Contagion and Information Frictions in Emerging Markets: The role of joint signals*

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Abstract

We show that information frictions can explain financial contagion without correlated fundamentals and explain why emerging markets are more susceptible to contagion. Costly information may cause investors to group country signals, because such imprecise signals are cheaper. These joint signals then cause asset prices to comove, which can be observed as contagion. Due to lower demand for country-specific information and lower risk weighted returns, it is likelier that investors group signals of emerging markets, thereby making them more prone to contagion. We find empirical evidence for our predictions using a novel data set on the number of joint news articles and exploit exogenous variation in news due to terrorism.

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1 Introduction

A feature of crises in emerging markets is that they often spill over and contagion is a real concern. According to Calvo and Mendoza (2000b), the spread of Thailand's financial crisis across East Asia in 1997 and the global financial disturbance following Russia's default in 1998 are broadly attributed to contagion effects through global financial markets. As Eichengreen et al. (1996) point out, a frequently cited reason for the assistance provided to Mexico in 1995 was that the Mexican crisis, if not stopped, would have serious effects in other emerging markets.

The topic of contagion has emerged with the Asian crisis[1] of the late 1990s. In addition to spreading throughout East Asia, the crisis went on to hit other emerging economies, particularly in Latin America in 1998. The fact that a regional phenomenon spread out so severely across the globe induced the need for further understanding of contagion. Interestingly, contagion is mostly a concern for emerging markets, around which much of the literature has revolved. Reinhart and Rogoff (2009, p. 243-244) list cases of bunched banking crises. They find that, with the exception of the Great Recession starting in 2007, there have been five global contagion episodes since World War II. All of these involved emerging markets or low income countries, with advanced economies having only been involved once. As Hutchison and Noy (2006) argue, emerging markets are different in regards to crisis susceptibility. Claessens (2005) also notes that it is mainly middle-income countries, i.e. emerging markets, that are exposed to financial contagion. It is especially surprising that contagion can happen among countries with seemingly uncorrelated, or at least imperfectly correlated fundamentals. We therefore view this puzzle as a matter of excess correlation among countries and link this to information frictions on the side of investors[2].

We show that information frictions play a role in explaining contagion with independent fundamentals and explain why emerging markets are more susceptible to contagion. Our paper has three main novelties. First, we consider both theoretically and empirically the type of information an agent receives, rather than just the amount. More specifically, we develop a model to analyze the effects of observing grouped signals, which are common to many countries vs. country-specific signals. Second, we find evidence that costly information, which results in grouped signals, can result in contagion. Unlike the literature, we do not simply look at the total number of news stories to proxy information, but distinguish between stories about a single country or many countries. Lastly, we offer an explanation for why emerging markets are more affected by contagion than developed or developing economies, which current models cannot explain. The reason is that emerging markets suffer more from information frictions.

The intuition for our results is that costly information may cause investors to group signals about countries, because such imprecise signals are cheaper, instead of obtaining detailed information for each country. The empirical evidence from Hameed et al. (2015) also suggests that investors tend to choose signals that are predictors of many assets[3]. This complementarity in information leads to complementarity in investors' behavior across countries. Therefore, if investors cut credit to one country, it may cause them to do the same

[1]The term "contagion" was introduced into the economic literature with the background of the Asian crisis (Claessens and Forbes (2004)). An analysis of the Asian crisis can be found e.g. in Perry and Lederman (1998).

[2]Boyer et al. (2006) for example show empirically that asset holdings of international investors are a channel through which stock market crises are spread globally.

[3]They find that analysts of American stock exchanges disproportionally follow firms who serve as good predictors for their peers. Furthermore, when earnings forecasts for such followed firms are revised, the prices of other firms are affected significantly.

in another, which is observed as contagion. Moreover, this information channel of contagion is stronger for emerging markets, as investors find it less worthwhile to obtain detailed information for such countries. This is because information discovery costs are high[4] and there is less demand for specific information on emerging markets due to a lower number of interested investors[5]. Such issues make country-specific information on emerging markets more expensive, partially because there are less investors to carry the fixed cost of information[6]. Furthermore, lower excess returns in emerging markets lower the benefits of detailed information. Nevertheless, for emerging markets, information costs are not likely to be high enough to result in no information whatsoever. If investors do not inform themselves at all, then there is no information induced contagion in our model, which explains why the least developed countries are rarely affected. Hence, it is most likely that investors group signals for emerging markets, which drives contagion in our model.

We find empirical evidence for our prediction that costly information can cause contagion and make it likelier for emerging markets. Many previous empirical studies on information frictions use the number of newspaper articles[7] to measure information flows. Using a novel data set, we go further and look at the type of news stories as an important factor. We consider news stories with a headline or first paragraph about a multitude of countries as joint signals. Our empirical results show that considering the type of information processed by agents matters and that joint news increases the comovement of asset prices across countries. We address endogeneity by using terror attacks, which crowd out other news, thereby generating exogenous financial news variation. The number of fatalities from a terror attack is used as an instrumental variable for joint news, as this likely proxies the extent of news coverage on the attack. Furthermore, the attacks in our sample are all relatively small and are not expected to affect the global economy. We find a negative relationship between grouped signals and market valuation as well as a positive relationship between grouped signals and the cost of information production, supporting the hypothesis that information frictions affect less developed countries to a higher degree. This evidence reinforces the importance of information frictions in international crisis contagion, highlighting a previously unexplored type of information friction in this context. A policy implication of our findings is that emerging markets can benefit from providing better and cheaper information.

In our paper, contagion is not considered in the sense of Dornbusch et al. (2000) as increased covariance of asset prices or financial flows after a shock, relative to this covariance in normal times. Rather, we examine it as steady excess covariance, which is particularly apparent when large disruptions, such as crises, occur. This is consistent with the finding of Forbes and Rigobon (2002), who show that for the 1997 Asian crisis and 1994 Mexican devaluation, there was a high level of comovement in all periods, but virtually no increase in correlation during the crisis. Similarly to Mondria and Quintana-Domeque (2013) we consider contagion as a price drop in one market due to a crisis in another, where the fundamentals of the two are independent. Contagion in our context is also similar to the definition of Calvo and Mendoza (2000b), who consider contagion as observed portfolio changes that are not a result of fundamentals.

The rest of this paper is structured as follows. Section 2 reviews the relevant literature, whereas section 3 presents the model. In section 4 we present the empirical evidence, while section 5 concludes.

[4]See e.g. Calvo (2004) and Kräussl (2005).

[5]Mondria et al. (2010) similarly expect larger countries to receive more attention.

[6]The result that the price of information can decrease with demand was prominently used in Veldkamp (2006b),Veldkamp (2006a) and Veldkamp and Wolfers (2007) as well.

[7]Examples include Fang and Peress (2009), Mondria and Quintana-Domeque (2013) and Veldkamp (2006b).

2 Literature Review

There is a large body of work dealing with international contagion, which has been nicely summarized in Dornbusch et al. (2000) and more recently in Forbes (2012). As they point out, the mechanisms are either through trade linkages, financial linkages, reassessments of fundamentals (wake-up calls) or country similarities such as macroeconomic characteristics or geographic proximity.

Not much attention has been given so far to information frictions as a reason for crises spreading among emerging markets. There is, however, reason to believe that information frictions are relevant in this context. Especially for the international crises in the mid to late 1990s, i.e. the Mexican crisis in 1994, the Asian crisis in 1997 and the Russian crisis in 1998, the role of information was seen as a possible explanation[8] for the observed vulnerability and the rapid transmission of shocks across countries. Furthermore, Calvo (2004) suggests the existence of high fixed costs in obtaining information and keeping up with the developments in emerging economies is an issue. Calvo and Mendoza (2000b) also argue that information frictions are very important for emerging markets. They claim that it is an empirical regularity that credit ratings of emerging markets are more volatile than others, meaning information plays a larger role here. Furthermore, they argue that empirically, information changes lead to larger adjustments for emerging markets than for OECD countries. Kräussl (2005) also provides empirical evidence that information frictions are a bigger issue in emerging markets than for developed countries, by examining the effects of public credit ratings. These ratings should have no substantial effect if investors are already informed about the countries, especially since these agencies do not have more access to information than private investors. He shows that credit ratings have a large influence on the volatility and volume of foreign credit in emerging markets, thereby indicating that information frictions play a role in there.

Several papers have focused on the role asymmetric information can play for contagion (Kodres and Pritsker (2002), Yuan (2005), Pasquariello (2007)). We will not rely on such differences in information, but instead focus on information frictions in the form of costly information for all investors. The two papers most related to ours are Calvo and Mendoza (2000b) and Mondria and Quintana-Domeque (2013), who study the spread of the East Asian Crisis. Another related paper is Veldkamp (2006a), who does not directly study contagion, but does have some relevant implications.

In Calvo and Mendoza (2000b) contagion is reflected in portfolio changes that are not a result of fundamentals. The information friction is that investors can acquire and process country-specific information at a fixed cost. In this model, the information frictions per se cannot produce contagion. Either short-selling constraints or portfolio manager performance costs are additionally necessary. A negative, but credible, rumor may have real effects in their model, since verifying the rumor may be too costly and it is believed otherwise. Short-selling constraints are required to prevent investors from taking full advantage of costly information. Alternatively, portfolio managers' performance costs can produce contagion, if the marginal cost of underperforming is larger than the marginal benefit of outperforming the market. There is then an equilibrium in which all investors hold the same portfolio. Furthermore, it is possible that a rumor calling for a different market portfolio can cause inefficient herding behavior[9], where all investors reset their portfolios. Unlike Calvo and Mendoza (2000b), we do not rely on rumors and in our model information frictions can

[8] See Calvo and Mendoza (2000a)

[9] Veldkamp (2006b) also studies herds in emerging equity markets, but does not discuss international contagion.

cause contagion even without short-selling constraints or performance costs.

