investors choose the same allocation of information resources given by*

$$\kappa_1 = \begin{cases} \frac{\sigma_{r1}^2\sigma_{z1}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)-\sqrt{\sigma_{r1}^2\sigma_{z1}^2\sigma_{r2}^2\sigma_{z2}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\left(\sigma_{r1}^2\sigma_{z1}^2+\rho^2\kappa\right)}}{\rho^2\left(\sigma_{r1}^2\sigma_{z1}^2-\sigma_{r2}^2\sigma_{z2}^2\right)} & \text{if } \sigma_{r1}^2\sigma_{z1}^2 \neq \sigma_{r2}^2\sigma_{z2}^2 \\ \frac{1}{2}\kappa & \text{if } \sigma_{r1}^2\sigma_{z1}^2 = \sigma_{r2}^2\sigma_{z2}^2 \end{cases} \tag{8}$$

and $\kappa_2 = \kappa - \kappa_1$.

The private signal about asset j of agent i contains more information the lower the variance of the error term in the private signal, σ_{ij}^2, which depends on the information resources allocated to the asset, κ_{ij}. The following proposition summarizes the impact of the risky assets' payoff and supply volatilities on investors' attention allocation.

Proposition 3 *Investors allocate more attention to first stock market, κ_{i1}, the higher the asset payoff volatility, σ_{r1}^2, and supply volatility, σ_{z1}^2, of the first risky asset and the lower the asset payoff volatility, σ_{r2}^2, and supply volatility, σ_{z2}^2, of the second stock market.*

An increase in the volatility of asset payoffs or asset supply increases the attention allocated to that market, which means that more information is processed about that market. This implies that an increase of uncertainty about the first stock market generates a reduction of the attention allocated to the second stock market.

4 Financial Contagion

Financial contagion is defined as an increase in uncertainty and a price drop in one market as a consequence of a financial crisis in another market. We interpret a financial crisis as an increase in the unconditional variance of the asset payoffs.[6] For clarification, we refer to uncertainty as the variance of asset payoffs conditional on the information set at a given time: $Var\left[\tilde{R} \mid Information\right]$. Kaminsky and Schmukler (1999) analyze the financial markets of nine different South East Asian countries during the Asian Crisis. They concentrate on the days of market "jitters", which they define as the 20 largest 1-day changes (downturns or upturns) in each country's stock market prices. Even though there is a pronounced negative trend in all markets since 1997, about 76 of the 180 largest changes are positive. This suggests large reversals in the mood of investors and an increase in the volatility of Asian markets during the crisis.[7]

After a stock market is hit by a financial crisis, investors optimally reallocate their attention towards that asset, as showed in Proposition 3, which means that the private signal is now providing more information about that stock market, to the detriment of other risky markets. This effect, which is called attention reallocation, leads investors to perceive the other stock

[6] There are several causes for financial crises, but a common element in all of them is the increase in the uncertainty of asset payoffs.

[7] Uncertainty about the IMF actions such bailouts, conditions of rescue package and negotiation of the loans increases the volatility in financial markets during turbulent episodes. There is also uncertainty about capital controls, reactions of finance ministers and policymakers, delays in multimillion dollar projects, credit ratings, riots, strikes...

markets as more risky since less information is processed about them. Hence, a financial crisis in one market leads to an increase in uncertainty another market with uncorrelated fundamentals. This is formalized in the following proposition.

Proposition 4 *A financial crisis in one stock market leads to an increase in the posterior variance of the other stock market with uncorrelated fundamentals through attention reallocation.*

Because investors optimally process more information about the region hit by a financial crisis, there is an endogenous increase in uncertainty in other regions as showed in Proposition 4 and an increase in price volatility in other regions as showed in the next proposition.

Proposition 5 *Under the following parameter conditions*

$$\sigma_{r1}^2 \sigma_{z1}^2 \neq \sigma_{r2}^2 \sigma_{z2}^2$$

and

$$\rho^2 + \frac{\rho^4 \kappa_1^2}{\sigma_{r1}^2 \sigma_{z1}^2} < \sigma_{r1}^2 \sigma_{z1}^2 + \rho^2 \kappa_1$$

where κ_1 *is given by (8), a financial crisis in one stock market leads to a strictly increase in the price volatility of the other stock market with uncorrelated fundamentals through attention reallocation.*

The first parameter condition requires the two asset markets to be not perfectly symmetric. The second parameter condition requires the prior variance of payoffs and noisy supply to be high enough.[8] In the empirical section we argue that these two parameter conditions are likely to hold.

Because a financial crisis tilts the attention allocation from the non-crisis market to the crisis market, Propositions 4 and 5 state that there is an increase in uncertainty and volatility in all markets that causes a reduction in the capacity of bearing risks by international investors. Hence, investors liquidate their positions from those risky assets, which suffer a reduction of

[8]Note that $0 < \kappa_1 < \kappa$. For high enough $\sigma_{r1}^2 \sigma_{z1}^2$ the second parameter condition will be satisfied.

market liquidity and a collapse of asset prices. Proposition 6 shows that a financial crisis in one stock market leads to a stock price decline of the other market with uncorrelated fundamentals.[9]

Proposition 6 *A financial crisis in one stock market leads to a decrease in the expected price of the other stock market with uncorrelated fundamentals through attention reallocation.*

5 Contagious vs. Non Contagious Financial Crises

The purpose of this section is to understand why not all the financial crises generate financial contagion. Kaminsky, Reinhart and Vegh (2003) and Rigobon and Wei (2009) provided empirical evidence that anticipated financial crises such as the devaluation of the real in Brazil on January 1999, the Argentinean default on December 2001 and Turkey's devaluation of the lira on February 2001 were not as contagious as the Mexican, Asian and Russian episodes. Rigobon and Wei (2009) used the number of articles in newspapers around the world to measure the degree of anticipation of financial crises. They showed that the Argentinean crisis in December of 2001 received attention, in terms of news, more than a year before the devaluation, while there was little news about Thailand before June 1997 even though the country was already under a speculative attack. Kaminsky, Reinhart and Vegh (2003) looked at the evolution of the EMBI (Emerging Markets Bond Index) spreads in Mexico, Russia, Brazil and Argentina during their financial crisis period. They noticed that the Mexican and Russian spreads took off just after their financial crises, which suggests that investors were taken by surprise. However, in Brazil and Argentina the spreads started rising months before their financial crises, which indicates that financial turbulence was anticipated.

[9] The entire discussion of contagion in this paper is about expected prices. Kaminsky and Schmukler (1999) showed that there was a negative trend (slow price decline) in all markets during the Asian crises. If some persistence in asset payoffs is added, this will generate a slow expected price decline (negative trend in asset prices) in the market not originally affected by the financial crisis. The reason is that past information will be used to obtain information about the current state of the economy. Thus, if persistence is added, this model predicts a negative trend in asset prices of emerging markets, which is not the same as concluding that realized asset prices are always going down. If investors receive better than expected news (a high draw of their private signal), realized prices will be higher than expected prices. As showed by Kaminsky and Schmukler (1999), although there is a negative trend in all markets (expected prices going down) since 1997, about 76 of the 180 largest changes in Asian stock markets are positive (realized prices being higher than expected prices in the model).

If the optimal information processing capacity decision, κ, is interpreted as a medium/long term decision, then an extension of the model allows us to distinguish anticipated from unanticipated financial crises. In anticipated crises, investors foresee problems in the future and they optimally decide their information processing resources. However, in unanticipated crises, investors are taken by surprise and they take as given their information processing resources.

5.1 Optimal Information Processing Capacity

In this section, the model is solved when investors are allowed to choose their optimal level of information processing capacity, κ. A strictly convex cost function $c(\kappa)$ is introduced in the budget constraint in equation (2). Given the optimal asset holdings and the optimal attention allocation for every information processing capacity, investors choose their optimal information processing capacity.

Proposition 7 *The optimal level of limited capacity to process information, κ, is implicitly given by*

$$\frac{1}{4\sigma_{r1}^2\left(\frac{1+\frac{1}{2}\left(\kappa+\frac{\sigma_{r2}^2\pi_{22}^2}{\sigma_{z2}^2}-\frac{\sigma_{r1}^2\pi_{11}^2}{\sigma_{z1}^2}\right)}{\sigma_{r1}^2}+\frac{\pi_{11}^2}{\sigma_{z1}^2}\right)}+\frac{1}{4\sigma_{r2}^2\left(\frac{1+\frac{1}{2}\left(\kappa+\frac{\sigma_{r1}^2\pi_{11}^2}{\sigma_{z1}^2}-\frac{\sigma_{r2}^2\pi_{22}^2}{\sigma_{z2}^2}\right)}{\sigma_{r2}^2}+\frac{\pi_{22}^2}{\sigma_{z2}^2}\right)}-\frac{R}{\rho}c'(\kappa)=0$$

Expressions for π_{11} and π_{22} are in the appendix.

This expression defines an implicit optimal level of information processing capacity, κ.

5.2 Numerical Example

This section conducts a numerical example chosen to reflect reasonable parameters. We take our parameter values from Yuan (2005).[10] This numerical example shows that the degree of (non)anticipation is crucial for the existence of contagion. If investors anticipate financial

[10] Each asset payoff has a variance of prior beliefs $\sigma_{r,1}^2 = \sigma_{r,2}^2 = 20\%$. Each asset has an expected net supply $\bar{z}_1 = \bar{z}_2 = 16$ and a variance $\sigma_{z,1}^2 = \sigma_{z,2}^2 = 20$. The coefficient of risk tolerance is $\rho = 1$ and the gross return of the risksless asset $R = 1$. The cost function is chosen to approximately obtain a signal-to-noise ratio of 30 assumed in Yuan (2005). Without loss of generality, we assume that the cost function is given by $c(\kappa) = \frac{\kappa^2}{10000}$. The results of the numerical example do not depend on this cost function, but they do depend on the signal-to-noise ratio.

turbulence, investors are able to choose their information processing capacity, κ. However, if a financial crisis is unanticipated, investors take as given their information capacity, κ, since increasing the information processing resources is assumed to be a medium/long term decision.

Figure 1 shows that the higher the variance in one of the risky assets, the more resources investors spend to analyze the international financial markets. Figure 2 shows the effect on expected prices if there is an anticipated financial crisis in the first stock market. In this case, investors acquire more information processing resources and there is less need to reallocate investor's limited attention when the financial crisis arrives. Therefore, financial contagion is mild. Figure 3 shows the effect on expected prices if there is an unanticipated financial crisis in the first risky asset. In this case, investors take as given their information processing capacity and severe financial contagion occurs as shown in Section 4.[11]

In this example, when the crisis is unanticipated, the model is able to explain the flight to quality after the Asian crisis. The reason is that after an unanticipated financial crisis hits a region, investors pull out from all risky assets because of attention reallocation. Hence, there is an increase in the risk premium on all risky assets that causes a collapse in prices around the world. Flight to quality is defined as an increase of the wealth allocated to the risk free asset. Since an unanticipated financial crisis in one stock market generates a collapse of all financial markets, less wealth is required to hold the asset supply. Therefore, there is an increase in the wealth allocated to bond holdings and in the relative price of the risk free asset.

[11] The information processing capacity, κ, is hold constant at the optimal level when $\sigma^2_{r1} = 0.2$.