Mondria and Quintana-Domeque (2013) apply the concept of rational inattention, i.e. investors' limited information processing ability, to the transmission of the Asian crisis in 1997 across countries. Contagion is defined there as an increase in uncertainty and a price drop in one market due to the occurrence of a crisis in another, without the two markets being linked by fundamentals. Attention of agents is assumed to be constrained as in rational inattention models[10]. Their mechanism of contagion entails the following chain of events: First, a crisis hits one market. Investors then shift their attention to this market to counter the increased uncertainty there. As attention is limited, this leads to attention being shifted away from the second market. Due to the agents having less information about the second market, it is now seen as more uncertain by the investors, who reduce their investment as a result.

Mondria and Quintana-Domeque (2013) make three theoretical predictions. First, higher volatility in the Asian markets should increase the relative attention to Asia. Second, the more relative attention given to Asia, the higher the volatility should be in Latin America. Lastly, more relative attention given to Asia, lowers expected prices in Latin American markets. The authors measure attention by counting the number of newspaper articles in the Financial Times (FT) with the name or adjective of a given country in the headline or first paragraph of the article. The number of articles in the FT about Thailand relative to those about Argentina, Brazil and Chile are used to proxy the relative attention of Asian to Latin American markets. Mondria and Quintana-Domeque find supporting empirical evidence for their predictions of an increase in Asian volatility leading to more attention being allocated to Asia (here Thailand) and less attention on the three Latin American countries. Furthermore, there is some empirical support for the hypothesis that more relative attention toward Asia leads to higher market volatilities in Latin American countries[11]. Finally, the authors also test if the price indices in Latin America are negatively correlated with the relative attention levels to Asia, but find very limited support for the hypothesis.

Unlike Mondria and Quintana-Domeque (2013), our model is not based on rational inattention, but rather on costly and noisy signals. We look at similar empirical data, but expand the number of countries considered. Unlike them, however, our data considers the type of news, namely whether a story is jointly related to several countries, or is focused on one country. Our model implies that investors may group signals, especially for emerging markets, which we proxy as joint news stories. It is precisely these joint news stories that drive contagion in our model.

Veldkamp (2006a) presents a model showing that information frictions can explain the excess covariance of asset prices[12]. In her context, when a piece of information can help forecast the value of many assets, and that information is observed by many investors, assets can exhibit excess covariance. Another interesting conclusion in Veldkamp (2006a) is that investors are more interested in assets that have a high value. The consequence of this is that information frictions will play a stronger role for less valuable assets, such as those in emerging markets. We present a similar insight and apply it to explain why contagion is seen more often in emerging markets than in developed economies. Our mechanism for excess covariance and our information production structure is similar to hers, with information that is demanded by many investors being

[10]For a review of the literature see Sims (2010), Veldkamp (2011) and Wiederholt et al. (2010).

[11]Although the authors admit the strength of this support is debatable.

[12]Veldkamp and Wolfers (2007) use a similar information friction argument, with imperfect information about productivity, to explain excessive comovement among the industries of a country instead of assets.

cheaper. As Veldkamp (2006a) points out, this resembles information markets in reality, with newspapers like the Wall Street Journal or the FT being much cheaper than specialized investment reports. Although our models are similar, there are some key differences. In Veldkamp (2006a), purchasing information about one asset can lead to excess covariance of two other assets, if the two other assets are correlated with the asset for which the information was purchased. However, such excess covariance requires the first asset to have some fundamental covariance with the other two. In our model, the result does not require any fundamental covariance. Furthermore, she does not analyze joint vs. specific signals as we do here. Lastly, information is modeled differently here. In her model, assets have a learnable and unlearnable component and agents can purchase full information about the learnable component. In our context, investors obtain a noisy signal and assets do not feature a learnable and unlearnable component explicitly.

3 A Model of Contagion and Information Frictions

This section introduces a model of information frictions that can lead to excess covariance among unrelated assets. The idea is that costly information can cause investors to group signals about several emerging market countries. In this case, the assets will be correlated due to the correlated information investors receive, even if the asset fundamentals are independent. Furthermore, this framework explains why contagion appears to be a bigger issue for emerging markets than for very developed or undeveloped countries. This is because information on small markets will be more expensive and the benefits from detailed information lower. This makes the grouping of information likelier, thereby inducing covariance in emerging markets. Furthermore, for the least developed countries, information costs can be so high that investors do not inform themselves at all, thereby not resulting in any information induced contagion there. While many studies examine the amount of information, our paper considers the type information as a new relevant channel.

There are two countries of equal size, M and R, indexed by the subscript $i \in \{M, R\}$. One can think of these countries for example as Mexico and Russia. There is a finite but large number λ of identical price-taking agents with mean-variance utility functions. The optimal portfolio and market prices under these preferences are equivalent to those under constant absolute risk aversion (CARA) utility functions, which are often assumed[13] in such models. Expected utility in vector notation is given by:

$$U = E[q'(E(\theta_i|S_j) - pr) - \frac{\rho}{2}q'Var(\theta_i|S_j)q - c_j] \tag{1}$$

Here q denotes the (2x1) vector of asset quantities purchased, p denotes the vector of asset prices, r is the risk free rate, $c_j = c(S_j)$ is the cost of the signal S_j, Var represents a variance covariance matrix and ρ is a preference parameter capturing risk aversion. To simplify notation, we will define $\hat{\mu} \equiv E(\theta_i|S_j)$ and $Var(\theta_i|S_j) \equiv \hat{\Sigma}$.

The fundamentals of each country are the asset returns, which are denoted θ_i and are normally distributed. It is common knowledge that they are independent of each other. The prior beliefs are:

[13] See e.g. Grossman and Stiglitz (1980), Veldkamp (2006a) and Van Nieuwerburgh and Veldkamp (2010).

$$\theta_i \sim N(\mu_{\theta_i}, \sigma^2_{\theta_i}) \text{ and } Cov(\theta_M, \theta_R) = 0 \quad (2)$$

Investors can purchase a noisy signal about the fundamentals, denoted S_j, $j \in \{M, R, B\}$. There are three signals being offered, a signal specific to country M, denoted S_M, a signal specific to R, S_R and a joint signal, S_B. The country-specific signals consist of the fundamental plus a zero mean noise term ϵ_i. The joint signal is a less precise signal about both country fundamentals.

$$S_i = \theta_i + \epsilon_i,\ S_B = g(\theta_M, \theta_R) + \epsilon_B,\ \epsilon_j \sim N(0, \sigma^2_{\epsilon_j}) \text{ and } \sigma^2_{S_B} > \sigma^2_{S_i} \quad (3)$$

Here $g(.)$ is a linear[14], positive, increasing function. Note that it is also possible to construct $S_B = g(S_M, S_R)$[15]. The returns θ_i and noise terms ϵ_j are independent of each other. Therefore, the country-specific signals S_j are independent of each other as well and have a bivariate normal distribution with the respective country fundamental.

In modeling information production we follow Veldkamp (2006a). Signals are produced with a fixed cost χ and no marginal cost. Agents cannot resell purchased information and there is perfect competition[16] in the production of information, which means that the price of a signal will be equal to its average cost[17]. Let λ_j denote the number of agents purchasing the signal S_j. Furthermore, I_j is an indicator variable equal to 1 if signal S_j is produced and zero otherwise. Formally, any agent producing a signal S_j solves:

$$\max_{c_j, I_j} \sum_j I_j(c_j \lambda_j - \chi) \quad (4)$$

The order of events is as follows. First, agents decide on what kind of signal to purchase. Then, the investment decision is made and lastly the payoffs are realized. The model is solved backwards.

As discussed, much of the literature has relied on asymmetric information to produce contagion. We will therefore instead focus only on symmetric equilibria. This provides the further advantage of a simpler, more tractable model. Therefore, in our model all agents make the same information choice and in equilibrium we have $\lambda_j \in \{0, \lambda\}$. In this case, to produce contagion, all agents must purchase the joint signal. With asymmetric information on the other hand, it suffices to show that some agents purchase the joint signal. Furthermore, our conclusion that contagion is a bigger issue for emerging markets will remain. This is because the excess covariance increases with the number of agents purchasing the joint signal and in an asymmetric equilibrium, more agents purchase the joint signal for emerging markets than other countries. Hence, considering asymmetric information would produce the same results for our purposes, but unnecessarily complicates the model. This leads to our following equilibrium definitions.

[14] For our purposes, a non-linear function works as well under the assumption that S_B and θ_i are jointly normal.

[15] Then, the derivative of g with respect to each signal must be sufficiently large to ensure the joint signal has higher variance than the specific signals. Furthermore, for contagion to be possible, the conditions derived later would imply a derivative of $g' < 1$.

[16] Veldkamp (2006b) discusses imperfect competition and finds similar properties of the information market equilibrium.

[17] This way of pricing information has also been used in Veldkamp (2006b) and Veldkamp and Wolfers (2007).

Definition 1. *A symmetric equilibrium is given by a set of asset demands q_i, asset prices p_i, signal prices c_j, signal supply decisions I_j and a symmetric signal demand choice λ_j, given the information structure (2), (3), rational expectations and noise shocks ϵ_i, such that:*

1. Given prices $\{p_i, c_j\}$ all agents choose whether to buy a signal S_j and then choose asset demands to maximize expected utility (1).

2. Signal prices c_j are a subgame-perfect Nash equilibrium that solves (4).

3. The markets for assets and information clear.

Definition 2. *A contagion equilibrium is a symmetric market equilibrium such that asset prices exhibit excess covariance.*

We first solve the portfolio problem. Let x denote the vector of asset supplies. The optimal portfolio and market price from solving the investor problem are:

$$q^* = \frac{1}{\rho}\hat{\Sigma}^{-1}[\hat{\mu} - pr] \tag{5}$$

$$p = \frac{1}{r}[\hat{\mu} - \rho\hat{\Sigma}x] \tag{6}$$

What remains is the optimal information choice. As the following proposition shows, the purchase of joint news is crucial in leading to contagion. Note that any correlation would be excessive, as the two countries' fundamentals are independent.

Proposition 1. *A symmetric market equilibrium is a contagion equilibrium if and only if the joint signal is purchased. The excess covariance tends to zero as the variance of the joint signal increases.*

Proof. Excess covariance is required for a contagion equilibrium. First, note that with perfect information the covariance should be zero, as the fundamentals are independent. Therefore, any covariance is excessive. Let $P_i(S_j)$ denote the price of asset i under signal S_j.