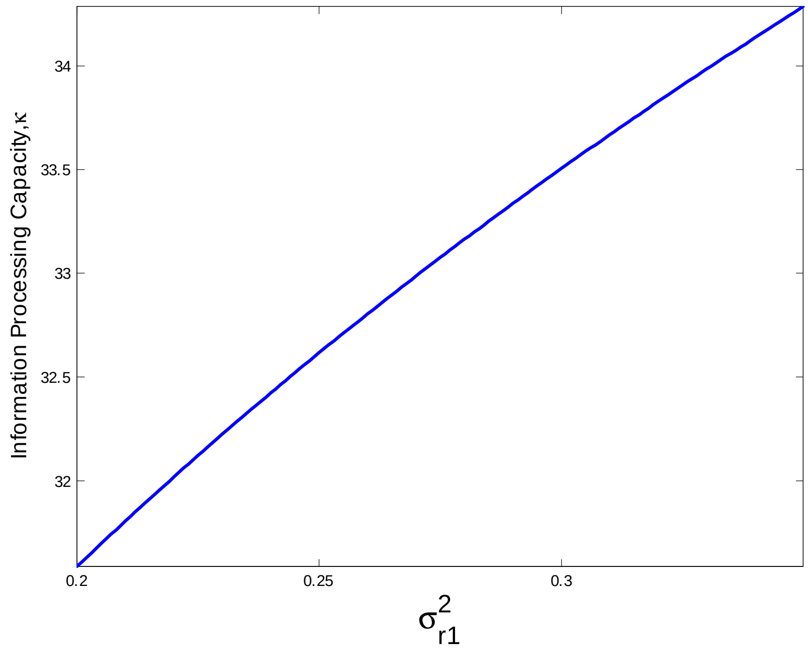

Figure 1: Optimal Information Processing Capacity. Numerical example with the following parameters $\sigma^2_{r2} = 0.2; \sigma^2_{z1} = \sigma^2_{z2} = 20; \rho = R = 1;\ \bar{z}_1 = \bar{z}_2 = 16; \bar{r}_1 = \bar{r}_2 = 1; c(\kappa) = \frac{\kappa^2}{10000}$. This figure shows that the optimal information processing capacity is increasing with the prior variance of the first asset payoff.

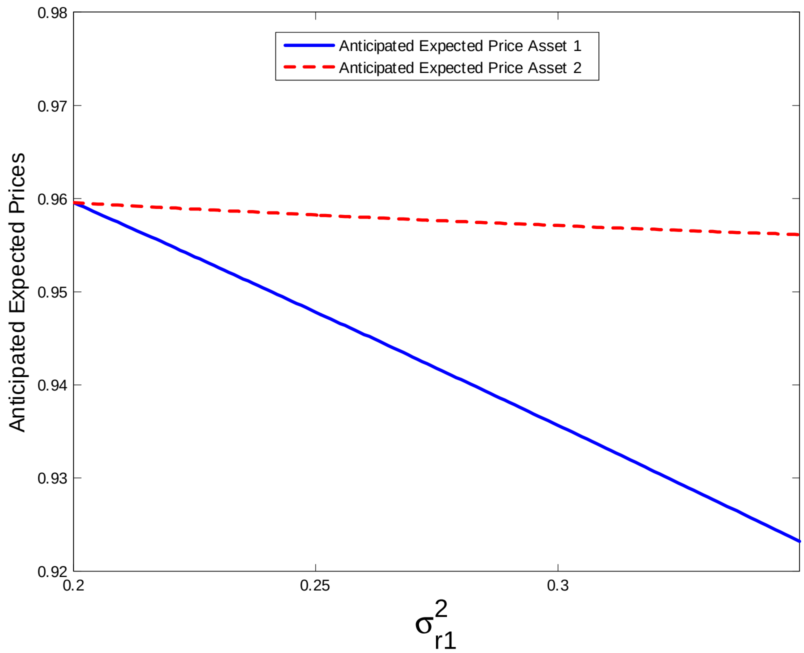

Figure 2: Anticipated Expected Prices. Numerical example with the following parameters $\sigma^2_{r2} = 0.2; \sigma^2_{z1} = \sigma^2_{z2} = 20; \rho = R = 1;\ \bar{z}_1 = \bar{z}_2 = 16; \bar{r}_1 = \bar{r}_2 = 1; c(\kappa) = \frac{\kappa^2}{10000}$. When investors can optimally choose the information processing capacity, κ, this figure shows that an increase in the prior variance of the first asset payoff generates a large decrease in the expected price of the first asset and a small decrease in the expected price of the second asset.

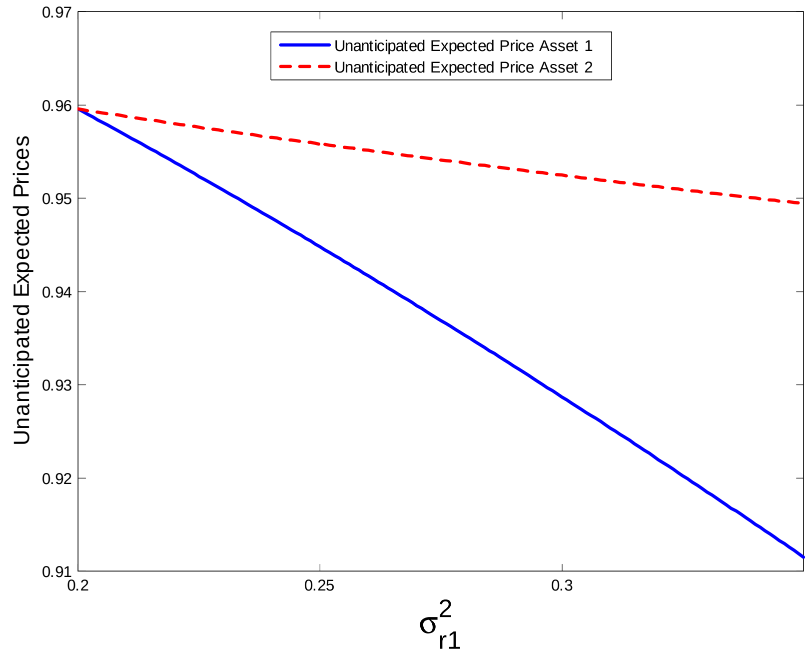

Figure 3: Unanticipated Expected Prices. Numerical example with the following parameters $\sigma^2_{r2} = 0.2; \sigma^2_{z1} = \sigma^2_{z2} = 20; \rho = R = 1;\ \bar{z}_1 = \bar{z}_2 = 16; \bar{r}_1 = \bar{r}_2 = 1; c(\kappa) = \frac{\kappa^2}{10000}$. When investors take as given their information processing capacity, κ, this figure shows that an increase in the prior variance of the first asset payoff generates a decrease in the expected price of the first and the second asset.

6 Empirical Application

This section presents evidence supporting the predictions of the model by studying financial contagion from Asia to Latin America, complementing empirical studies in the area of financial crises and contagion, such as Boyer, Kumagai and Yuan (2006), who show that stock market crises are spread globally through asset holdings of international investors.

We focus on Latin American emerging markets since contagion from Asia to Latin American markets has motivated most of the recent contributions on the financial contagion literature. The period of time examined, January 1997 - July 1998, corresponds to the time window selected by Nouriel Roubini in the "Chronology of the Asian Currency Crisis and its Global Contagion".[12] The *key* predictions of our model can then be stated as:

Prediction 1: (from Proposition 3) The higher the price volatility of the Asian market, the more relative attention allocated to the Asian market. Moreover, for unexpected shocks to the Asian market (total investor attention remains unchanged), the higher the price volatility of the Asian market, the higher the amount of attention allocated to the Asian market and the lower the amount of attention allocated to Latin American markets.

Prediction 2: (from Proposition 5) The more relative attention allocated to the Asian market, the higher the price volatility of Latin American markets. This prediction requires a clarification though, since there are two parameter restrictions to be satisfied: the two asset markets must be not perfectly symmetric and the prior variance of payoffs and noisy supply must be high enough. Given that we study contagion between countries of different regions, it is reasonable to assume that asset markets are somehow different, so that the first condition is satisfied. In addition, it is reasonable to assume that there was a significant amount of uncertainty in all asset markets since we are analyzing a financial crisis period, so that the second condition holds as well.

Prediction 3: (from Proposition 6) The more relative attention allocated to the Asian market, the lower the expected prices of Latin American markets.

[12] http://www.roubini.com

6.1 Data: Measuring prices, volatilities, and attention

The data used in this paper come from two main sources: the Datastream Global Index and the Lexis Nexis Database. We have a time series of daily observations for Argentina, Brazil, Chile, Thailand and Asia between January 1st, 1997, and June 30th, 1998. The reason to select Argentina, Brazil and Chile to study financial contagion from Asia to Latin America is that these are the most relevant countries in economic terms of Latin America.

The beginning of the East Asian crisis is considered to be on July 2nd, 1997, with the devaluation of the Thai Baht, although there were speculative attacks on the currency before that date. There was financial turbulence until June 1998, which is considered the end of the Asian financial turmoil. Since there is evidence of speculative attacks on Thailand, we assume that investors were updating their beliefs about the stock market volatility of Asia.

The *price* (index) for each country, which is obtained from Datastream Global Index, measures a country's daily market capitalization.[13] We normalize it to 100 for each country at our base date (January 1st, 1997). The *price volatility* is estimated from a Generalized Autoregressive Conditional Heteroskedastic (GARCH) model for the stock daily price index, which is a standard procedure in the literature.[14] We use the simplest GARCH (1, 1) model, forecasting the variance of date t price as a weighted average of a constant, past variance and past shock.[15] Finally, *attention* to a country is measured as the number of news articles in the Financial Times about this country, which are obtained from the Lexis Nexis Database.[16] More specifically, our measure captures the number of daily news articles in the Financial Times with the name or adjective of the country in the title or lead paragraph of the article. The news articles in the Financial Times about Thailand, Argentina, Brazil and Chile are used

[13] http://product.datastream.com/navigator/HelpFiles/DatatypeDefinitions/en/3/PI.htm

[14] The Generalized Autoregressive Conditional Heteroskedastic (GARCH) models, introduced by Engle (1982) and Bollerslev (1986), have been proposed to capture the empirical properties of financial time series like changing volatility and volatility clustering.

[15] Daily financial returns (and daily stock returns, in particular) are commonly modeled as GARCH(1, 1) processes, and they appear to be reasonably adequate in terms of reproducing various aspects of nonlinear serial dependence (Ashley and Patterson, 2010).

[16] The Financial Times is a British international business newspaper which reports extensively on business and features extensive share and financial product listings. It also has a sizeable network of international reporters -about 110 of its 475 journalists are based outside the UK. The Financial Times is usually written in two sections. The first section covers national and international news, while the second section covers company and market news.

as a proxy for *absolute attention* to Asian, Argentinean, Brazilian and Chilean stock markets, respectively. We use the ratio of Thailand news over the sum of news on Argentina, Brazil and Chile as our measure of *relative attention* to Asia.[17]

Are the news articles in the Financial Times (FT) about a country a reasonable proxy for attention allocation to that country? Over 1.8 million readers in more than 140 countries rely on the FT for timely and objective coverage of key events across the globe. Here, the FT is assumed to match the amount of attention allocated to each country by the representative international investor. In other words, we assume that news stories in the FT are driven by investors' demand for information and investors process information about international financial markets by reading the FT. The higher the number of news articles about a country, the more attention is allocated to that country. This assumption seems to be reasonable and empirically plausible given that circulation of the FT is the highest among financial newspapers in the world, after the Wall Street Journal, from which we do not have available data.

Table 1 displays the key descriptive statistics for our analysis, namely the daily stock market price indexes and their volatilities in Argentina, Brazil, Chile and Asia, and the daily number of FT news articles on Argentina, Brazil, Chile and Thailand over the period of analysis, from January 1st of 1997 through June 30th of 1998. The differences between the maximum and the minimum price volatilities are around 8000 in Asia, 10000 in Argentina, 11000 in Chile, and 13000 in Brazil. The average FT news on Argentina is 3, on Brazil is 5, on Chile is 1.4, and in Thailand about 4.7.

We complement the information in Table 1 with Figure 4, which contains the time series on the price volatilities in Argentina, Brazil, Chile, and Asia, and the number of FT news on Thailand during the period under analysis. A simple visual inspection of Figure 4 indicates that the volatilities among these countries are positively correlated, and that the number of FT news on Thailand and the volatilities in these countries are positively related as well. While

[17] We use news stories about Thailand as a measure of attention allocated to Asia to avoid double-counting of news articles in the Financial Times, since most articles about Asian countries during the period of turmoil used to cite Thailand as the country that was first hit by the crisis.

Table 1: Descriptive Statistics. Daily Data. Period: January 1st 1997 – June 30th 1998.

	N	Mean	Median	SD	Min	Max
Price Index of Argentina	390	120.90	121.42	9.60	98.61	142.08
Price Index of Brazil	390	113.17	109.22	15.24	85.46	142.70
Price Index of Chile	390	111.16	112.13	13.51	83.26	134.07
Price Index of Asia (t-1)	389	87.18	90.78	13.04	61.08	109.32
Price Index Volatility of Argentina	389	14736.05	14771.39	2252.418	9884.94	20050.48
Price Index Volatility of Brazil	389	13052.47	11941.77	3463.67	7327.53	20330.10
Price Index Volatility of Chile	389	12545.08	12568.79	2984.04	6933.02	17961.56
Price Index Volatility of Asia (t-1)	388	7765.17	8263.25	2263.95	3731.86	11920.50
Financial Times (FT) News on Argentina (A)	390	2.97	3	2.21	0	12
Financial Times News on Argentina if A > 0	347	3.34	3	2.06	1	12
Financial Times News on Brazil (B)	390	4.97	5	3.42	0	26
Financial Times News on Brazil if B > 0	372	5.21	5	3.32	1	26
Financial Times News on Chile (C)	390	1.40	1	1.39	0	9
Financial Times News on Chile if C > 0	273	2.00	2	1.24	1	9
Financial Times News on Thailand (T)	390	4.67	4	2.92	0	24
Financial Times News on Thailand if T > 0	378	4.82	4	2.85	1	24
Relative FT News on Thailand (T/A+B+C)	380	0.68	0.5	0.70	0	6
Relative FT News on Latin America (A+B+C/T)	378	2.84	2	2.65	0	19

Notes. Price Index is the default price index by Datastream Global Index, which measures a country's daily market capitalization, normalized to 100 for each country at our base date (1/1/1997). Price Index Volatility is estimated from a GARCH (1, 1) of the country stock Price Index with daily data from January 1st 1997 through June 30th 1998.

these two observations are consistent with predictions 1 and 2, they do not constitute clean tests of them for several reasons. Perhaps, the two most substantial ones are that the time structure of events is not yet defined and that the presence of many potential confounding factors is not accounted for.

6.2 Time structure and econometric specification

We define financial contagion from *Asia* to *Latin America* as:

$$\frac{dVol_t^{Latin\ America}}{dVol_{t-1}^{Asia}} > 0 \tag{9}$$

where $Vol_t^{Latin\ America}$ is a measure of the daily stock market price volatility in *Latin America*.[18] The correlation between the stock market volatility in Latin America at t and that of Asia at $t-1$ in our sample is 0.74 (p-value < 0.01).

Table 2 shows that all the correlation coefficients of the volatilities between the selected Latin American countries (Argentina, Brazil, and Chile) and Asia are positive and statistically significant. While the volatility correlations with Asia are larger than 0.85 for Brazil and Chile, the correlation corresponding to Argentina is smaller (lower than 0.30), suggesting that financial contagion is more severe from Asia to Brazil and Chile.

To understand the role of the subindex t, it is important to note the time difference between Asia (specifically, Thailand), London (where the Financial Times is edited) and Latin American countries. The time zone of Thailand is GMT +07:00, London is GMT, Brazil and Argentina are GMT –03:00 and Chile is GMT –04:00. When the Thai stock market opens on a particular date, the news articles of the Financial Times in London are already written. Hence, current volatility in Asia appears as news stories in the Financial Times the following

[18] There are many different definitions of financial contagion. What we call financial contagion might be called financial interdependence by other authors. See Fry, Martin and Tang (2010) for a recent class of tests of contagion.

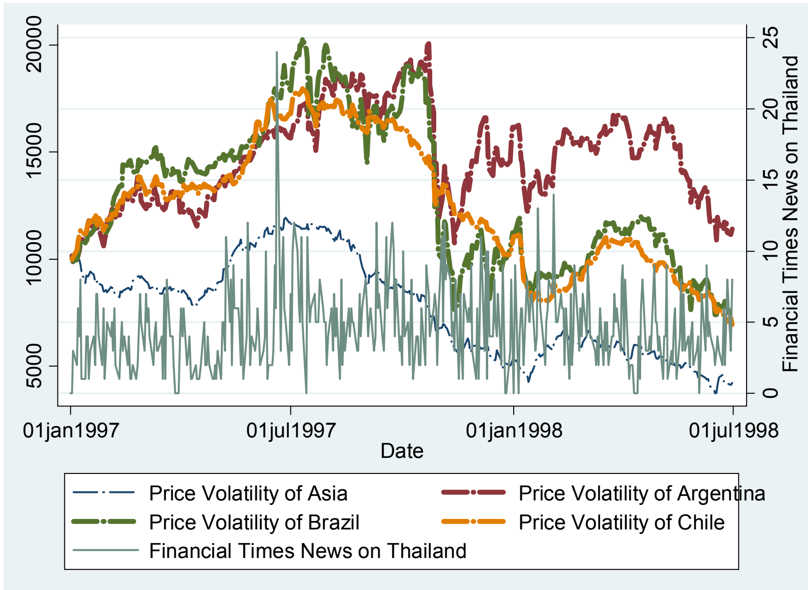

Figure 4: Evolution of price volatilities in Asia and Latin American countries and FT news about Thailand.

Table 2: Correlations between Asian and Latin American Price Index Volatilities. Daily Data. Period: January 1st 1997 – June 30th 1998.

	Volatility Argentina (t)	Volatility Brazil (t)	Volatility Chile (t)
Volatility Asia (t)	0.2554***	0.8561***	0.8781***
	(0.000)	(0.000)	(0.000)
	389	389	389
Volatility Asia (t-1)	0.2654***	0.8607***	0.8851***
	(0.000)	(0.000)	(0.000)
	388	388	388
	Log Volatility Argentina (t)	**Log Volatility Brazil (t)**	**Log Volatility Chile (t)**
Log Volatility Asia (t)	0.2292***	0.8651***	0.8787***
	(0.000)	(0.000)	(0.000)
	389	389	389
Log Volatility Asia (t-1)	0.2383***	0.8689***	0.8862***
	(0.000)	(0.000)	(0.000)
	388	388	388

Notes. Volatility is the Price Index Volatility, which is estimated from a GARCH (1, 1) of the country stock Price Index with daily data from January 1st 1997 through June 30th 1998. Log volatility is the log of the Price Index Volatility. p-values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

day. In other words, previous day Asian volatility will be reflected in current Asian news articles. When Latin American stock markets open on a particular date, the Asian stock markets are closing. Hence, today's Latin American stock market volatility does not have any effect in today's Asian stock market volatility.

Given the time structure and according to our theoretical model, financial contagion from *Asia* to *Latin America* can be decomposed into two channels:

$$\frac{dVol_t^{Latin\ America}}{dVol_{t-1}^{Asia}} = \underbrace{\frac{\partial Vol_t^{Latin\ America}}{\partial Vol_{t-1}^{Asia}}|_{RA_t^{Asia}=0}}_{direct\ channel} + \underbrace{\frac{\partial Vol_t^{Latin\ America}}{\partial RA_t^{Asia}} \frac{\partial RA_t^{Asia}}{\partial Vol_{t-1}^{Asia}}}_{indirect\ channel} \tag{10}$$

where RA_t^{Asia} is the attention allocated to Asia *relative* to Latin America. The first term in the RHS of (10) captures a *direct* channel of contagion: an increase in the stock market price volatility of Asia affects the stock market price volatility of Latin America when the relative allocation of information is fixed, i.e., when international investors do not modify their relative attention allocation. The second term in the RHS of (10) captures an *indirect* channel of contagion: an increase in the stock market price volatility of Asia affects the relative attention allocated to this region, and *the change in relative attention allocation affects the stock market price volatility of Latin America.* This is the **attention reallocation** effect.

In practice, the decomposition of financial contagion into direct and indirect effects can be thought of as coming from the following linear system of equations:

$$RA_t^{Asia} = \alpha^{RA} + \beta^{RA} Vol_{t-1}^{Asia} + X_t' \Phi^{RA} + \varepsilon_{RA,t}^{Asia} \tag{11}$$

$$Vol_t^{Latin\ America} = \pi^{LA} + \rho^{LA} Vol_{t-1}^{Asia} + \gamma^{LA} RA_t^{Asia} + X_t' \Gamma^{LA} + u_t^{LA} \tag{12}$$

where X is a vector of control variables: a year indicator, a quadratic daily time trend, day-of-week indicators, and US interest rates (US Treasury Bills: daily 3-month, 6-month, 5-year, and 10-year). The purpose of adding these controls is to account for standard mechanisms such as financial links, release of new information, or wealth effects and their correspondent exchange rate movements or IMF responses.[19] As long as (11) is well specified, estimation by OLS gives us a consistent estimate of β^{RA}.[20] According to **Prediction 1**, $\beta^{RA} > 0$, i.e., the higher the price volatility of the Asian market, the more relative attention allocated to the Asian market.

In addition, for unexpected shocks to the Asian market (total investor attention remains unchanged), the higher the price volatility of the Asian market, the higher the amount of attention allocated to the Asian market and the lower the amount of attention allocated to Latin America. Hence, if we specify the following linear model of (absolute) attention to Asia (A^{Asia}) and to Latin America (A^{LA}):

$$A_t^{Asia} = \alpha^{AAsia} + \beta^{AAsia} Vol_{t-1}^{Asia} + X_t' \Phi^{AAsia} + \varepsilon_{AAsia,t}^{Asia} \tag{13}$$

and

$$A_t^{LA} = \alpha^{ALA} + \beta^{ALA} Vol_{t-1}^{Asia} + X_t' \Phi^{ALA} + \varepsilon_{ALA,t}^{LA} \tag{14}$$

we expect $\beta^{AAsia} > 0$ and $\beta^{ALA} < 0$.

More problematic is the estimation of (12). As it is well known from the path analysis literature (Pedhazur, 1997), RA_t^{Asia} might seem insignificant in (12) because of the correlation between Vol_{t-1}^{Asia} and RA_t^{Asia}: the variation of the RA_t^{Asia} is mostly explained by Vol_{t-1}^{Asia}. A more important concern in estimating (12) is that, given the *simultaneity* implied by equations (11) and (12), we cannot estimate ρ^{LA} and γ^{LA} consistently without additional information, i.e., exclusion restrictions (at least one variable affecting RA_t^{Asia} but not Vol_{t-1}^{Asia}, and at least one variable affecting Vol_{t-1}^{Asia} but not RA_t^{Asia}). Indeed, the literature on potential outcomes has highlighted the intrinsic difficulties in distinguishing between direct and indirect effects.