The covariance between the two prices if the country-specific signals are observed, $Cov(P_M(S_M), P_R(S_G))$, will be zero. This is because the only random variable in the asset price of a country is the country-specific signal, which is independent across countries. Hence, there will be no covariance. Similarly, with no information, there is also no covariance.

We now turn to the case where the investors observe the joint signal S_B. From equation (6) we have:

$P_M(S_B) = \frac{1}{r}\left[\mu_{\theta_M} + \frac{\sigma^2_{\theta_M}}{\sigma^2_{S_B}}[S_B - E(S_B)] - \rho x_M\, \sigma^2_{\theta_M}\left(1 - \frac{\sigma^2_{\theta_M}}{\sigma^2_{S_B}}\right)\right]$

$P_R(S_B) = \frac{1}{r}\left[\mu_{\theta_R} + \frac{\sigma^2_{\theta_R}}{\sigma^2_{S_B}}[S_B - E(S_B)] - \rho x_R\, \sigma^2_{\theta_R}\left(1 - \frac{\sigma^2_{\theta_R}}{\sigma^2_{S_B}}\right)\right]$

The covariance therefore is:

$$Cov(P_M(S_B), P_R(S_B)) = \frac{\sigma^2_{\theta_M}\sigma^2_{\theta_R}}{r^2\sigma^2_{S_B}} > 0$$

which is decreasing in $\sigma^2_{S_B}$. □

Since the same joint signal enters the portfolio decision for both assets, there is covariance between the markets, even though they are independent. The intuition for contagion is that, due to the joint signal, if asset sales are warranted in country M, leading to a crisis there, investors will also sell their assets in country R, thereby causing a crisis there as well. Hence, contagion becomes possible in this model. Furthermore, information frictions in the form of noisy signals alone are not sufficient for contagion, unless investors group signals. Interestingly, if the variance of the joint signal goes to infinity, making it uninformative, the excess covariance will also go to zero. This is because investors believe less in the joint signal, the less informative it becomes. In this case, a little information on both countries can be more harmful in terms of contagion than no information. We now turn to the conditions under which a contagion equilibrium occurs.

Proposition 2. *A contagion equilibrium exists if and only if $\sigma^2_{S_B} < \sigma^2_{S_i} + \sigma^2_{\epsilon_i}$ and one of the following conditions holds:*

1. Average information costs $\frac{\chi}{\lambda}$ are intermediate.
2. Average information costs are high and excess returns $(\mu_{\theta_i} - pr)$ are intermediate.
3. Agents inform themselves and $\sigma^2_{\epsilon_i}$ or $\sigma^2_{\theta_i}$ are sufficiently high.

Proof. See appendix. □

The exact ranges for the parameters are discussed in the proof. The restriction on $\sigma^2_{S_B}$ is to ensure that the joint signal is not strictly dominated. If such a signal is very noisy, it becomes useless and is therefore never purchased. Recall that the price of a signal is given by the average information costs. If signals are cheap, then the country-specific signals, which have better information content, will be purchased. Similarly, if signal prices are excessive, no information becomes optimal. Hence, the joint signal is only purchased for an intermediate level of average information costs, which depends negatively on the number of potentially interested investors λ. Therefore, larger countries have inherently cheaper country-specific information, if investors are home-biased. Furthermore, markets of developed countries, for which there is a lot of interest, will also have cheaper information and will be less likely to suffer from these types of information frictions.

Signal prices also depend positively on the cost of information discovery χ. We might expect the costs of information production to be larger in emerging markets than in developed countries, due to factors such as a lack of infrastructure or data quality issues. Calvo (2004) also argues that there are larger costs for information on emerging markets. Further, Calvo and Mendoza (2000b) as well as Kräussl (2005) find evidence that information issues may be larger in emerging markets. Such factors make contagion in less developed countries likelier. On the other hand, if information discovery costs are prohibitively high and no information is consumed, there will not be a contagion equilibrium.

The benefit from country-specific signals increases with the excess returns. Hence, if rich markets promise better returns, it is less likely for investors to group signals of those countries. If countries offer very low returns, then no information can again be optimal and investors do not purchase the joint signal. Lastly, if $\sigma^2_{\epsilon_i}$ or $\sigma^2_{\theta_i}$ are sufficiently high, then the country-specific signals become as noisy as the joint signal and offer no additional benefit. Hence, if no information is not optimal, then in this case the joint signal can become optimal. Such a case is also more realistic for emerging market countries.

In conclusion, we do not expect developed countries to be hit by contagion, while for emerging markets this becomes a real possibility. At the other extreme, investors may not purchase any information for the least developed countries, which means there is no information induced contagion for them. This can explain why contagion episodes are rarely observed among very developed or undeveloped countries. Therefore, our framework can explain why it is precisely emerging market countries that are more susceptible to contagion, as noted by Claessens (2005). This insight is summarized in the following corollary.

Corollary 1. *A contagion equilibrium is likelier for emerging market countries than for very undeveloped or developed countries.*

Contagion occurs here even though all agents are behaving rationally. With information frictions, the investors rationally do not find it worthwhile to strongly inform themselves about emerging markets, which in a way creates a negative externality. The empirical literature often sees contagion as a regional phenomenon[18]. This could arise in an extension of our model. Faced with the prospect of investing in many different countries and with different combinations of signals being offered, the investors may find it optimal to group signals of similar countries. Hence, the optimal joint signals are likely to contain groups of similar countries, which would lead to contagion among them.

4 Empirical Evidence

This section presents empirical evidence supporting the theoretical implications of our model. As stated in the introduction, our paper has three main novelties. The first is that we take into account differences in the information structure i.e. the type of information an agent receives as opposed to just the amount of information processed by agents. Of special interest for our propositions 1 and 2 are the existence of grouped signals – or joint news – that are processed by international investors. The second novelty is that the information structure can cause contagion i.e. joint news result in excess comovement of asset prices, which is our proposition 1. The last novelty is that our theory predicts joint signals to be more common for countries with intermediate cost of information, high information cost and intermediate excess returns or very volatile country-specific fundamentals or signals – our proposition 2 – which offers an explanation why contagion affects emerging markets countries more often.

Our data set covers the time period from January 1996 to December 1999. This time frame is selected as it includes the Asian Crisis of 1997-1998, the following crisis in Latin America as well as some time not marked by any specific crisis, or *tranquil*, for the included countries. The reason for this selection is that according to our theory, information frictions play a role in times of crisis as well as more tranquil times. During periods of crisis, however, the steady excess covariance of assets is especially apparent. The period from 1st January 1997 to 30th June 1998[19] is defined as the Asian crisis period.

[18] See e.g. Forbes and Warnock (2012).

[19] This coincides with the sample period from Mondria and Quintana-Domeque (2013).

To measure the information acquired by investors we choose an approach similar to the one used by Mondria and Quintana-Domeque (2013) and look at the number of daily articles covering countries in our sample that are published in the FT. The novelty of our dataset – in comparison to the data used by Mondria and Quintana-Domeque (2013) – is that we differentiate between single and joint news i.e. articles that cover a single country or several countries at once.

The reasons for choosing the FT are similar to the ones stated in Veldkamp (2006b, Page 586.) and Mondria and Quintana-Domeque (2013, Page 442.). The FT has 1.8 million readers in over 140 countries. It is published daily and therefore should reasonably match the rate in which newsworthy events occur and are absorbed by investors especially in times before the widespread spread of information distribution via the internet. Veldkamp (2006b) points out that out of a random sample of 100 relevant articles in the FT 97 contained information about the strength of the assets of a given country. The broad circulation of the FT, the fact that it is published in English and its global focus[20] makes it a reasonable proxy for global information about countries concerning mainly news that is relevant for economic topics. Furthermore, the focus on a single news source avoids the problem of double counting the investors' signals.

The argument for a piece of information appearing in the FT being also processed by investors follows the economic logic of the news market. An article about a certain event appears in the FT, because it is in high demand by investors. If the demand for a certain story by investors would be too low, for instance because it contains very specialized information, it would not be reported in the FT. If the FT would report too many low demand stories the interest of investors (or readers of the FT in general) would decrease and sales and subscription of the FT would drop. In order to remain profitable, the FT has to publish high demand stories. This is also consistent with the idea of endogenous information markets[21]. The high demand stories appearing in the FT are relatively cheap and consumed by a high number of readers, while the more specialized stories like specific country reports for investors are characterized by a lower demand and are relatively more expensive. If agents devote more attention to a country, the demand for articles about this country increases, thereby meaning these stories are more likely to appear in the FT.

In our data, an article in the FT is regarded as being a signal about a single country if its name, adjective or abbreviation of its currency is featured in the headline or first paragraph. For this study the number of daily newspaper articles is counted using data from the Lexis Nexis Database. Given the sample group of countries articles are sorted into two categories. An article in the FT containing only a reference, i.e. name, adjective or abbreviation of currency, to a single country of our sample, but no reference to any other country from the sample is considered to be a *single news* about the country. This is a proxy for attention investors pay to a single country i.e. it reflects the type of signals that are used in the frameworks presented by Veldkamp (2006b), Van Nieuwerburgh and Veldkamp (2009), Mondria et al. (2010), Van Nieuwerburgh and Veldkamp (2010) or Mondria and Quintana-Domeque (2013). To allow for the possibility of signals that are a combination of the information about two or more countries, *joint signals*[22] are counted separately. The proxy for a joint signal is if references to at least two countries of the group appear in either the headline or the first paragraph of a FT article. This definition is chosen in order to avoid double counting of joint news and single news.

[20]See footnote 16 in Mondria and Quintana-Domeque (2013).
[21]See Veldkamp (2006a).
[22]See the signals used in Veldkamp (2006a), Veldkamp and Wolfers (2007) or Mondria (2010).