Given these concerns we will present two different approaches. The first approach, the naïve one, consists in estimating (12) without including Vol_{t-1}^{Asia} by OLS. In practice, however,

[19] The year indicator is useful in capturing phenomena like the period after October 17$^{\text{th}}$, 1997, where there was a change in the level of international stock markets because of the Hang Seng collapse

[20] We also present TOBIT estimates to account for censoring of the attention variable at zero.

we have a system of equations, one for each Latin American country under analysis:

$$Vol_t^{Argentina} = \pi^{Arg} + \gamma^{Arg} RA_t^{Asia} + X_t' \Gamma^{Arg} + u_t^{Arg} \tag{15}$$

$$Vol_t^{Brazil} = \pi^{Bra} + \gamma^{Bra} RA_t^{Asia} + X_t' \Gamma^{Bra} + u_t^{Bra} \tag{16}$$

$$Vol_t^{Chile} = \pi^{Chi} + \gamma^{Chi} RA_t^{Asia} + X_t' \Gamma^{Chi} + u_t^{Chi} \tag{17}$$

Hence, we estimate equations (15)-(17) by seemingly unrelated regressions (SUR), allowing u_t^{Arg}, u_t^{Bra} and u_t^{Chi} to be correlated, which is useful when performing the joint test $\gamma^{Arg} = \gamma^{Bra} = \gamma^{Chi} = 0$. According to **Prediction 2**, $\gamma = (\gamma^{Arg}, \gamma^{Bra}, \gamma^{Chi}) > 0$, i.e., the more relative attention allocated to the Asian market, the higher the price volatility of Latin American (i.e., Argentinean, Brazil, and Chilean) markets. Of course, both potential omitted variables and measurement error in RA_t^{Asia} will tend to contaminate our estimate of $\gamma = (\gamma^{Arg}, \gamma^{Bra}, \gamma^{Chi})$. While the direction of the omitted variable bias is in principle unknown, classical measurement error in RA_t^{Asia} will tend to produce attenuation bias (bias towards zero).

To overcome these pitfalls, we estimate equations (15)-(17) using 2SLS, where RA_t^{Asia} (the ratio of FT news on Thailand over the sum of FT news about Argentina, Brazil and Chile) is instrumented with non-financial news from the Daily Mirror on Argentina, Brazil and Chile[21]: (1) non-financial news about Argentina, Brazil and Chile may lead investors to allocate more attention to those countries (*relevance* condition), but (2) should not be directly related to stock volatility of those countries (*exogeneity* condition).

[21] Founded in 1903, the Daily Mirror is one of Great Britain's largest tabloid newspapers. Best described as a national, mass market newspaper, it has almost nine million adult readers a day. Coverage includes local, national, and international reporting of news, sports and features. The information was obtained from the 2011 LexisNexis, a division of Reed Elsevier Inc.

Finally, our model has a third prediction regarding prices in Latin American markets and relative attention to Asia, which can be tested with the following empirical model:

$$PI_t^{Argentina} = \lambda^{Arg} + \sigma^{Arg} PI_{t-1}^{Asia} + \delta^{Arg} RA_t^{Asia} + X'\Sigma^{Arg} + e_t^{Arg} \tag{18}$$

$$PI_t^{Brazil} = \lambda^{Bra} + \sigma^{Bra} PI_{t-1}^{Asia} + \delta^{Bra} RA_t^{Asia} + X'\Sigma^{Bra} + e_t^{Bra} \tag{19}$$

$$PI_t^{Chile} = \lambda^{Chi} + \sigma^{Chi} PI_{t-1}^{Asia} + \delta^{Chi} RA_t^{Asia} + X'\Sigma^{Chi} + e_t^{Chi} \tag{20}$$

As before, given potential measurement error in RA_t^{Asia} and omitted variable bias concerns, we estimate (18)-(20) by both SUR and 2SLS. According to **Prediction 3**, $\delta = (\delta^{Arg}, \delta^{Bra}, \delta^{Chi}) < 0$, i.e., the more relative attention allocated to the Asian market, the lower the expected price of Latin American markets. Although this proposition makes a prediction regarding the expected price not the realized price, we follow standard practice and use the latter as a proxy for the former.

6.3 Empirical Findings

Evidence on the first prediction

Table 3 displays a series of regressions of attention measures on the price volatility (or log price volatility) of the Asian stock market and the aforementioned controls. The table contains two panels: The first one reports OLS estimates, while the second one reports TOBIT estimates, accounting for censoring of the attention variables at zero. Each panel contains two rows, I and II: I uses price volatility of Asia, and II uses its logarithm. In column (1) we estimate equation (11) and investigate the first component of **P1**: The higher the price volatility of the Asian market, the more relative attention allocated to Asia. Our measure of relative attention to Asia is the ratio of news stories about Thailand over the sum of news about Argentina, Brazil and Chile. Our prediction is confirmed: The higher is the price volatility in Asia, the higher is the relative number of news on Thailand. In addition, column (2) reports the estimates of the previous equation *but* using as a dependent variable the reciprocal of the relative number of news on Thailand (i.e., relative number of news on Latin America). As expected, we find the opposite pattern: The higher the price volatility in Asia, the lower the relative number of news on Latin America. The magnitudes of these estimates are not negligible. For example, a one standard deviation increase in Asian price volatility is associated with a 0.33 standard deviation increase in Thailand relative news, with the other variables held constant.[22]

The second component of **P1** is investigated in columns (3) and (4). In column (3) we estimate equation (13) and find that the daily Asian stock market price volatility at $t-1$ is positively associated with the daily number of news stories about Thailand in the Financial Times appeared at t (p-value < 0.05). Equation (14) is estimated in column (4): A higher price volatility in Asia is related to a smaller number of news about Latin America (p-value < 0.01). The results in these two columns indicate that for unexpected shocks to the Asian stock market (total investor attention remains unchanged), the higher the price volatility of the Asian market, the higher the amount of attention allocated to the Asian market and the lower the amount of attention allocated to Latin American markets. A one standard deviation increase in Asian price volatility is associated with a 0.25 standard deviation increase in Thailand news (or a 0.21 standard deviation decrease in Latin American news), with the other variables held constant.

The qualitative results using log volatility (in row II) are the same. In addition, the panel reporting the TOBIT results shows virtually identical point estimates. All in all, the evidence in Table 3 supports **P1**.

Interestingly, similar results to those reported in column (3) are found by Veldkamp (2006), who uses weekly data on 23 emerging stock markets between 1989 and 2002 and a weekly count

[22] A one standard deviation increase in Asian price volatility (i.e., a 2264 increase) is associated with a $0.0001 \times 2264 = 0.23$ increase in Thailand relative news. Since the standard deviation in Thailand relative news is 0.70, then $0.23/0.70 = 0.33$, i.e., a one standard deviation increase in Asian price volatility is associated with a 0.33 standard deviation increase in Thailand relative news.

Table 3: Regressions of Attention Measures on the Price Volatility of Asia. Daily Data. Period: January 1st 1997 – June 30th 1998.

$$\boldsymbol{Attention\ measure_t^j = \alpha^j + \beta^j Vol_{t-1}^{Asia} + X'\Phi^j + \varepsilon_t^j}$$

	Attention measure:			
	Thailand Relative News	LA Relative News	Thailand News	LA News
	(1)	(2)	(3)	(4)
OLS				
I. Vol_{t-1}^{Asia} = Volatility Asia				
$\boldsymbol{\beta}$	0.0001**	–0.0004***	0.0003**	–0.0005***
	(0.0000)	(0.0001)	(0.0001)	(0.0002)
R^2	0.11	0.08	0.14	0.17
II. Vol_{t-1}^{Asia} = Log Volatility Asia				
$\boldsymbol{\beta}$	0.713*	–2.89***	2.14*	–3.36*
	(0.386)	(0.947)	(1.09)	(1.78)
R^2	0.10	0.07	0.14	0.17
TOBIT				
I. Vol_{t-1}^{Asia} = Volatility Asia				
$\boldsymbol{\beta}$	0.0001**	–0.0004***	0.0003**	–0.0005**
	(0.0000)	(0.0001)	(0.0001)	(0.0002)
Pseudo-R^2	0.05	0.02	0.03	0.03
II. Vol_{t-1}^{Asia} = Log Volatility Asia				
$\boldsymbol{\beta}$	0.718*	–2.85***	2.23**	–3.20*
	(0.381)	(0.938)	(1.10)	(1.81)
Pseudo-R^2	0.05	0.02	0.03	0.03
Observations censored at 0	2	1	10	9
Observations	379	378	388	388

Notes. Thailand relative news (Thailand news over the sum of news on Argentina, Brazil and Chile) is a proxy for relative attention to Asia. LA (Latin America) relative news is the inverse of Thailand relative news. Thailand news is a proxy of absolute attention to Asia. LA news is a proxy of absolute attention to Latin America. *X* is a vector of control variables: year indicator, quadratic daily time trend, day-of-week indicators, and US interest rates (US Treasury Bills: daily 3-month, 6-month, 5-year, and 10-year). Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

of the number of news articles from the Financial Times that contain the name of the country or the adjective form of that name in the title or lead paragraph.[23]

Evidence on the second prediction

In Table 4 we present two panels of estimates of equations (15)-(17), focusing on days with *strictly* positive news ($N = 250$), i.e., restricting our attention to a case in which investors are processing information about financial markets by reading the Financial Times. In the first panel, estimation is performed by means of SUR, while in the second one we use 2SLS. The SUR estimates show that the higher is the attention allocated to Asia relative to Latin America (i.e., the relative number of news on Thailand), the higher are the price volatilities of the stock markets in Argentina, Brazil and Chile. A one standard deviation increase in relative attention to Asia is associated with a: 0.06 standard deviation increase in the Argentina stock market price volatility (albeit not statistically significant), 0.11 standard deviation increase in the Brazil stock market price volatility (p-value < 0.1), and 0.12 increase in the Chile stock market price volatility (p-value < 0.05). The Breusch-Pagan test of independence indicates that the errors in equations (15)-(17) are indeed correlated. In addition, we reject $\gamma^{Arg} = \gamma^{Bra} = \gamma^{Chi} = 0$ at the 10% level.[24]

In the second panel, we report the 2SLS estimates, which confirm the qualitative results from the SUR, supporting **P2**, although the magnitudes are much bigger: A one standard deviation increase in relative attention to Asia leads to increases in Latin American volatilities of at least 2 standard deviations. Part of this discrepancy may be well explained by the presence of measurement error in our attention variable, which will tend to bias towards zero our SUR estimates.

Taken altogether these results suggest that during the period under analysis the attention allocation mechanism played an important role in explaining financial contagion from Asia to Latin America. However, we must admit that we find evidence of weak instruments (the

[23] Veldkamp shows that asset payoff volatility generates demand for news, which in terms of attention allocation means that an increase in the variance of the asset payoffs causes an increase of attention allocated to that stock market. Panel A in Table A1 in the Appendix replicates Table 3 using weekly data, obtaining identical results. Hence, our results are robust to market microstructure issues.

[24] Panel B in Table A1 in the Appendix replicates Table 4 using weekly data, obtaining the same qualitative results. Hence, our results are robust to market microstructure issues.

F-statistic is far below 10), meaning that point estimates, hypothesis tests, and confidence intervals must be taken with caution.[25]

Evidence on the third prediction

In Table 5 we assess the empirical relevance of our last prediction, again focusing on days with *strictly* positive news ($N = 250$). The table contains two panels of estimates (SUR, 2SLS) of equations (15)-(18). The first panel shows that price indexes in Argentina, Brazil and Chile are negatively correlated with relative attention to Asia, although none of these relationships is statistically significant at conventional levels. In the second panel, the 2SLS estimates indicate that the previous estimates were severely downward biased, consistent with the results in Table 4. However, only one of the coefficients is statistically significant: A one standard deviation increase in relative attention to Asia leads to a one standard deviation decrease in the price index of Argentina.[26] Hence, the empirical support for **P3** is, if anything, limited.

Our empirical weak support for this last prediction may be a direct consequence of the additional layer of (classical) measurement error introduced by using (realized) price index as a proxy of expected price. Classical measurement error in the dependent variable raises the standard errors of our estimates, which will lead us to erroneously failing to reject the null hypothesis ($\delta = 0$) when indeed it is false (type II error).[27]

7 Conclusion

This paper presents a rational expectations model of asset prices with information processing constraints and explains the transmission of financial crises as a change in the attention

[25] Similar results are obtained when using the price index volatility of *Latin America* (see Panel A in Table A2 in the Appendix).