Importantly, joint news articles are not evaluated in how far each of the included countries plays a role. While this leaves the exact weights of the joint signals with respect to the included countries open, it still requires an article that is counted as joint news to be at least covering two countries in the title or the first paragraph i.e. it is not enough for a country name to be mentioned in a later part of the article for it to be counted as joint news. By concentrating our selection criteria on the headline and the first paragraph we feel reasonably assured of capturing the true object of the signal.

Furthermore, we consider the sum of single and joint articles referring to a certain country as *overall news*, which we take as a proxy for general attention that is paid to a country. This allows us to study the amount of attention any country faces in general as well as a closer look at the structure of this attention, i.e. whether the news about a certain country are dominated by more precise single news or less precise joint news articles.

Table 1: Descriptive Statistics - News

Countries	Single News	Joint News	Overall News
Asia	6954	1029	7983
Thailand	1790	722	2512
Malaysia	1570	679	2249
Philippines	1438	396	1834
Indonesia	2156	696	2852
Latin America	6920	937	7857
Brazil	2414	765	3179
Mexico	2658	528	3186
Argentina	1005	646	1651
Chile	843	370	1213

Daily number of news articles in FT. Source: Lexis Nexis Database.
Period: 1st January 1996 to 31st December 1999.

Table 1 presents an overview of the number of single, joint and overall news for each country included in this study as well as the aggregated values[23] for the groups of Asian and Latin American countries in the sample.

In order to get a measure of importance of joint signals for countries, the ratio of joint news to overall news[24] is calculated for the entire sample. An increase in the joint news ratio while the overall news remains constant therefore signifies a reduction in the precision of the information demanded about a given country.

It is important to consider that we measure attention by the raw number of articles being published in the FT without specifically aiming for content beyond the reference criteria given above and the exclusion of non-business articles from the selected articles. The classification[25] of articles into business and non-business news was done by using the categories provided by the Lexis Nexis database. While an article about a non-business news topic e.g. sports or societal events can also be seen as attention that is paid to

[23]Note that the aggregated values for joint news for the groups differ from the simple sum of the joint news of the countries as the definition of joint news also takes into account joint articles with other states from the sample but different group of countries. The aggregated values of joint news exclude joint news between the two groups.

[24]This will be named the *joint news ratio* for the remainder of this paper.

[25]The exact code for the selection criteria of articles is available upon request.

a certain country, it is less likely to be information that is processed by investors with sparse capacity of attention to make investment decisions. Therefore, the number of articles without non-business news is regarded as a closer proxy to the true attention of international investors. Nonetheless, to be able to take the non-financial attention that a country faces into account we also collect the overall amount of *Daily Mirror*[26] news about countries from the Lexis Nexis Database and add these as a separate variable to our database.

The countries in the sample are divided into two groups. Similar to Mondria and Quintana-Domeque (2013), we are interested in the effects of the Asian crisis in Latin America. Therefore, like Mondria and Quintana-Domeque (2013), we select Thailand for Asia and Argentina, Brazil and Chile for Latin America. To fully capture the effects of the Asian crisis, we add Indonesia, Malaysia and Philippines, as these countries played a prominent role[27] during this episode. Furthermore, we add Mexico due to its economic importance to our sample of Latin American countries.

One important issue to consider with respect to the countries in our sample and the FT as our proxy for the attention of investors is the timing[28] of the variables included. The events of the Asian crisis taken as the main drivers of uncertainty in our sample take place in South-East Asia several time zones to the east of London, the place where the FT is edited. The Latin American countries in our sample on the other hand are located a few time zones to the west of London. As a consequence, uncertainty in the Asian market can only appear in an FT article of the following day. Furthermore, uncertainty in the Latin American stock market cannot affect Asian stock market on the same day.

To observe asset price movements, a measure of stock market prices is included. As a source for a country's stock market valuation we use Datastream Global Index, from which the daily value of the total market value is taken. In order to make the values comparable across countries the asset prices are evaluated in US-dollars (USD). Table 2 presents the summary statistics of the collected data on market valuation.

The volatility of the daily stock market returns are modeled as a GARCH (generalized autoregressive conditional heteroscedastic) process as is standard[29] in the literature.

Furthermore, we use a number of control variables. To account for fundamental channels of contagion we add monthly trade flows between the countries in the sample from the Direction of Trade Statistics (DOTS) of the IMF. We also include 3 month and 6 month US interest rates to control for global economic effects as well as day of week, month or year indicators and a quadratic time trend.

We first study the differences of effects of single news, overall news and joint news in cases of international shifts of attention. In order to do this we take parts of the empirical study of Mondria and Quintana-Domeque (2013) and test how the results therein are affected by taking the type of signals processed by investors into account. We can show that some of the results of shifting attention in times of crisis presented by Mondria and Quintana-Domeque (2013) are confirmed with our data. The fact that our sample allows to test for the effects of different types of attention allows for a clearer picture, though.

[26]In this we follow again Mondria and Quintana-Domeque (2013).

[27]South Korea joined the OECD in 1996 making it somewhat closer to developed countries than the other four Asian nations in our sample. It was therefore left out of the sample, although it was also affected by the Asian crisis.

[28]This point is also made by Mondria and Quintana-Domeque (2013).

[29]We follow Mondria and Quintana-Domeque (2013). For more information on GARCH see e.g. Bollerslev (1987).

Table 2: Descriptive Statistics - Market Valuation

Market Valuation	(1) N	(2) mean	(3) sd	(4) min	(5) max
Asia					
Thailand (million USD)	1,045	0.0456	0.0244	0.0129	0.0957
Malaysia (million USD)	1,045	0.109	0.0525	0.0301	0.195
Philippines (million USD)	1,045	0.0409	0.0140	0.0149	0.0668
Indonesia (million USD)	1,045	0.0410	0.0214	0.00821	0.0766
Latin America					
Brazil (million USD)	1,045	0.132	0.0326	0.0662	0.216
Mexico (million USD)	1,045	0.0921	0.0181	0.0547	0.135
Argentina (million USD)	1,045	0.0463	0.00761	0.0300	0.0632
Chile (million USD)	1,045	0.0477	0.00674	0.0306	0.0635
Aggregations					
Asia (million USD)	1,045	0.236	0.107	0.0706	0.391
Latin America (million USD)	1,045	0.319	0.0569	0.196	0.438

Source: Datastream Global Index. Last accessed 2nd March 2017.

To study the attention shift during the Asian crisis we estimate the following equation[30]:

$$Vol_t^j = \pi^j + \gamma^j Attention_{t,i}^{Asia} + \mathbf{X}_t'\Gamma + u_t^j \tag{7}$$

where $Attention_{t,i}^{Asia}$ is the attention in absolute or relative[31] terms paid to Asia on day t. The index i denotes the type of signal used in the estimation, with $i \in (Single, Joint, Overall)$ being one of our three proxies for investor attention. Vol_t^j is the daily volatility of stock market returns in country j, with j being one of the Latin American countries of our sample. **X** is a vector of control variables i.e. a day of the week and year indicator, a quadratic time trend and 3 month and 6 month US Treasury Bill interest rates. We exclude the data for the year 1996 from the estimation to avoid any lingering effects of the Mexican peso crisis in 1994 and 1995 and make the estimation more the estimation more comparable to Mondria and Quintana-Domeque (2013).

We estimate equation (7) using the absolute and relative amount of attention once for each type of signal that we consider. The four countries of Latin America create a system of four equations, one for each country that we then estimate with seemingly unrelated regressions[32] (SUR). Table 3 shows the results of this estimation. We find that on average an increase of absolute attention towards Asia increases the volatility in Latin American countries, largely driven by increased uncertainty in Mexico. The coefficients of interest for overall news are jointly significant on at least a 5 % level. For the cases of single and joint news we do not find significant joint effects although we find increases in joint Asian news to increase volatilities in Mexico and Brazil to be significant on 5 % and 10 % level, respectively. For our estimation with relative Asian news on the other hand, we can find only a significant effect on a 10 % level of single news on Latin American volatility. Hence, if single news about Asia increase relative to single news about Latin American countries,

[30] See Mondria and Quintana-Domeque (2013).

[31] Relative to the Latin American countries in our sample.

[32] We additionally estimated equation (7) with 2SLS using the amount of non-financial news as an instrument for relative attention. The results can be found in table 9 in the appendix.

we find that this results in increased uncertainty in the Latin American stock market. This effect cannot be found for the cases of relative joint or overall news, though, which are insignificant in our estimation. The results of the Breusch-Pagan test of independence give support to the hypothesis that errors in our systems of equations are correlated.

Table 3: Estimation equation 7 - OLS

		Brazil	Mexico	Argentina	Chile
Absolute Attention					
Single News	Coefficient	0.0001319	0.0000807	0.0000153	0.0000572*
		(0.000117)	(0.0000696)	(0.0000743)	(0.0000319)
	Breusch-Pagan test	990.075***			
	p-value	0.0000			
	Joint significance	1.58			
	p-value	0.2087			
	Observations	783	783	783	783
Joint News	Coefficient	0.0001371**	0.0001104*	0.0000153	0.00000156
		(0.0000906)	(0.0000536)	(0.0000572)	(0.0000247)
	Breusch-Pagan test	993.328***			
	p-value	0.0000			
	Joint significance	2.68			
	p-value	0.1017			
	Observations	783	783	783	783
Overall News	Coefficient	0.0000699	0.0001116***	0.0000721	0.0000215
		(0.0000703)	(0.0000416)	(0.0000445)	(0.0000192)
	Breusch-Pagan test	987.555***			
	p-value	0.0000			
	Joint significance	4.11**			
	p-value	0.0427			
	Observations	783	783	783	783
Relative Attention					
Single News	Coefficient	0.0003878	0.000402*	0.0001894	0.0001949**
		(0.0003657)	(0.0002164)	(0.0002319)	(0.0000994)
	Breusch-Pagan test	965.280***			
	p-value	0.0000			
	Joint significance	2.76*			
	p-value	0.0965			
	Observations	768	768	768	768
Joint News	Coefficient	-0.0001026	0.0000227	-0.0000255	-0.0001109*
		(0.0002195)	(0.0001598)	(0.0001538)	(0.000067)
	Breusch-Pagan test	584.421***			
	p-value	0.0000			
	Joint significance	0.20			
	p-value	0.6529			
	Observations	361	361	361	361
Overall News	Coefficient	-0.0001441	0.0000632	0.0000825	-0.00000773
		(0.0002769)	(0.0001642)	(0.0001756)	(0.0000754)
	Breusch-Pagan test	974.016***			
	p-value	0.0000			
	Joint significance	0.00			
	p-value	0.9908			
	Observations	770	770	770	770

Robust standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

These results show that it is important to take the different types of news into account when analyzing the effects of processed information by investors on the market. Estimating equation (7) we find some support for the prediction by Mondria and Quintana-Domeque (2013) that the shifting attention causes uncertainty in Latin American countries. Importantly, we find that the estimated effect strongly depends on the type of news that we consider as a measure of attention paid to a country. Taking the case of an increase in absolute attention[33] directed towards the Asian countries, for instance, we see that more overall news attention seems to increase the uncertainty in the Latin American markets. This does not hold for an increase in joint news for Asia. For a shift in relative attention from Latin America to Asia we can only find the increase in uncertainty for a rise in the ratio of single news in Asia. Notably, we do not find any effect of shifting joint news between Asia and Latin America on the uncertainty in Latin America which is in line with our model.