[26] Again, 2SLS estimates must be taken with caution.

[27] Similar results are obtained when using the price index of *Latin America* (see Panel B in Table A2 in the Appendix).

Table 4: Regressions of Price Volatility of Latin American countries on Relative Attention to Asia. Daily data. Period: January 1st 1997 – June 30th 1998.

$$Vol_t^{Argentina} = \pi^{Arg} + \gamma^{Arg} RA_t^{Asia} + X'\Gamma^{Arg} + u_t^{Arg}$$
$$Vol_t^{Brazil} = \pi^{Bra} + \gamma^{Bra} RA_t^{Asia} + X'\Gamma^{Bra} + u_t^{Bra}$$
$$Vol_t^{Chile} = \pi^{Chi} + \gamma^{Chi} RA_t^{Asia} + X'\Gamma^{Chi} + u_t^{Chi}$$

	Volatility Argentina (1)	Volatility Brazil (2)	Volatility Chile (3)
SUR			
$Vol =$ **Volatility**			
γ	179.71	537.71*	510.71**
	(252.29)	(324.37)	(200.70)
Breusch-Pagan test of independence		$\chi^2(3) = 401.31$*** p = 0.0000	
Test of $\gamma^{Arg} = \gamma^{Bra} = \gamma^{Chi} = 0$		$\chi^2(3) = 7.64$* p = 0.0540	
2SLS			
I. $Vol =$ **Volatility**			
γ	6478.72	11602.73*	8700.44*
	[4233.06]	[6301.66]	[4918.36]
Over-identifying restrictions test	$\chi^2(2) = 1.12$ p = 0.5705	$\chi^2(2) = 1.73$ p = 0.4214	$\chi^2(2) = 3.05$ p = 0.2177
II. $Vol =$ **Log Volatility**			
γ	2.05*	2.37*	2.18*
	[1.10]	[1.26]	[1.18]
Over-identifying restrictions test	$\chi^2(2) = 0.09$ p = 0.9565	$\chi^2(2) = 0.25$ p = 0.8846	$\chi^2(2) = 0.34$ p = 0.8421
Instrument relevance test		F(3,235) = 1.25 p = 0.2915	
Observations	250	250	250

Notes. RA is a proxy of relative attention to Asia (Thailand relative news = Thailand news over the sum of news on Argentina, Brazil and Chile). *X* is a vector of control variables: year indicator, quadratic daily time trend, day-of-week indicators, and US interest rates (US Treasury Bills: daily 3-month, 6-month, 5-year, and 10-year). RA is instrumented with 3 variables: Daily Mirror News on Argentina, Daily Mirror News on Brazil, and Daily Mirror News on Chile. Tests: Over-identifying restriction test (Hansen's J statistic); Instrument relevance test (first-stage robust F statistic). Standard errors in parentheses. Robust standard errors in brackets. *** p < 0.01, ** p < 0.05, * p < 0.1

Table 5: Regressions of Price Indexes of Latin American countries on Relative Attention to Asia. Daily data. Period: January 1st 1997 – June 30th 1998.

$$PI_t^{Argentina} = \lambda^{Arg} + \sigma^{Arg} PI_{t-1}^{Asia} + \delta^{Arg} RA_t^{Asia} + X'\Sigma^{Arg} + e_t^{Arg}$$
$$PI_t^{Brazil} = \lambda^{Bra} + \sigma^{Bra} PI_{t-1}^{Asia} + \delta^{Bra} RA_t^{Asia} + X'\Sigma^{Bra} + e_t^{Bra}$$
$$PI_t^{Chile} = \lambda^{Chi} + \sigma^{Chi} PI_{t-1}^{Asia} + \delta^{Chi} RA_t^{Asia} + X'\Sigma^{Chi} + e_t^{Chi}$$

	Price Index Argentina (1)	Price Index Brazil (2)	Price Index Chile (3)
SUR			
PI = Price Index			
$\boldsymbol{\delta}$	–1.08	–0.555	–0.121
	(0.904)	(1.14)	(0.608)
Breusch-Pagan test of independence		$\chi^2(3) = 287.31$*** p = 0.0000	
Test of $\delta^{Arg} = \delta^{Bra} = \delta^{Chi} = 0$		$\chi^2(3) = 1.72$ p = 0.6330	
2SLS			
I. PI = Price Index			
$\boldsymbol{\delta}$	–13.56*	–3.65	–9.47
	[8.17]	[5.37]	[6.87]
Over-identifying restrictions test	$\chi^2(2) = 7.58$** p = 0.0226	$\chi^2(2) = 3.96$ p = 0.1383	$\chi^2(2) = 3.97$ p = 0.1375
Instrument relevance test		F(3,234) = 1.27 p = 0.2849	
II. PI =Log Price Index			
$\boldsymbol{\delta}$	–0.425*	–0.318	–0.414*
	[0.256]	[0.196]	[0.245]
Over-identifying restrictions test	$\chi^2(2) = 1.19$ p = 0.5516	$\chi^2(2) = 0.82$ p = 0.6647	$\chi^2(2) = 0.92$ p = 0.6322
Instrument relevance test		F(3,234) = 0.99 p = 0.3978	
Observations	250	250	250

Notes. RA is a proxy of relative attention to Asia (Thailand relative news = Thailand news over the sum of news on Argentina, Brazil and Chile). *X* is a vector of control variables: daily stock (log) price index of Asia at (t-1), year indicator, quadratic daily time trend, day-of-week indicators, and US interest rates (US Treasury Bills: daily 3-month, 6-month, 5-year, and 10-year). RA is instrumented with 3 variables: Daily Mirror News on Argentina, Daily Mirror News on Brazil, and Daily Mirror News on Chile. Tests: Over-identifying restriction test (Hansen's J statistic); Instrument relevance test (first-stage robust F statistic). Standard errors in parentheses. Robust standard errors in brackets. *** p < 0.01, ** p < 0.05, * p < 0.1

allocation of investors over short periods of time.

Devaluations and defaults have triggered "fast and furious" financial contagion episodes in the last two decades. When a financial crisis hits a country, the amount of daily news, rumors and concerns increases dramatically. We model the process of attention allocation that underlies portfolio investment in international markets. Investors optimally allocate more attention to the region hit by a financial crisis, to the detriment of other regions. The resulting endogenous increase in the posterior volatility of asset payoffs causes a reduction in the willingness of bearing risks by international investors and an increase in the risk premium on all stock markets. Hence, investors liquidate their positions in the risky assets and there is a reduction of market liquidity that leads to an increase in price volatility and a collapse of asset prices in all emerging markets.

Financial contagion between two independent international stock markets arises even in the absence of correlated information shocks, correlated liquidity shocks, direct or indirect macroeconomic links and borrowing constraints, provided there is attention reallocation.

In the case where the limited information processing capacity is interpreted as a long term decision, an extension of the model allows one to distinguish between anticipated and unanticipated crises. This is the first theoretical model, to our knowledge, that points towards the degree of (non)anticipation of a financial crisis as the explanation of why some crises cause severe financial contagion and why others do not. If a financial crisis suddenly hits a country, investors are taken by surprise and there exists financial contagion through attention reallocation. However, if financial turbulence is anticipated, then more information processing resources are acquired and less attention needs to be reallocated when the financial crisis arises.

This extension provides an explanation for the existence of international credit rating agencies. The effects of financial contagion are less severe when financial crises are anticipated. Therefore, credit ratings by international agencies alert investors of possible future financial turbulence and help reduce the effects of financial contagion.

Using data from the East Asian crisis and the number of news stories about Thailand in the Financial Times relative to news stories about Argentina, Brazil and Chile as a proxy for the relative attention allocated to the Asian stock market, we find evidence consistent with two key predictions of our model: first, the higher the *price volatility* of the *originator market*, the more *relative attention* allocated to this market; and second, the more *relative attention* allocated to the originator market, the higher the *price volatility* of the *other markets*. Our findings support the attention reallocation channel as a transmission mechanism of financial crises between regions during the period from January 1997 to July 1998.

The future empirical research agenda on attention allocation as a financial contagion mechanism could complement and extend upon our empirical analysis by covering other countries, other crises, and longer time periods, even using ambitious identification strategies.

8 Appendix

8.1 Proof of Proposition 1

The objective function in the third period is a standard mean variance objective function. A closed form solution of a REE can be derived following Admati (1985). The equilibrium prices have the following form

$$\tilde{P} = A_0 + A_1\tilde{R} - A_2\tilde{Z}, \text{ with } A_2 \text{ nonsingular}$$

where

$$\begin{aligned}
A_0 &= \frac{\rho}{R}\left(\rho\Sigma_R^{-1} + \rho\Pi\Sigma_Z^{-1}\Pi + \Pi\right)^{-1}\left(\Sigma_R^{-1}\bar{R} + \Pi\Sigma_Z^{-1}\bar{Z}\right)\\
A_1 &= \frac{1}{R}\left(\rho\Sigma_R^{-1} + \rho\Pi\Sigma_Z^{-1}\Pi + \Pi\right)^{-1}\left(\Pi + \rho\Pi\Sigma_Z^{-1}\Pi\right)\\
A_2 &= \frac{1}{R}\left(\rho\Sigma_R^{-1} + \rho\Pi\Sigma_Z^{-1}\Pi + \Pi\right)^{-1}\left(I + \rho\Pi\Sigma_Z^{-1}\right)
\end{aligned}$$

Following Admati, we defined Π as the average precision matrix of the signals weighted by the risk tolerance coefficient.

$$\Pi = \left[\int_0^1 \rho\Sigma_i^{-1} di\right] \tag{21}$$

Intuitively, Π contains the average stock market information processed by the investors. The conditional distribution of $\tilde{R}$ given a private signal $\tilde{Y}_i$ and the equilibrium price vector $\tilde{P}$ is a multivariate normal with covariance matrix

$$V_i = Var\left[\tilde{R} \mid \tilde{Y}_i, \tilde{P}\right] = \left(\Sigma_R^{-1} + \Pi\Sigma_Z^{-1}\Pi + \Sigma_i^{-1}\right)^{-1}$$

The optimal asset holdings by an investor i, who observes the state of the world with a measurement error $\tilde{Y}_i$ and the equilibrium price vector $\tilde{P}$, are given by

$$X_i\left(\tilde{Y}_i, \tilde{P}\right) = G_{0i} + G_{1i}\tilde{Y}_i - G_{2i}\tilde{P}$$

where

$$\begin{aligned}
G_{1i} &= \rho\Sigma_i^{-1}\\
G_{2i} &= \rho R\left[(I + \rho\Pi\Sigma_Z^{-1})^{-1}\Sigma_R^{-1} + \Sigma_i^{-1}\right]\\
G_{0i} &= \rho G_0 = \rho(I + \rho\Pi\Sigma_Z^{-1})^{-1}\left(\Sigma_R^{-1}\bar{R} + \Pi\Sigma_Z^{-1}\bar{Z}\right)
\end{aligned}$$

For a more detailed solution see Admati (1985).

8.1.1 Proof of Proposition 2

In this proof, first we will characterize the optimization problem of an infinitessimal investor. Second, we will establish the existence of four potential linear symmetric equilibria and show that only one of them exists. Finally, we will show that no other linear rational expectations equilibrium exists.