As stated in proposition 1, we regard joint news to have a special effect on investors. To further explore the role of joint news we estimate the following equation to test how the importance of joint news about

[33] This can be justified as a shift in attention away from Latin America to Asia if we assume that the information processing capacity of agents is fixed and limited and agents do not only shift attention from other parts of the world to Asia.

Latin America changed during the time of increased uncertainty in Asia:

$$Joint_t^{LA} = \rho_1^{LA} + \rho_2^{LA} Vol_{t-1}^{Asia} + \mathbf{X}_t' \Phi^{LA} + \varepsilon_t^{LA} \tag{8}$$

$Joint_t^{LA}$ is either the absolute amount of joint news in Latin America on day t or the joint news ratio in t. The variable of interest is Vol_{t-1}^{Asia}, the volatility in Asia at $t-1$. We expect the coefficient ρ_2^{LA} to be positive i.e. that increasing uncertainty in Asia as happened during the Asian crisis led to more joint signals about Latin America being processed by investors. **X** is again a vector of controls. Note that the reason for taking the Asian volatility of the preceding day is that due to the different time zones of Asia, Latin America and London, i.e. the place where editing of the FT takes place, any news stories about uncertainty in the Asian market would appear in the FT of the following day. This timing of the variables also ensures that changes in the volatility in Asia affect the news about Latin America and not in the other direction in our estimation.

Table 4: Joint news shift

	(1) Joint News Latin America	(2) Joint News Latin America (% overall)
Lagged Volatility Asia	22.50**	113.2*
	(2.08)	(1.79)
Quadratic time trend	-2.082	-5.429
	(-1.59)	(-0.80)
3-Month interest rate	1.783	11.00
	(1.06)	(1.22)
6-Month interest rate	-2.686*	-15.17*
	(-1.65)	(-1.82)
Constant	7.989***	42.73***
	(3.20)	(3.10)
Weekday dummies	Yes	Yes
Year dummies	Yes	Yes
Observations	1044	1027
Adjusted R^2	0.024	0.020

Robust *t* statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimating equation (8) we find the coefficient of lagged Asian volatility to be positive and significant for both of our dependent variables. On average, increases in the uncertainty in Asia led to more signals about Latin American countries being grouped and a higher share of overall attention paid towards Latin America becoming less precise joint news. We find that a one standard deviation increase of volatility in the Asian market results in an increase of 8.91 % of absolute joint news or a 8.33 % standard deviation increase of the share of joint news in Latin America the following day. This supports the hypothesis that investors grouped signals in times of the Asian crisis. We therefore find that the effects of the Asian crisis could be seen to affect the structure of the news market in Latin America. In the context of our model, this can occur, because the increased resources devoted to Asian news, can increase the cost of finding specific information for Latin America, as this must now be done with less resources. For example, with more of the newspaper's journalists devoted to Asian news, the remaining few covering Latin America would have to work overtime to obtain specific news. The resources available to the newspaper (e.g. number of journalists) may very well be fixed in the short run.

The next step is to look at the evidence for proposition 1. Our model predicts that joint news in Latin America will lead to excess comovement of asset prices among the respective countries. To empirically test this prediction we estimate the following equation:

$$Cov_{\tau,i,j} = \omega_0 + \omega_1 Joint_{\tau-1,i,j} + \zeta A_{\tau,i,j} + \mathbf{Y}_t'\Psi + \epsilon_{\tau,i,j} \quad (9)$$

where $Cov_{\tau,i,j}$ is either the covariance or the correlation of the stock market prices of countries i and j in τ. We estimate equation (9) with both measures of comovement as dependent variables to test the validity of our proposition 1. $Joint_{\tau-1,i,j}$ is the amount of joint news about countries i and j in $\tau-1$. $A_{\tau,i,j}$ is the sum of the attention that countries i and j face. We apply two different measures – the amount of single news and overall news – of general attention that the countries face and expect our proposition 1 to hold with both measures. $\mathbf{Y}$ is a vector of control variables like the strength of the trade link between countries i and j to control for fundamental contagion links and the sum of the market valuation of the stock market of the two countries as a measure of economic size. Additionally, we control for strength of the trade links to Asia to take care of fundamental contagion between Asia and Latin America in this time period. As in the previous estimations, we also include the weekday indicators, a quadratic time trend, month indicators to control for any special effects in certain months, e.g. any global event affecting the global news markets, and the US interest rates.

To make use of the daily frequency of the data in our sample, we calculate the covariance and correlation of market returns over a rolling window of 30 days. Similarly, we compute the amount of articles, single and overall, for the same rolling window. Therefore, for each day the new day of market return data is added to the calculation of the covariance and correlation and analogously to the single and overall news, while the 31st day of the rolling window is falling out. This makes sure that we have daily variation in our variables of comovement and attention and keeps the time order of lagged joint news to concurrent comovement of market returns at the same time.

One important point about the estimation of our proposition 1 is that we expect information frictions to create non-fundamental based contagion as opposed to contagion between two countries due to fundamental linkages[34] such as trade flows. Our theoretical model in the previous chapter excluded any type of fundamental contagion by having the fundamentals, specific signals and noise terms being independent of each other. This obviously does not hold in the real world where countries are linked through a number of fundamental channels with different strengths almost all the time. The goal of the estimation of equation 9 is to estimate the strength of the non-fundamental based contagion between countries. Therefore, we not only include the trade flows as one of the main fundamental channels of contagion as a control we also have to consider any potential issues of endogeneity for our variable of interest i.e. in how far joint news exogenously drive asset price comovement.

There are two possible issues of endogeneity with this estimation. One is the problem of reverse causality, i.e. that the joint news do not only create comovement but are themselves a result of existing changes in the comovement of market returns. By taking the lagged amount of joint news as the variable of interest,

[34]For a more detailed description of types of contagion see Dornbusch et al. (2000).

we avoid the possibility of comovement affecting joint news. The second issue is the possibility of omitted variables bias in our estimation. This is the case if there is a variable omitted from our regression that would be correlated with the amount of lagged joint news in our estimation and at the same time affect the comovement of market returns in the sample period. An example would be an event affecting both countries at the same time resulting in fundamental contagion i.e. increased comovement as well as a higher amount of joint news about the two countries that are affected. In this case the coefficient of interest in our estimation would be biased. To account for this possible source of endogeneity, we instrument the amount of lagged joint news of two countries and estimate equation 9 with 2-stage least squares (2SLS). Any suitable instrument has to fulfill two criteria. On the one hand the exclusion restriction means that the dependent variable cannot be affected by the instrument itself. On the other hand the instrument itself has to be (partially) correlated with our potential endogenous variable of interest.

We consider two instruments in our estimation that fulfill these criteria. The first is to instrument joint news with the lagged value of volatility in the Asian market. The exclusion restriction requires that comovement within Latin America is not affected by previous Asian volatility. From our estimation of equation (8) we find that the amount of joint news is affected by the volatility in the Asian stock market. The results of the estimation with the lagged Asian volatility as an instrument are presented in table 5.

Table 5: Proposition 1 - Asian volatility

	(1)	(2)	(3)	(4)
	Asset price covariance (level)		Asset price correlation	
Lagged Shared News	0.000829***	0.000828***	0.769***	0.764***
	(3.21)	(3.23)	(3.46)	(3.48)
Attention (single news)	0.00000131***		0.0000890	
	(4.51)		(0.34)	
Attention (overall news)		0.00000106***		-0.000263
		(2.92)		(-0.82)
Trade flows	-3.70e-14	-4.70e-14	-7.95e-11*	-8.15e-11**
	(-0.78)	(-1.01)	(-1.94)	(-2.04)
Market valuation	-1.93e-11***	-1.57e-11**	5.83e-09	1.42e-08**
	(-3.06)	(-2.38)	(0.94)	(2.21)
Mean Trade flows with Asia	6.56e-13**	5.73e-13*	-5.02e-10*	-6.08e-10**
	(2.09)	(1.86)	(-1.68)	(-2.08)
Quadratic time trend	-0.00000274	-0.0000380	-0.794	-0.799
	(-0.00)	(-0.05)	(-1.19)	(-1.21)
3-Month interest rate	-0.000266**	-0.000273**	-0.126	-0.117
	(-2.48)	(-2.53)	(-1.28)	(-1.19)
6-Month interest rate	0.000111	0.000119	0.0717	0.0607
	(1.17)	(1.24)	(0.79)	(0.67)
Constant	0.000476**	0.000378	0.292	0.337*
	(2.03)	(1.59)	(1.56)	(1.78)
Weekday dummies	Yes	Yes	Yes	Yes
Month dummies	Yes	Yes	Yes	Yes
Observations	6096	6096	6096	6096
1st stage F-statistics	14.7606	15.0519	14.7606	15.0519

Robust *t* statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Our second instrument is the number of fatalities in terrorist attacks[35] on a given day. Any terrorist attack will affect the news cycle and therefore, affect the number of joint news about certain countries in the

[35] This data can be found in the Global Terrorism Database. See National Consortium for the Study of Terrorism and Responses to Terrorism (START) (2017).

FT. We assume that the more severe any terrorist attack is, the stronger the consequences on the news market on a given day. Additionally, we don't assume that terrorist attacks affect market comovement between two countries. Nonetheless, we exclude any fatalities in attacks in the countries of our sample to avoid any potential direct effects[36] on the stock markets that we study. The results of this estimation can be found in tables 6 and 7. Interestingly, there have been attacks on nearly each day of our time frame.[37] Therefore, using this instrument does not result in a loss of observations. Instruments regarding news congestion have been applied before, for example in Eisensee and Strömberg (2007), who study disaster relief. The occurrence of terror attacks has been used as an instrument in Garz (2017) in the context of unemployment reports, whereas the number of fatalities has also been used in Garz and Pagels (2017) in the context of tax evasion.

According to proposition 1 we expect the coefficient ω_1 to be significantly positive in our estimation. Tables 5, 10[38], 6 and 7 show the results of the different specifications that were estimated with the amount of lagged shared or lagged joint news[39] between the two countries as our variable of interest. In the tables the first two columns show the estimated effects on the covariance of the market returns with column one using the sum of single news as a control for attention and column two the sum of overall news. Columns 3 and 4 repeat these estimations with the market return correlation as the dependent variable. The coefficient of interest ω_1 is positive and significant for all specifications on at least a 10% level with the lagged Asian volatility as well as the number of fatalities in terrorist attacks as the instrument. Testing for weak instruments[40] shows that we can clearly reject the hypothesis of weak instruments in our estimation for the instrument of the lagged Asian volatility. For our second instrument of fatalities in terrorist attacks we can weakly reject it for the estimation with lagged shared news presented in table 6 and strongly reject the weak instrument hypothesis for the estimation with lagged joint news presented in table 7.

We therefore find support for our proposition 1: An increase in news that cover more than a single country results in higher comovement of market returns for these countries. The economic significance of this effect is also not negligible with a one standard deviation increase of lagged shared news resulting in an increase of the market return covariance of 1.1196 to 1.1213 standard deviations and an increase of the correlation between 1.3265 and 1.3350 standard deviations[41] using our first instrument. Using the second instrument of fatalities in terrorist attacks we see an increase of lagged shared news resulting in an increase of the market return covariance of 0.4124 to 0.4400 standard deviations and an increase between 0.8301 and

[36] While a direct effect of terrorist attacks on the economy cannot be discounted (e.g. the attacks on 11.09.2001), we do not see any attack of such significance in our sample period.

[37] Out of the 1045 days in our sample 212 days have no fatalities in terrorist attacks. The sample average of fatalities is 16.69 fatalities per day in any country but the countries in our sample. The average number of terrorist attacks, excluding attacks in the countries of our sample is 5.39 per day making it less likely that any single big attack is having too large an effect on global asset markets for our instrument to be valid.

[38] Table 10 can be found in the appendix.

[39] Shared news is the number of news that refer to both countries for which we use the covariance in the respective observation in the sample while joint news is the number of joint news that feature either of the two countries. We expect the measure of shared news to be more precise but show both results.

[40] The F-statistic of the first stage regression is at least 14.7606 and always significant on at least a 1 % level for lagged Asian volatility. The results for the estimation with the first instrument and lagged joint news as the variable of interest do not change qualitatively and can be found in table 10 in the appendix. For the instrument of fatalities of terrorist attacks we find for the case of shared news a F-statistic of at least 9.57518 and always significant on at least a 5 % level. For the case of joint news and our second instrument the first stage results are much stronger and show an F statistic of at least 32.5272.

[41] A change of one standard deviation of joint news results in between a 0.7441 and 0.7454 standard deviations higher covariance and between a 0.8833 and 0.8863 standard deviations higher correlation.

Table 6: Proposition 1 - Terrorist fatalities

	(1)	(2)	(3)	(4)
	Asset price covariance (level)		Asset price correlation	
Lagged Shared News	0.000325*	0.000305*	0.478**	0.482**
	(1.80)	(1.69)	(2.23)	(2.18)
Attention (single news)	0.00000169***		0.000306	
	(8.98)		(1.39)	
Attention (overall news)		0.00000170***		0.0000789
		(6.90)		(0.26)
Trade flows	4.88e-14	4.10e-14	-3.00e-11	-3.41e-11
	(1.49)	(1.27)	(-0.80)	(-0.89)
Market valuation	-1.75e-11***	-2.05e-11***	6.89e-09	1.17e-08**
	(-5.13)	(-5.67)	(1.52)	(2.38)
Mean Trade flows with Asia	5.74e-13***	5.57e-13***	-5.49e-10**	-6.16e-10***
	(3.17)	(3.21)	(-2.51)	(-2.85)
Quadratic time trend	0.000361	0.000334	-0.585	-0.598
	(0.72)	(0.68)	(-1.19)	(-1.22)
3-Month interest rate	-0.000230***	-0.000247***	-0.105	-0.102
	(-3.20)	(-3.51)	(-1.46)	(-1.42)
6-Month interest rate	0.000102*	0.000123**	0.0664	0.0626
	(1.80)	(2.20)	(1.02)	(0.95)
Constant	0.000430**	0.000250	0.265**	0.269*
	(2.57)	(1.49)	(1.98)	(1.88)
Weekday dummies	Yes	Yes	Yes	Yes
Month dummies	Yes	Yes	Yes	Yes
Observations	6096	6096	6096	6096
1st stage F-statistics	9.95362	9.57518	9.95362	9.57518

Robust *t* statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

0.8367 standard deviations[42] of the correlation. We conclude that this is an effect of economic significance.

The next step is to test proposition 2, i.e. in how far the conditions of information and asset markets affect the existence of a contagion equilibrium which depends according to proposition 1 on investor purchasing the joint signal. The higher importance of joint signals for countries might be the consequence of either intermediate information cost, high information cost and intermediate excess returns or volatile country specific fundamentals and signals. Therefore, we estimate the following equation to test the hypothesis of our proposition 2:

$$Joint_{t,i} = \eta_0 + \eta_1 Cost_t^i + \eta_2 Return_{t-1}^i + \eta_3 Vola_{t-1}^i + \mathbf{Z}'\delta + \epsilon_{t,i} \tag{10}$$

where the dependent variable $Joint$ is a measure of the importance of information frictions in either relative or absolute terms for a given country i at time t. Our main variables of interest are proxies for cost of information production, $Cost_t^i$, of the excess market return, $Return_{t-1}^i$, and of the fundamental volatility, $Vola_{t-1}^i$. Our proxies for cost of information production are the distance[43] to the UK in km as well as the squared value of the distance. As was stated in proposition 2, if information cost are too high, we expect investors not to inform themselves at all, while the case of the cost being too low leads to investors preferring the more informative specific signals. Therefore, we estimate the relationship between information cost and joint signals to be non-linear. Additionally, we include a dummy for a country having English – being the

[42] A change of one standard deviation of joint news results in a between 0.2557 and 0.2755 standard deviations higher covariance and between a 0.5185 and 0.5203 standard deviations higher correlation.

[43] The distance is between the most populated city in the UK i.e. London and the most populated city in the respective country. Source: Mayer and Zignago (2011).

Table 7: Proposition 1 - Terrorist fatalities (alternative)

	(1)	(2)	(3)	(4)
	Asset price covariance (level)		Asset price correlation	
Lagged Joint News	0.0000432*	0.0000401*	0.0635***	0.0633***
	(1.91)	(1.80)	(2.66)	(2.61)
Attention (single news)	0.00000183***		0.000515***	
	(14.32)		(4.20)	
Attention (overall news)		0.00000189***		0.000379***
		(13.29)		(2.60)
Trade flows	9.35e-14***	8.24e-14***	3.56e-11***	3.14e-11***
	(7.59)	(7.01)	(3.45)	(3.06)
Market valuation	-1.68e-11***	-2.14e-11***	7.93e-09**	1.02e-08***
	(-5.74)	(-7.10)	(2.19)	(2.74)
Mean Trade flows with Asia	4.85e-13***	4.89e-13***	-6.80e-10***	-7.23e-10***
	(3.05)	(3.09)	(-3.78)	(-3.98)
Quadratic time trend	0.000466	0.000431	-0.430	-0.444
	(1.02)	(0.96)	(-1.09)	(-1.12)
3-Month interest rate	-0.000216***	-0.000236***	-0.0843	-0.0859
	(-3.22)	(-3.57)	(-1.44)	(-1.47)
6-Month interest rate	0.0000925*	0.000117**	0.0520	0.0538
	(1.78)	(2.28)	(0.98)	(1.00)
Constant	0.000353**	0.000156	0.151	0.119
	(2.18)	(0.99)	(1.39)	(1.11)
Weekday dummies	Yes	Yes	Yes	Yes
Month dummies	Yes	Yes	Yes	Yes
Observations	6096	6096	6096	6096
1st stage F-statistics	33.3203	32.5272	33.3203	32.5272

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

language of the FT – as an official[44] language. This controls for the potential cost of translating reports or data published in other languages into English. We expect our measures of cost of information production to positively, but non-linearly, affect the amount or share of joint news. To estimate the effect of our other two variables of interest, the excess return and volatility of the fundamentals, we include the lagged daily return and volatility of the stock market of country i. We expect the coefficient of the market return to be negative according to condition 2 of proposition 2 and the coefficient of market volatility to be negative in line with the respective condition 3.

Additionally, we control for inherent investor interest in a given country by including the lagged market valuation as well as a dummy for a colonial history with the UK. The vector $\mathbf{Z}$ collects a number of further control variables. These are a quadratic time trend, a weekday indicator, the US interest rates and yearly time dummies to control for any special effects of global events at a given time that might shift attention e.g. sport tournaments like the Olympics. Additionally, we include the amount of overall news to control for general attention paid to a country. We then estimate this equation for each of the eight countries in our sample.