The objective function of an infinitessimal agent in the second period is given by

$$EU_i = E\left\{E\left[-\exp\left(-\frac{W_i'}{\rho}\right) \mid \tilde{Y}_i, \tilde{P}\right]\right\}$$

By standard results from statistics, the expectation of a CARA utility function when the wealth is normally distributed can be written as a mean-variance objective function

$$EU_i = E\left\{-\exp\left(-\frac{1}{\rho}E\left[W_i' \mid \tilde{Y}_i, \tilde{P}\right] + \frac{1}{2\rho^2}Var\left[W_i' \mid \tilde{Y}_i, \tilde{P}\right]\right)\right\} \tag{22}$$

where

$$E\left[W_i' \mid \tilde{Y}_i, \tilde{P}\right] = W_{i0}R + \rho\left[E\left[\tilde{R} - R\tilde{P} \mid \tilde{Y}_i, \tilde{P}\right]\right]' Var\left[\tilde{R} \mid \tilde{Y}_i, \tilde{P}\right]^{-1}\left[E\left[\tilde{R} - R\tilde{P} \mid \tilde{Y}_i, \tilde{P}\right]\right]$$

and

$$Var\left[W_i' \mid \tilde{Y}_i, \tilde{P}\right] = \rho^2\left[E\left[\tilde{R} - R\tilde{P} \mid \tilde{Y}_i, \tilde{P}\right]\right]' Var\left[\tilde{R} \mid \tilde{Y}_i, \tilde{P}\right]^{-1}\left[E\left[\tilde{R} - R\tilde{P} \mid \tilde{Y}_i, \tilde{P}\right]\right]$$

Substituting the previous conditional expectation and variance into the mean-variance objective function given by (22), the objective function can be rewritten as

$$EU_i = E\left\{-\exp\left(-\frac{1}{2}\left[E\left[\tilde{R} - R\tilde{P} \mid \tilde{Y}_i, \tilde{P}\right]\right]' V_i^{-1}\left[E\left[\tilde{R} - R\tilde{P} \mid \tilde{Y}_i, \tilde{P}\right]\right] - \frac{RW_{i0}}{\rho}\right)\right\} \tag{23}$$

Define $\bar{R}^e = (\bar{r}_1^e, \bar{r}_2^e)'$ as the expectation of the conditional expected excess returns

$$\begin{aligned} \bar{R}^e &= E\left[\tilde{R} - R\tilde{P} \mid \tilde{Y}_i, \tilde{P}\right] \qquad (24) \\ &= \bar{R} - RE(\tilde{P}) \\ &= \bar{R} - RA_0 - RA_1\bar{R} + RA_2\bar{Z} \\ &= \left(\rho\Sigma_R^{-1} + \rho\Pi\Sigma_Z^{-1}\Pi + \Pi\right)^{-1}\bar{Z} \end{aligned}$$

where expressions for A_0, A_1 and A_2 are given in the proof of Proposition 1.

Define V_{ER} as the covariance matrix of the conditional expected excess returns

$$V_{ER} = Var\left(E\left[\tilde{R} - R\tilde{P} \mid \tilde{Y}_i, \tilde{P}\right]\right)$$

By standard results from statistics, if X and Y are arbitrary random variables for which the necessary expectations and variances exist, then $Var(Y) = E[Var(Y \mid X)] + Var(E[Y \mid X])$. Using this result, the covariance matrix of the conditional expected excess returns is given by

$$\begin{aligned} V_{ER} &= Var\left(E\left[\tilde{R} - R\tilde{P} \mid \tilde{Y}_i, \tilde{P}\right]\right) \\ &= Var\left(\tilde{R} - R\tilde{P}\right) - Var\left(\tilde{R} \mid \tilde{Y}_i, \tilde{P}\right) \\ &= \Sigma_R + R^2A_1\Sigma_RA_1' + R^2A_2\Sigma_ZA_2' - RA_1\Sigma_R - R\Sigma_RA_1' - V_i \\ &= Q - V_i \end{aligned}$$

where expressions for V_i, A_0, A_1 and A_2 are given in the proof of Proposition 1 and the matrix Q is defined as

$$Q = Var\left(\tilde{R} - R\tilde{P}\right) = \Sigma_R + R^2 A_1 \Sigma_R A_1' + R^2 A_2 \Sigma_Z A_2' - R A_1 \Sigma_R - R \Sigma_R A_1' \tag{25}$$

By standard results from statistics, if $w \sim N(0, \Sigma)$, then

$$E\left[\exp\left(w'Aw + b'w + d\right)\right] = |I - 2\Sigma A|^{-\frac{1}{2}} \exp\left(\frac{1}{2} b' (I - 2\Sigma A)^{-1} \Sigma b + d\right)$$

where A is a symmetric $m \times m$ matrix, b is an m-vector, d is a scalar, $|X|$ is the determinant of X and I is the identity matrix. For more details, see Brunnermeier (2001).

Using the previous result about the expectation of an exponential function and the definitions of $\bar{R}^e$ and V_{ER}, the objective function in equation (23) can be rewritten as

$$EU_i = -\left|QV_i^{-1}\right|^{-\frac{1}{2}} \exp\left(-\frac{1}{2}\bar{R}^{e\prime} Q^{-1} \bar{R}^e - \frac{RW_{i0}}{\rho}\right)$$

Because the investor has an infinitesimal measure, her decision does not have any effect on the price and therefore takes as given $\bar{R}^e$ and Q. Hence, the relevant term of the objective function for the optimization problem in the second period is given by

$$\max_{\{\kappa_{i1}, \kappa_{i2}\}} -\left|QV_i^{-1}\right|^{-\frac{1}{2}}$$

or equivalently given by

$$\max_{\{\kappa_{i1}, \kappa_{i2}\}} \log\left(\left|V_i^{-1}\right|\right) \tag{26}$$

The posterior covariance matrix V_i is given by equation (6) and it can be expressed by

$$V_i = \begin{pmatrix} \frac{1}{\sigma_{r1}^2} + \frac{\pi_{11}^2}{\sigma_{z1}^2} + \frac{\kappa_{i1}}{\sigma_{r1}^2} & 0 \\ 0 & \frac{1}{\sigma_{r2}^2} + \frac{\pi_{22}^2}{\sigma_{z2}^2} + \frac{\kappa_{i2}}{\sigma_{r2}^2} \end{pmatrix}^{-1} \tag{27}$$

where expressions for π_{11} and π_{22} are taken from each of the elements in the matrix Π given in equation (21). Taking the determinant of the covariance matrix V_i and substituting it into the objective function in equation (26), an infinitesimal investor maximizes the following objective function.

$$\max_{\{\kappa_{i1}, \kappa_{i2}\}} \log\left(\frac{1 + \kappa_{i1}}{\sigma_{r1}^2} + \frac{\pi_{11}^2}{\sigma_{z1}^2}\right) + \log\left(\frac{1 + \kappa_{i2}}{\sigma_{r2}^2} + \frac{\pi_{22}^2}{\sigma_{z2}^2}\right)$$

subject to the information resources constraint given by $\kappa_{i1} + \kappa_{i2} \leq \kappa$ and $\kappa_{i1} \geq 0$, $\kappa_{i2} \geq 0$. The investor when optimizing takes as given π_{11} and π_{22}. The attention allocation of investors is given by

$$\begin{aligned} \kappa_{i1} &= \begin{cases} \kappa & \text{if } \kappa \leq \frac{\sigma_{r2}^2 \pi_{22}^2}{\sigma_{z2}^2} - \frac{\sigma_{r1}^2 \pi_{11}^2}{\sigma_{z1}^2} \\ 0 & \text{if } \kappa \leq \frac{\sigma_{r1}^2 \pi_{11}^2}{\sigma_{z1}^2} - \frac{\sigma_{r2}^2 \pi_{22}^2}{\sigma_{z2}^2} \\ \frac{1}{2}\left(\kappa + \frac{\sigma_{r2}^2 \pi_{22}^2}{\sigma_{z2}^2} - \frac{\sigma_{r1}^2 \pi_{11}^2}{\sigma_{z1}^2}\right) & \text{otherwise} \end{cases} \\ \text{and } \kappa_{i2} &= \kappa - \kappa_{i1} \end{aligned} \tag{28}$$

This is the reaction function where investors take as given the aggregate variables of the economy.

Next, we will show the existence of a unique linear symmetric equilibrium. In a symmetric equilibrium, all investors choose the same attention allocation, $\kappa_{i1} = \kappa_1$ and $\kappa_{i2} = \kappa_2$ for any investor i, and therefore we can write each of the elements in the matrix Π, π_{11} and π_{22}, given in equation (21) as

$$\begin{aligned} \pi_{11} &= \frac{\rho}{\sigma_{i1}^2} = \rho \frac{\kappa_1}{\sigma_{r1}^2} \\ \pi_{22} &= \rho \frac{1}{\sigma_{i2}^2} = \rho \frac{\kappa_2}{\sigma_{r2}^2} \end{aligned} \tag{29}$$

There are four potential symmetric equilibria. First, a corner solution where all investors choose to allocate their attention to the first market, $\kappa_1 = \kappa$. For this case to constitute an equilibrium, we need to check that the condition in equation (28) for this outcome to be a best response given aggregates is satisfied. In this case, the condition is given by

$$\kappa \leq \frac{\sigma_{r2}^2 \pi_{22}^2}{\sigma_{z2}^2} - \frac{\sigma_{r1}^2 \pi_{11}^2}{\sigma_{z1}^2} = -\frac{\sigma_{r1}^2 \left(\rho \frac{\kappa_1}{\sigma_{r1}^2}\right)^2}{\sigma_{z1}^2}$$

This condition is never satisfied, and therefore we can rule out $\kappa_1 = \kappa$ as a symmetric equilibrium. Second, a corner solution where all investors choose to allocate their attention to the second market, $\kappa_1 = 0$. For this case to constitute an equilibrium, we need to check that the condition in equation (28) for this outcome to be a best response given aggregates is satisfied. In this case, the condition is given by

$$\kappa \leq \frac{\sigma_{r1}^2 \pi_{11}^2}{\sigma_{z1}^2} - \frac{\sigma_{r2}^2 \pi_{22}^2}{\sigma_{z2}^2} = -\frac{\sigma_{r2}^2 \left(\rho \frac{\kappa_2}{\sigma_{r2}^2}\right)^2}{\sigma_{z2}^2}$$

This condition is never satisfied, and therefore we can rule out $\kappa_1 = 0$ as a symmetric equilibrium. Finally, there are two other potential symmetric equilibria obtained from substituting π_{11} and π_{22} from equation (29) into the interior solution of the reaction function $\kappa_1 = \frac{1}{2}\left(\kappa + \frac{\sigma_{r2}^2 \pi_{22}^2}{\sigma_{z2}^2} - \frac{\sigma_{r1}^2 \pi_{11}^2}{\sigma_{z1}^2}\right)$ in equation (28). One of the solutions is given by

$$\kappa_1^+ = \begin{cases} \frac{\sigma_{r1}^2\sigma_{z1}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)+\sqrt{\left[\sigma_{r1}^2\sigma_{z1}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\right]^2-\rho^2\kappa\sigma_{r1}^2\sigma_{z1}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\left(\sigma_{r1}^2\sigma_{z1}^2-\sigma_{r2}^2\sigma_{z2}^2\right)}}{\rho^2\left(\sigma_{r1}^2\sigma_{z1}^2-\sigma_{r2}^2\sigma_{z2}^2\right)} & \text{if } \sigma_{r1}^2\sigma_{z1}^2 \neq \sigma_{r2}^2\sigma_{z2}^2 \\ \frac{1}{2}\kappa & \text{if } \sigma_{r1}^2\sigma_{z1}^2 = \sigma_{r2}^2\sigma_{z2}^2 \end{cases}$$

However, κ_1^+ can be ruled out as a symmetric equilibrium since if $\sigma_{r1}^2\sigma_{z1}^2 < \sigma_{r2}^2\sigma_{z2}^2$, then $\kappa_1^+ < 0$ and if $\sigma_{r1}^2\sigma_{z1}^2 > \sigma_{r2}^2\sigma_{z2}^2$, then $\kappa_1^+ > \kappa$. The other solution is given by

$$\kappa_1^- = \begin{cases} \frac{\sigma_{r1}^2\sigma_{z1}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)-\sqrt{\left[\sigma_{r1}^2\sigma_{z1}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\right]^2-\rho^2\kappa\sigma_{r1}^2\sigma_{z1}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\left(\sigma_{r1}^2\sigma_{z1}^2-\sigma_{r2}^2\sigma_{z2}^2\right)}}{\rho^2\left(\sigma_{r1}^2\sigma_{z1}^2-\sigma_{r2}^2\sigma_{z2}^2\right)} & \text{if } \sigma_{r1}^2\sigma_{z1}^2 \neq \sigma_{r2}^2\sigma_{z2}^2 \\ \frac{1}{2}\kappa & \text{if } \sigma_{r1}^2\sigma_{z1}^2 = \sigma_{r2}^2\sigma_{z2}^2 \end{cases}$$

Under this solution, the attention allocated to the first market, κ_1^-, is always between the bounds, $0 \leq \kappa_1^- \leq \kappa$, and therefore satisfies the conditions $\frac{\sigma_{r2}^2 \pi_{22}^2}{\sigma_{z2}^2} - \frac{\sigma_{r1}^2 \pi_{11}^2}{\sigma_{z1}^2} \leq \kappa$ and $\frac{\sigma_{r1}^2 \pi_{11}^2}{\sigma_{z1}^2} - \frac{\sigma_{r2}^2 \pi_{22}^2}{\sigma_{z2}^2} \leq \kappa$. Hence, κ_1^- is the unique linear symmetric equilibrium. By simplifying the terms inside the squared root when $\sigma_{r1}^2\sigma_{z1}^2 \neq \sigma_{r2}^2\sigma_{z2}^2$, the attention allocated to the first asset can be written as

$$\kappa_1^- = \begin{cases} \kappa_1^- = \frac{\sigma_{r1}^2\sigma_{z1}^2(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa)-\sqrt{\sigma_{r1}^2\sigma_{z1}^2\sigma_{r2}^2\sigma_{z2}^2(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa)(\sigma_{r1}^2\sigma_{z1}^2+\rho^2\kappa)}}{\rho^2(\sigma_{r1}^2\sigma_{z1}^2-\sigma_{r2}^2\sigma_{z2}^2)} & \text{if } \sigma_{r1}^2\sigma_{z1}^2 \neq \sigma_{r2}^2\sigma_{z2}^2 \\ \frac{1}{2}\kappa & \text{if } \sigma_{r1}^2\sigma_{z1}^2 = \sigma_{r2}^2\sigma_{z2}^2 \end{cases}$$

Finally, to show that the symmetric equilibrium κ_1^- is the unique linear rational expectations equilibrium, there is left to show that a linear asymmetric equilibrium does not exist. Any linear asymmetric equilibrium defines a unique aggregate π_{11} and π_{22}. As we have seen above, there is a unique solution to the optimal allocation of attention given aggregates π_{11} and π_{22} which is given by equation (28). Therefore, at least one type of investor has always incentives to deviate from any potential asymmetric equilibrium since there is always a unique solution to the attention allocation decision that is given by equation (28). Thus, a linear asymmetric equilibrium does not exist and the symmetric equilibrium is the unique linear rational expectations equilibrium.

8.2 Proof of Proposition 3

We will show that the derivative of κ_{i1}, given by equation (8), with respect to the asset payoff volatility, σ_{r1}^2, is positive $\frac{\partial\kappa_1}{\partial\sigma_{r1}^2} \geq 0$. If $\sigma_{r1}^2\sigma_{z1}^2 = \sigma_{r2}^2\sigma_{z2}^2$, then $\frac{\partial\kappa_1}{\partial\sigma_{r1}^2} = 0$. If $\sigma_{r1}^2\sigma_{z1}^2 \neq \sigma_{r2}^2\sigma_{z2}^2$, then $\frac{\partial\kappa_1}{\partial\sigma_{r1}^2}$ is given by

$$\begin{aligned} \frac{\partial\kappa_1}{\partial\sigma_{r1}^2} = & \frac{1}{\rho^2\left(\sigma_{r1}^2\sigma_{z1}^2-\sigma_{r2}^2\sigma_{z2}^2\right)^2 2\sqrt{\sigma_{r1}^2\sigma_{z1}^2\sigma_{r2}^2\sigma_{z2}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\left(\sigma_{r1}^2\sigma_{z1}^2+\rho^2\kappa\right)}} \\ & \Big\{-2\sigma_{z1}^2\sigma_{r2}^2\sigma_{z2}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\sqrt{\sigma_{r1}^2\sigma_{z1}^2\sigma_{r2}^2\sigma_{z2}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\left(\sigma_{r1}^2\sigma_{z1}^2+\rho^2\kappa\right)} \\ & -\sigma_{z1}^2\sigma_{r2}^2\sigma_{z2}^2\rho^2\kappa\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\left(\sigma_{r1}^2\sigma_{z1}^2-\sigma_{r2}^2\sigma_{z2}^2\right)+ \\ & -2\sigma_{r1}^2\left(\sigma_{z1}^2\right)^2\sigma_{r2}^2\sigma_{z2}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\left(\sigma_{r1}^2\sigma_{z1}^2-\sigma_{r2}^2\sigma_{z2}^2\right)+ \\ & +2\sigma_{r1}^2\left(\sigma_{z1}^2\right)^2\sigma_{r2}^2\sigma_{z2}^2\left(\sigma_{r2}^2\sigma_{z2}^2+\rho^2\kappa\right)\left(\sigma_{r1}^2\sigma_{z1}^2+\rho^2\kappa\right)\Big\} > 0 \end{aligned}$$

This expression is strictly positive for any parameter values, and therefore investors allocate more attention to first stock market, κ_{i1}, the higher the asset payoff volatility in the first market, σ_{r1}^2. Also notice that in the expression for κ_1^-, σ_{r1}^2 is always post-multiplied by σ_{z1}^2. Therefore, it must be also the case that $\frac{\partial\kappa_1}{\partial\sigma_{z1}^2} \geq 0$, investors allocate more attention to first stock market, κ_{i1}, the higher the asset supply volatility in the first market, σ_{z1}^2. Similarly, one can show that the attention to the first asset, κ_{i1}, is decreasing in the asset payoff volatility, σ_{r2}^2, and supply volatility, σ_{z2}^2 of the second asset.

8.3 Proof of Proposition 4

Financial crises are modeled as an increase in the variance of asset payoffs in one market. Therefore, it is enough to show that $Var\left[\tilde{r}_1 \mid \tilde{Y}, \tilde{P}\right]$ is increasing in $\sigma_{r,2}^2$ in order to prove volatility contagion when a region is hit by a financial crisis. The conditional variance of the first asset payoff is given in equation (27) and can be written as

$$Var\left[\tilde{r}_1 \mid \tilde{Y}_i, \tilde{P}\right] = \frac{1}{\frac{1}{\sigma_{r1}^2}+\frac{\pi_{11}^2}{\sigma_{z1}^2}+\frac{\kappa_{i1}}{\sigma_{r1}^2}}$$

Because in equilibrium all investors choose the same attention allocation, then π_{11} and π_{22} are given in equation (29) and $Var\left[\tilde{r}_1 \mid \tilde{Y}, \tilde{P}\right]$ can be written as

$$Var\left[\tilde{r}_1 \mid \tilde{Y}_i, \tilde{P}\right] = \frac{1}{\frac{1}{\sigma_{r1}^2} + \frac{\rho^2 \kappa_1^2}{\left(\sigma_{r1}^2\right)^2 \sigma_{z1}^2} + \frac{\kappa_1}{\sigma_{r1}^2}}$$

Then, $\frac{\partial Var\left[\tilde{r}_1 | \tilde{Y}, \tilde{P}\right]}{\partial \sigma_{r,2}^2}$ is given by

$$\frac{\partial Var\left[\tilde{r}_1 | \tilde{Y}, \tilde{P}\right]}{\partial \sigma_{r,2}^2} = -\frac{1}{\left(\frac{1}{\sigma_{r1}^2} + \frac{\rho^2 \kappa_1^2}{\left(\sigma_{r1}^2\right)^2 \sigma_{z1}^2} + \frac{\kappa_1}{\sigma_{r1}^2}\right)^2} \left(\frac{2\rho^2 \kappa_1}{\left(\sigma_{r1}^2\right)^2 \sigma_{z1}^2} + \frac{1}{\sigma_{r1}^2}\right) \frac{\partial \kappa_1}{\partial \sigma_{r2}^2} \geq 0$$

Therefore, $\frac{\partial Var\left[\tilde{r}_1 | \tilde{Y}, \tilde{P}\right]}{\partial \sigma_{r,2}^2} \geq 0$ because $\frac{\partial \kappa_1}{\partial \sigma_{r2}^2} \leq 0$ as shown in the proof of Proposition 3.

Similarly, one can show that the posterior variance of the second asset, $Var\left[\tilde{r}_2 \mid \tilde{Y}, \tilde{P}\right]$, is increasing with the prior variance of the first asset, σ_{r1}^2.

8.4 Proof of Proposition 5

We will show that the variance of $\tilde{p}_1$, where $\tilde{p}_1$ is given by (5), is increasing when there is a financial crisis in the second asset, that is modeled as an increase in $\sigma_{r,2}^2$. The variance of the price vector is given by $Var\left(\tilde{P}\right) = A_1 \Sigma_R A_1' + A_2 \Sigma_Z A_2'$. The variance of the first asset can be written as

$$Var\left(\tilde{p}_1\right) = \frac{1}{R^2} \left(\frac{1 + \frac{\rho \pi_{11}}{\sigma_{z1}^2}}{\frac{\rho}{\sigma_{r1}^2} + \frac{\rho \pi_{11}^2}{\sigma_{z1}^2} + \pi_{11}}\right)^2 \left(\sigma_{r,1}^2 \pi_{11}^2 + \sigma_{z1}^2\right)$$

where π_{11} and π_{22} in equilibrium when all investors choose the same attention allocation are given in equation (29). The expression for $\frac{\partial Var[\tilde{p}_1]}{\partial \sigma_{r,2}^2}$ is given by

$$\frac{\partial Var[\tilde{p}_1]}{\partial \sigma_{r,2}^2} = \frac{2}{R^2} \left(\frac{1 + \frac{\rho \pi_{11}}{\sigma_{z1}^2}}{\frac{\rho}{\sigma_{r1}^2} + \frac{\rho \pi_{11}^2}{\sigma_{z1}^2} + \pi_{11}}\right) \frac{\partial \pi_{11}}{\partial \sigma_{r2}^2} \times$$

$$\times \left[\left(\frac{\frac{\rho}{\sigma_{z1}^2}\left(\frac{\rho}{\sigma_{r1}^2} + \frac{\rho \pi_{11}^2}{\sigma_{z1}^2} + \pi_{11}\right) - \left(1 + \frac{\rho \pi_{11}}{\sigma_{z1}^2}\right)\left(1 + \frac{2\rho \pi_{11}}{\sigma_{z1}^2}\right)}{\left(\frac{\rho}{\sigma_{r1}^2} + \frac{\rho \pi_{11}^2}{\sigma_{z1}^2} + \pi_{11}\right)^2}\right) \left(\sigma_{r,1}^2 \pi_{11}^2 + \sigma_{z1}^2\right) + \sigma_{r,1}^2 \pi_{11} \left(\frac{1 + \frac{\rho \pi_{11}}{\sigma_{z1}^2}}{\frac{\rho}{\sigma_{r1}^2} + \frac{\rho \pi_{11}^2}{\sigma_{z1}^2} + \pi_{11}}\right)\right]$$

If $\sigma_{r1}^2 \sigma_{z1}^2 \neq \sigma_{r2}^2 \sigma_{z2}^2$, then $\frac{\partial \pi_{11}}{\partial \sigma_{r2}^2} < 0$ because $\frac{\partial \kappa_1}{\partial \sigma_{r2}^2} < 0$ as shown in the proof of Proposition 3. Given that $\frac{\partial \pi_{11}}{\partial \sigma_{r2}^2} < 0$, then the following condition

$$\rho^2 + \frac{\rho^4 \kappa_1^2}{\sigma_{r1}^2 \sigma_{z1}^2} < \sigma_{r1}^2 \sigma_{z1}^2 + \rho^2 \kappa_1$$

where κ_1 is given by (8) is sufficient to show that $\frac{\partial Var[\tilde{p}_1]}{\partial \sigma^2_{r,2}} > 0$.