Table 8 shows the result of the estimation of equation (10). The first column was estimated using the absolute number of joint news of a country as the dependent variable while column two estimates the same with the share of joint news of the overall news as the dependent variable.

Our results show that we find support for the three measures that can cause the grouping of signals

[44]This information was taken from the CIA factbook.

Table 8: Proposition 2

	(1) Joint news (amount)	(2) Joint News (% overall)
Distance to London (km)	0.00197***	0.145***
	(3.52)	(9.05)
Squared Distance	-9.63e-08***	-0.00000689***
	(-3.58)	(-8.90)
English (official)	-0.256***	-13.77***
	(-5.09)	(-7.92)
Lagged Market Value (million USD)	-0.210	-24.15*
	(-0.44)	(-1.91)
Colonial history	-0.0850	-6.788***
	(-1.39)	(-3.89)
Lagged Asset return (%)	-1.531**	-23.27*
	(-2.56)	(-1.69)
Lagged Asset volatility	10.10***	73.85***
	(8.15)	(2.61)
Lagged Attention (overall news)	0.0199**	-0.180
	(2.28)	(-1.00)
Quadratic time trend	-0.174	-3.056
	(-1.24)	(-0.67)
3 months US interest rate	0.589***	15.56***
	(3.17)	(2.89)
6 months US interest rate	-0.657***	-17.72***
	(-3.91)	(-3.61)
Constant	-8.876***	-717.9***
	(-3.09)	(-8.63)
Weekday dummies	Yes	Yes
Year dummies	Yes	Yes
Observations	8344	6248
Adjusted R^2	0.046	0.042

Robust *t* statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

according to proposition 2. We find an increase of joint news with a higher distance of a country to the UK. Additionally, we find support for this effect to be a nonlinear one as the quadratic distance is significantly negative. Altogether, the further a country is away from the UK the more likely it is that the news about this countries are joint news in absolute as well as relative values. Furthermore, we find negative and significant coefficients for the English-dummy which means that countries in our sample without English as an official language are more likely to appear in joint news articles and have a lower share of more precise single news in their overall attention. Furthermore, we find the coefficients of the asset returns to be negative and significant on at least a 10 % level. Countries with higher stock market returns are less likely to appear in joint news and have on average a lower joint news ratio. The coefficient of our third variable of interest, the lagged stock market volatility is positive and significant on at least a 1 % level. We see this as countries with a higher volatility of the fundamental being more likely to be covered in joint news in absolute as well as relative terms.

Additionally, we find support for a higher market valuation and a colonial history with the UK reducing the joint news ratio which we see as a control for more inherent investor interest in countries. Countries that are of higher interest in general for investors have a higher share of more specific single news and should therefore on average be less affected by information frictions based contagion.

Altogether, we find that our proxies for cost of information, excess returns and volatility of fundamentals support proposition 2. A higher, but not too high cost of information, lower excess returns and higher volatility of fundamentals result in joint news being more important for a country and therefore, information frictions to be of a higher relevance. This also helps explain why episodes of non-fundamental contagion are less likely to affect more advanced economies, our corollary 1, that are generally seen as assets with higher market returns, have a lower cost of information production and more stable fundamentals.

Therefore, we conclude that information-friction induced crises of the kind described in this paper are more relevant for emerging economies and less likely to affect more developed nations. The reason for investors in less developed countries to group signals can be that these are of less inherent interest or that the cost of information production in these countries is just higher, for instance, because data about economic variables is not available or less reliable, reports or statements need to be translated or the distance is higher, which results in higher costs for personal investigations.

5 Conclusion

In this paper we show theoretically as well as empirically that costly information plays a role for episodes of contagion between countries. Furthermore, we point out the importance of taking the type of information into account when dealing with investors that face costly information. We find that these information frictions can lead to less precise signals, in the form of grouped information on several countries, which can drive contagion. Such joint information leads to a steady excess comovement of asset prices between the countries involved. Furthermore, these joint signals are likelier to be observed for emerging economies, thereby making them especially vulnerable to contagion. This kind of contagion coexists among the more classical types due to fundamental trade or financial links.

It is noteworthy that this does not happen due to agents behaving irrationally. Specific information about smaller, less developed economies is too expensive to produce or the expected risk-weighted returns are too low, for them to be processed by rational agents. A clear policy implication would be for emerging markets to provide better and cheaper information. However, since they are underdeveloped and less interesting for investors, it may be that the loss from a sub-optimal action in an emerging market is so small, that it is not worthwhile to obtain and process detailed information for these countries.

An additional issue we see, is that the empirical evidence is based on a sample from before the rise of the internet as the most prominent medium to convey information. We specifically picked this time frame for our study as the Asian crisis is a very common example of contagion in the literature, that is unlikely to be caused mainly by fundamental channels. Furthermore, relying on daily newspaper articles as a measure for processed information by investors is more reasonable to assume before the new information channels of the internet emerged since the beginning of the new millennium. While we are confident that the mechanism of contagion presented in this paper works regardless of the technological environment, it remains a task for further research to test this mechanism of contagion based on information frictions with more recent means of information transfers.

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Appendix

Proof of Proposition 2

We must find all conditions under which the joint signal is purchased in equilibrium. From proposition 1 it then follows that a contagion equilibrium exists if only if these conditions hold. We begin by finding the equilibrium signal prices. Information suppliers make zero profits due to free entry. Otherwise, other suppliers would enter, which would not be an equilibrium. From zero profits it follows that $c_j = \chi/\lambda_j$.

The equilibrium asset demands and prices are given by equations (5) and (6), which ensure the asset market clears. What remain now are the signal demand and supply choices, which are equivalent in equilibrium. Plugging in the optimal asset demands, utility becomes:

$$U = E[\tfrac{1}{2\rho}(\hat{\mu} - pr)'\hat{\Sigma}^{-1}(\hat{\mu} - pr) - c_j]$$

Note that $\hat{\Sigma} = \begin{bmatrix} \sigma^2_{\theta_M|S_j} & 0 \\ 0 & \sigma^2_{\theta_R|S_j} \end{bmatrix}$

Here $\sigma^2_{\theta_i|S_j}$ denotes the conditional variances. Let B denote the gross signal benefit before costs, i.e. $U = B - c_j$. Denote the gross benefit of purchasing the joint signal as $B(S_B)$, that of two specific signals as $B(S_M, S_R)$ and that of no signal as B^0. Therefore, $U(S_M, S_R) = B(S_M, S_R) - 2\chi/\lambda$, $U(S_B) = B(S_B) - \chi/\lambda$ and for no information $U = B^0$. Writing out the expectation yields:

$$B(S_M, S_R) = \tfrac{1}{2\rho}E[\tfrac{(\hat{\mu}_{\theta_M} - pr)^2}{\sigma^2_{\theta_M|S_M}} + \tfrac{(\hat{\mu}_{\theta_R} - pr)^2}{\sigma^2_{\theta_R|S_R}}]$$

$$B(S_B) = \tfrac{1}{2\rho}E[\tfrac{(\hat{\mu}_{\theta_M} - pr)^2}{\sigma^2_{\theta_M|S_B}} + \tfrac{(\hat{\mu}_{\theta_R} - pr)^2}{\sigma^2_{\theta_R|S_B}}]$$

$$B^0 = \tfrac{1}{2\rho}E[\tfrac{(\mu_{\theta_M} - pr)^2}{\sigma^2_{\theta_M}} + \tfrac{(\mu_{\theta_R} - pr)^2}{\sigma^2_{\theta_R}}]$$

Investors take prices as given and have rational expectations. Solving the expectations, we have:

$$B(S_M, S_R) = \tfrac{1}{2\rho}[\tfrac{\sigma^2_{S_M}(\mu_{\theta_M} - pr)^2}{\sigma^2_{\theta_M}(\sigma^2_{S_M} - \sigma^2_{\theta_M})} + \tfrac{\sigma^2_{\theta_M}}{\sigma^2_{S_M} - \sigma^2_{\theta_M}} + \tfrac{\sigma^2_{S_R}(\mu_{\theta_R} - pr)^2}{\sigma^2_{\theta_R}(\sigma^2_{S_R} - \sigma^2_{\theta_R})} + \tfrac{\sigma^2_{\theta_R}}{\sigma^2_{S_R} - \sigma^2_{\theta_R}}]$$

$$B(S_B) = \tfrac{1}{2\rho}[\tfrac{\sigma^2_{S_B}(\mu_{\theta_M} - pr)^2}{\sigma^2_{\theta_M}(\sigma^2_{S_B} - \sigma^2_{\theta_M})} + \tfrac{\sigma^2_{\theta_M}}{\sigma^2_{S_B} - \sigma^2_{\theta_M}} + \tfrac{\sigma^2_{S_B}(\mu_{\theta_R} - pr)^2}{\sigma^2_{\theta_R}(\sigma^2_{S_B} - \sigma^2_{\theta_R})} + \tfrac{\sigma^2_{\theta_R}}{\sigma^2_{S_B} - \sigma^2_{\theta_R}}]$$

To compare the gross benefits, we subtract the benefit of the joint signal from the benefit of the country-specific signals. We also subtract the benefit of no information from that of the joint signal. We define $\Delta B_1 \equiv B(S_M, S_R) - B(S_B)$ and $\Delta B_2 \equiv B(S_B) - B^0$. This yields:

$$\Delta B_1 = \tfrac{1}{2\rho}\left[\frac{\left[(\mu_{\theta_M} - pr)^2 + \sigma^2_{\theta_M}\right]\left(\sigma^2_{S_B} - \sigma^2_{\theta_{S_M}}\right)}{(\sigma^2_{S_M} - \sigma^2_{\theta_M})(\sigma^2_{S_B} - \sigma^2_{\theta_M})} + \frac{\left[\left(\mu_{\theta_R} - pr\right)^2 + \sigma^2_{\theta_R}\right]\left(\sigma^2_{S_B} - \sigma^2_{\theta_{S_R}}\right)}{(\sigma^2_{S_R} - \sigma^2_{\theta_R})(\sigma^2_{S_B} - \sigma^2_{\theta_R})}\right] > 0$$

$$\Delta B_2 = \tfrac{1}{2\rho}\left[\frac{(\mu_{\theta_M} - pr)^2 + \sigma^2_{\theta_M}}{\sigma^2_{S_B} - \sigma^2_{\theta_M}} + \frac{(\mu_{\theta_R} - pr)^2 + \sigma^2_{\theta_R}}{\sigma^2_{S_B} - \sigma^2_{\theta_R}}\right] > 0$$

Therefore, there exists a clear ranking of gross signal benefits $B(S_M, S_R) > B(S_B) > B^0$. With symmetric information decisions, there are 8 potential combinations of signal supply and demand. Nevertheless, we can rule out three cases. Purchasing all three signals is not an equilibrium, as the joint signal has a positive cost, but no added benefit if the two specific signals are observed. Purchasing one specific signal and the joint signal is also not an equilibrium. Such a case has the same information cost as purchasing two specific signals, but less benefit and is therefore strictly dominated.