8.5 Proof of Proposition 6

Financial crises are modeled as an increase in the variance of asset payoffs in one market. Expected asset prices can be written as

$$\bar{p}_1 = \tfrac{1}{R}\left(\bar{r}_1 - \bar{r}_1^e\right) \quad \bar{p}_2 = \tfrac{1}{R}\left(\bar{r}_2 - \bar{r}_2^e\right)$$

where the expected excess returns $\bar{R}^e = \left(\bar{r}_1^e, \bar{r}_2^e\right)'$ are given by equation (24) and they can be expressed by

$$\bar{R}^e = \begin{pmatrix} \frac{\rho}{\sigma^2_{r1}} + \frac{\rho\pi^2_{11}}{\sigma^2_{z1}} + \pi_{11} & 0 \\ 0 & \frac{\rho}{\sigma^2_{r2}} + \frac{\rho\pi^2_{22}}{\sigma^2_{z2}} + \pi_{22} \end{pmatrix}^{-1} \bar{Z}$$

where π_{11} and π_{22} in equilibrium when all investors choose the same attention allocation are given in equation (29). The expected excess return of the first risky asset in equilibrium when all investors choose the same attention allocation is given by

$$\bar{r}_1^e = \frac{\bar{z}_1}{\frac{\rho}{\sigma^2_{r1}} + \frac{\rho^3\kappa_1^2}{\left(\sigma^2_{r1}\right)^2\sigma^2_{z1}} + \frac{\rho\kappa_1}{\sigma^2_{r1}}}$$

Hence, it is enough to show that $\bar{r}_1^e$ is increasing in σ^2_{r2} in order to prove that the expected price of the first asset falls when there is a financial crisis in the second market, $\frac{\partial \bar{p}_1}{\partial \sigma^2_{r2}} \leq 0$. The expression for $\frac{\partial \bar{r}_1^e}{\partial \sigma^2_{r,2}}$ is given by

$$\frac{\partial \bar{r}_1^e}{\partial \sigma^2_{r,2}} = -\frac{\bar{z}_1}{\left(\frac{\rho}{\sigma^2_{r1}} + \frac{\rho^3\kappa_1^2}{\left(\sigma^2_{r1}\right)^2\sigma^2_{z1}} + \frac{\rho\kappa_1}{\sigma^2_{r1}}\right)^2}\left(\frac{2\rho^3\kappa_1}{\left(\sigma^2_{r1}\right)^2\sigma^2_{z1}} + \frac{\rho}{\sigma^2_{r1}}\right)\frac{\partial\kappa_1}{\partial\sigma^2_{r2}} \geq 0$$

Therefore, $\frac{\partial \bar{r}_1^e}{\partial \sigma^2_{r,2}} \geq 0$ because $\frac{\partial \kappa_1}{\partial \sigma^2_{r2}} \leq 0$ as shown in the proof of Proposition 3. This implies that the expected price of the first asset falls when there is an increase in the prior variance of the second asset $\frac{\partial \bar{p}_1}{\partial \sigma^2_{r2}} \leq 0$. Similarly, one can show that the expected price of the second asset, $\bar{p}_2$, falls when there is an increase in the prior variance of the first asset, σ^2_{r1}.

8.6 Proof of Proposition 7

First, we will write the optimization problem. Following the same steps as in the proof of Proposition 2, the objective function is given by

$$\max_{\kappa_i} -\left|QV_i^{-1}\right|^{-\frac{1}{2}} \exp\left(-\frac{1}{2}\bar{R}^{e\prime}Q^{-1}\bar{R}^e - \frac{RW_{i0}}{\rho} + \frac{R}{\rho}c(\kappa_i)\right)$$

Since the investor has an infinitesimal measure, her decision does not have any effect on the price and therefore take as given $\bar{R}^e$ and Q. Hence, the relevant term of the objective function for the optimization problem in the first period is given by

$$\max_{\kappa} \frac{1}{2} \log\left(\left|V_i^{-1}\right|\right) - \frac{R}{\rho} c(\kappa)$$

where V_i is given by equation (6) and each infinitesimal investor chooses the attention allocation given by equation (28). The investor when optimizing takes as given π_{11} and π_{22}. Second, taking the first order condition, we obtain the implicit equation that solves for κ

$$\frac{1}{4\sigma_{r1}^2\left(\frac{1+\frac{1}{2}\left(\kappa+\frac{\sigma_{r2}^2\pi_{22}^2}{\sigma_{z2}^2}-\frac{\sigma_{r1}^2\pi_{11}^2}{\sigma_{z1}^2}\right)}{\sigma_{r1}^2}+\frac{\pi_{11}^2}{\sigma_{z1}^2}\right)} + \frac{1}{4\sigma_{r2}^2\left(\frac{1+\frac{1}{2}\left(\kappa+\frac{\sigma_{r1}^2\pi_{11}^2}{\sigma_{z1}^2}-\frac{\sigma_{r2}^2\pi_{22}^2}{\sigma_{z2}^2}\right)}{\sigma_{r2}^2}+\frac{\pi_{22}^2}{\sigma_{z2}^2}\right)} - \frac{R}{\rho}c'(\kappa) = 0 \tag{30}$$

where π_{11} and π_{22} when all investors choose the same attention allocation are given in equation (29). This is the reaction function where investors take as given the aggregate variables of the economy. The second order condition is given by

$$\frac{-1}{8\left(\sigma_{r1}^2\right)^2\left(\frac{1+\frac{1}{2}\left(\kappa+\frac{\sigma_{r2}^2\pi_{22}^2}{\sigma_{z2}^2}-\frac{\sigma_{r1}^2\pi_{11}^2}{\sigma_{z1}^2}\right)}{\sigma_{r1}^2}+\frac{\pi_{11}^2}{\sigma_{z1}^2}\right)^2} + \frac{-1}{8\left(\sigma_{r2}^2\right)^2\left(\frac{1+\frac{1}{2}\left(\kappa+\frac{\sigma_{r1}^2\pi_{11}^2}{\sigma_{z1}^2}-\frac{\sigma_{r2}^2\pi_{22}^2}{\sigma_{z2}^2}\right)}{\sigma_{r2}^2}+\frac{\pi_{22}^2}{\sigma_{z2}^2}\right)^2} - \frac{R}{\rho}c''(\kappa) < 0$$

Note that the second order condition is always negative and therefore any κ that solves the first order condition in equation (30) is a maximum. Once the optimal amount of information resources is found, we still have to find the fix point where all investors choose the same information processing capacity, κ, in equilibrium.

Table A1: Robustness I. Weekly Data. Period: January 1st 1997 – June 30th 1998.

$$\boldsymbol{Attention\ measure_t^j = \alpha^j + \beta^j Vol_{t-1}^{Asia} + X'\Phi^j + \varepsilon_t^j}$$

	Attention measure:			
	Thailand News	LA News	Thailand Relative News	LA Relative News
	(1)	(2)	(3)	(4)
Panel A: OLS estimates				
$\boldsymbol{Vol}$ **= Volatility**				
$\boldsymbol{\beta}$	0.0003*	–0.0006**	0.0001***	–0.0004***
	[0.0002]	[0.0002]	[0.0000]	[0.0002]
Observations	77	77	77	77

$$\boldsymbol{Vol_t^{Argentina} = \pi^{Arg} + \gamma^{Arg} RA_t^{Asia} + X'\Gamma^{Arg} + u_t^{Arg}}$$
$$\boldsymbol{Vol_t^{Brazil} = \pi^{Bra} + \gamma^{Bra} RA_t^{Asia} + X'\Gamma^{Bra} + u_t^{Bra}}$$
$$\boldsymbol{Vol_t^{Chile} = \pi^{Chi} + \gamma^{Chi} RA_t^{Asia} + X'\Gamma^{Chi} + u_t^{Chi}}$$

	Volatility Argentina	Volatility Brazil	Volatility Chile
	(1)	(2)	(3)
Panel B: SUR estimates			
$\boldsymbol{Vol}$ **= Volatility**			
$\boldsymbol{\gamma}$	966.45*	1856.99***	1405.33**
	(527.00)	(616.39)	(415.42)
Breusch-Pagan test of independence		$\chi^2(3) = 162.87$*** p = 0.0000	
Test of $\boldsymbol{\gamma^{Arg} = \gamma^{Bra} = \gamma^{Chi} = 0}$		$\chi^2(3) = 14.24$*** p = 0.0026	
Observations	78	78	78

Notes. RA is a proxy of relative attention to Asia (Thailand relative news = Thailand news over the sum of news on Argentina, Brazil and Chile). *X* is a vector of control variables: year indicator, linear weekly time trend, and US interest rates (US Treasury Bills: daily 3-month, 6-month, 5-year, and 10-year). Standard errors in parentheses. Robust standard errors in brackets. *** p < 0.01, ** p < 0.05, * p < 0.1

Table A2: Robustness II. 2SLS estimates using Price Index and Volatility for Latin America. Period: January 1st 1997 – June 30th 1998.

$$Vol_t^{LA} = \pi^{LA} + \gamma^{LA} RA_t^{Asia} + X'\Gamma^{LA} + u_t^{LA}$$

	Volatility Latin America	O-IR Test	IR Test
Panel A:			
I. Vol = Volatility			
γ^{LA}	9205.85*	$\chi^2(2) = 1.12$	F(3,235) = 1.25
	(5306.45)	p = 0.5723	p = 0.2915
II. Vol = Log Volatility			
γ^{LA}	2.20*	$\chi^2(2) = 0.12$	F(3,235) = 1.25
	(1.18)	p = 0.9440	p = 0.2915

$$PI_t^{LA} = \lambda^{LA} + \sigma^{LA} PI_{t-1}^{Asia} + \delta^{LA} RA_t^{Asia} + X'\Sigma^{LA} + e_t^{LA}$$

	Price Index Latin America	O-IR Test	IR Test
Panel B:			
I. PI = Price Index			
δ^{LA}	–6.11	$\chi^2(2) = 8.01$**	F(3,234) = 1.27
	(6.52)	p = 0.0183	p = 0.2849
II. PI = Log Price Index			
δ^{LA}	–0.414	$\chi^2(2) = 0.76$	F(3,234) = 0.99
	(0.254)	p = 0.6841	p = 0.3978
Observations	250		

Notes. Volatility of Latin America is estimated from a GARCH (1, 1) of the Latin America stock price index with daily data from January 1st 1997 through June 30th 1998. Price Index is the default price index of Latin America provided by Datastream Global Index, which we have normalized to 100 at our base date (1/1/1997). X is a vector of control variables: year indicator, quadratic daily time trend, day-of-week indicators, and US interest rates (US Treasury Bills: daily 3-month, 6-month, 5-year, and 10-year). RA is instrumented with 3 variables: Daily Mirror News on Argentina, Daily Mirror News on Brazil, and Daily Mirror News on Chile. Tests: O-IR Test (Over-identifying restriction test: Hansen's J statistic); IR Test (Instrument relevance test: first-stage robust F statistic). Robust standard errors in parenthesis. *** p < 0.01, ** p < 0.05, * p < 0.1

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