We must also rule out that agents choose to only purchase one country-specific signal. Such a semi-informative signal would have the same cost as the joint signal. If the gross benefit of the joint signal is always smaller than that of the semi-informative signal, then it is never optimal to purchase the joint signal. Due to the diagonality of the covariance matrix, we can split the gross benefits $B(.)$ into the benefit when purchasing assets of each country, denoted B_i. We have $B(.) = B_M(.) + B_R(.)$. The semi-informed case is dominated if:

$B_M(S_B) - B_M(S_M) + B_R(S_B) - B_R^0 > 0$ and $B_M(S_B) - B_M^0 + B_R(S_B) - B_R(S_R) > 0$

This condition boils down to: $\sigma^2_{S_B} < \sigma^2_{S_i} + \sigma^2_{\epsilon_i}$.

Furthermore, this implies $2B(S_B) - B(S_M, S_R) - B^0 > 0$, which will be useful later on. Therefore, only three cases can be optimal. Either the joint signal, two single signals or no information is purchased. What remains is to find all conditions under which the joint signal is purchased in a symmetric equilibrium. The information markets then clear with $\lambda_B = \lambda$, I_B=1, $\lambda_i = I_i = 0$.

First consider different information prices for a given level of gross benefits. The ranking of the signal prices is analogous to that of the gross benefits. Two specific signals cost more than a joint signal, which costs more than no information. Furthermore, there is a clear ranking of utility for zero costs. Therefore, for low costs, the specific signals are chosen. Similarly, for sufficiently high information prices, no information can become optimal. It remains to be shown that it is possible for the joint signal to be optimal for an intermediate level of costs. This requires that a case exists such that:

$U(S_B) > U(S_M, S_R)$ and $U(S_B) > B^0$

which holds under the aforementioned condition $2B(S_B) - B(S_M, S_R) - B^0 > 0$. Hence, the joint signal is purchased for intermediate levels of $\frac{\chi}{\lambda}$, namely for $\frac{\chi}{\lambda} \in (\Delta B1, \Delta B2)$.

Consider now different levels of benefits for given costs. The benefit differences are monotonically increasing in the excess returns.

$\frac{dB(S_M,S_R)}{d(\mu_{\theta_i} - pr)} > \frac{dB_M(S_B)}{d(\mu_{\theta_i} - pr)} > \frac{dB^0}{d(\mu_{\theta_i} - pr)} > 0$

For a given cost level, there are in general six possible utility rankings. Two rankings, namely, $B^0 > U(S_M, S_R) > U(S_B)$ and $U(S_M, S_R) > B^0 > U(S_B)$ are impossible under the aforementioned condition $2B(S_B) - B(S_M, S_R) - B^0 > 0$. We compare the remaining cases starting from $\mu_{\theta_i} - pr = 0$. However, the analysis holds for any other initial point.

If initially we have the ranking $U(S_M, S_R) > U(S_B) > B^0$, then the two specific signals will remain optimal for any higher levels of $(\mu_{\theta_i} - pr)$. In such a case,the joint signal is never optimal for a given level of costs. If initially we have one of the two rankings where S_B is optimal, this must imply an intermediate level of information costs. As we had already established that intermediate average information costs lead to the joint signal becoming optimal, this is a redundant condition for the proposition.

This leaves one last possible initial ranking $B^0 > U(S_M, S_R) > U(S_B)$. Such a case requires high average information costs. As the excess returns increase, the joint signal will first become optimal and then the two specific signals become optimal. The case that the joint signal is dominated by two specific signals for intermediate levels of $\mu_{\theta_i} - pr$ is again ruled out by $2B(S_B) - B(S_M, S_R) - B^0 > 0$. Therefore, the joint signal can also be optimal for high information prices and intermediate levels of excess returns. The exact ranges can be found by solving for $\mu_{\theta_i} - pr$ such that $\chi/\lambda - \Delta B_1 > 0$ and $\Delta B_2 - \chi/\lambda > 0$.

The only remaining elements of the gross benefit functions not discussed are $\sigma^2_{S_B}$, $\sigma^2_{\theta_i}$ and $\sigma^2_{\epsilon_i}$. From the lowest initial point of $\sigma^2_{S_B}$, higher values are consistent with S_B being optimal only if it is optimally initially. Such a case would require intermediate average information prices and $\sigma^2_{S_B} < \sigma^2_{S_i} + \sigma^2_{\epsilon_i}$, which is already covered. Similarly, if S_B is initially optimal, a higher $\sigma^2_{\epsilon_i}$ does not change this ranking.

Furthermore, as $\sigma^2_{\epsilon_i}$ or $\sigma^2_{\theta_i}$ increase, the the benefit of the country specific signals approaches that of the joint signal. Hence, if the joint signal is not dominated by no information, then the joint signal can become optimal for sufficiently high $\sigma^2_{\epsilon_i}$ or $\sigma^2_{\theta_i}$. To see this, note that from condition (3), $\sigma^2_{\theta_i}$ and $\sigma^2_{\epsilon_i}$ are bounded above by $\sigma^2_{S_B} > \sigma^2_{\theta_i} + \sigma^2_{\epsilon_i}$. We then have:

$$\lim_{\sigma^2_{\theta_i} \to \sigma^2_{S_B} - \sigma^2_{\epsilon_i}} \Delta B1 = \lim_{\sigma^2_{\epsilon_i} \to \sigma^2_{S_B} - \sigma^2_{\theta_i}} \Delta B1 = 0$$

$$\lim_{\sigma^2_{\theta_i} \to \sigma^2_{S_B} - \sigma^2_{\epsilon_i}} \Delta B2 > 0, \quad \lim_{\sigma^2_{\epsilon_i} \to \sigma^2_{S_B} - \sigma^2_{\theta_i}} \Delta B2 > 0$$

□

Empirical Appendix

Table 9 replicates the estimation of equation 7 presented in table 3 using the relative attention paid to Asia with 2SLS and the amount of non-financial news in the Daily Mirror as an instrument. In this we follow Mondria and Quintana-Domeque (2013). The results do not contradict our results presented in table 3.

Table 9: Estimation equation 7 - IV

		Brazil	Mexico	Argentina	Chile
Relative Attention					
Single News	Coefficient	0.0036738	0.0079507***	0.0036069*	0.0023656**
		(0.0030969)	(0.0028024)	(0.0021158)	(0.0010196)
	Overidentification	25.68**			
	p-value	0.0119			
	Joint significance	5.61**			
	p-value	0.0179			
	Observations	768	768	768	768
Joint News	Coefficient	-0.0025811	-0.0028396	-0.0002049	-0.0007559
		(0.0021312)	(0.0018328)	(0.0012864)	(0.0006272)
	Overidentification	12.796			
	p-value	0.3840			
	Joint significance	1.74			
	p-value	0.1878			
	Observations	361	361	361	361
Overall News	Coefficient	-0.0036612	0.0087759	0.0050465	0.0015587
		(0.0048723)	(0.0056682)	(0.0040096)	(0.0015072)
	Overidentification	20.131*			
	p-value	0.0646			
	Joint significance	1.15			
	p-value	0.2830			
	Observations	770	770	770	770

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10 shows the result of estimating equation 9 i.e. our proposition 1 with the alternative measure of joint news as the variable of interest. The results are qualitatively in line with those in table 5 and therefore shown here in the appendix.

Table 10: Proposition 1 - Asian volatility (alternative)

	(1)	(2)	(3)	(4)
	Asset price covariance (level)		Asset price correlation	
Lagged Joint News	0.000117***	0.000117***	0.108***	0.108***
	(4.24)	(4.29)	(4.90)	(4.91)
Attention (single news)	0.00000166***		0.000412***	
	(9.45)		(2.68)	
Attention (overall news)		0.00000154***		0.000179
		(8.14)		(1.11)
Trade flows	7.52e-14***	6.35e-14***	2.45e-11**	2.04e-11*
	(4.91)	(4.25)	(1.98)	(1.67)
Market valuation	-1.76e-11***	-1.79e-11***	7.44e-09	1.23e-08***
	(-3.89)	(-3.86)	(1.62)	(2.63)
Mean Trade flows with Asia	4.24e-13*	3.78e-13	-7.17e-10***	-7.88e-10***
	(1.80)	(1.59)	(-3.13)	(-3.43)
Quadratic time trend	0.000246	0.000203	-0.564	-0.576
	(0.42)	(0.35)	(-1.10)	(-1.13)
3-Month interest rate	-0.000231***	-0.000246***	-0.0936	-0.0914
	(-2.70)	(-2.86)	(-1.26)	(-1.22)
6-Month interest rate	0.0000859	0.000102	0.0480	0.0452
	(1.16)	(1.37)	(0.70)	(0.65)
Constant	0.000272	0.000116	0.102	0.0959
	(1.32)	(0.57)	(0.69)	(0.66)
Weekday dummies	Yes	Yes	Yes	Yes
Month dummies	Yes	Yes	Yes	Yes
Observations	6096	6096	6096	6096
1st stage F-statistics	44.4977	45.029	44.4977	45.029

Robust *t* statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$