Contagion and information frictions in emerging markets: the role of joint signals

Avdiu, Besart and Gruhle, Tobias

Goethe University Frankfurt, Johannes Gutenberg University of Mainz

28 February 2018

Contagion and Information Frictions in Emerging Markets: The Role of Joint Signals*

Besart Avdiu†1 and Tobias Gruhle‡2

[1] *Goethe University Frankfurt*
[2] *Johannes Gutenberg University Mainz*

January 31, 2019

Abstract

We show that information frictions can explain financial contagion among independent markets and explain why emerging market countries 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. Furthermore, this contagion channel is more likely for emerging markets than for very developed or low income countries. This is because incentives to demand country specific information instead of joint signals are higher in developed countries as opposed to emerging markets. Furthermore, for the least developed countries, investors have a stronger incentive to not process any information, which precludes information driven 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.

Keywords: Financial Crises, Emerging Markets, Contagion, Information Choice, News.

JEL Classification: D8, F30, G11.

---

*We thank Jocelyn Donze, Ester Faia, Philipp Harms, Philip Sauré, Alfons Weichenrieder and Mirko Wiederholt for their valuable comments. We would also like to thank seminar participants at the universities of Frankurt, Mainz and Siegen, as well as participants at the Jahrestagung des Vereins für Socialpolitik 2018, the 74th annual congress of the IIPF, the 17th Journées Louis-André Gérard-Varet, the 15th Augustin Cournot Doctoral Days and the 20th Göttinger Workshop Internationale Wirtschaftsbeziehungen.

†avdiu@wiwi.uni-frankfurt.de
‡tobias.gruhle@uni-mainz.de

1 Introduction

A feature of crises in emerging markets is that they often exhibit contagion. 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. Similarly, as Eichengreen et al. (1996) point out, an important justification for the assistance provided to Mexico in 1995 was that their crisis could 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[2] 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), for example, 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. Furthermore, it is especially surprising that contagion can happen among countries with seemingly unrelated fundamentals. We therefore view this puzzle as a matter of excess covariance among countries and link this to information frictions on the side of investors[3].

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 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 that costly information, which results in grouped signals, can result in contagion. Unlike the literature, in our empirical setup 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 do not adequately address. The reason is that emerging

[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]One concern with the crisis in Turkey in August 2018 was that it might spread to other emerging markets. The IMF states in its World Economic Outlook report from October 2018: "The recent turmoil in Turkey,[...], exemplifies the increased salience of this risk for other vulnerable emerging markets." See `https://www.imf.org/~/media/Files/Publications/WEO/2018/October/English/main-report/Text.ashx?la=en`, last accessed 11th October 2018.

[3]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.

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[4]. 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 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, compared to developed ones. This is because information discovery costs are high[5] and there is less demand for specific information on emerging markets due to a lower number of interested investors[6]. Such issues make country-specific information on emerging markets more expensive than for rich countries, partially because there are less investors to carry the fixed cost of information. Furthermore, emerging markets are likely to exhibit lower benefits from detailed information. Nevertheless, for these countries 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 emerging markets especially prone to contagion. 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. Using this richer news data set, we replicate and re-examine some of the empirical analysis in Mondria and Quintana-Domeque (2013). Furthermore, the identification strategy to test our original hypotheses exploits terrorist attacks, which crowd out other news, thereby generating exogenous financial news variation. The number of terrorist attacks is used as an instrumental variable for joint news, as this likely proxies the extent of news coverage on attacks. Moreover, the terrorist attacks in our sample are all relatively small in terms of fatalities and are not expected to affect the global economy. Our 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 also find the relationship between grouped signals and the cost of information production to be of an inverted U-shape, supporting the hypothesis that information frictions especially affect emerging economies while least developed and advanced economies are less exposed. This evidence

[4]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.

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

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

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

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. Nevertheless, for countries where investors have no information, providing slightly easier access to information can increase the likelihood of contagion. This occurs if at first the increase in information causes investors to group signals instead of processing country specific 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.

2 Literature Review

There is a large body of work dealing with international contagion, which has been 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

[8] See Calvo and Mendoza (2000a)

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 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

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

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

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. 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. They make three predictions and find strong empirical evidence for one, but more limited evidence for the other two.

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[11]. 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 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.

[11] 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.

3 A Model of Contagion and Information Frictions

This section introduces a model of information frictions that can lead to excess covariance among independent 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 assets are independent. Furthermore, this framework explains why contagion appears to be a bigger issue for emerging markets than for very developed or low income countries. This is because information on small markets will be more expensive and the benefits from detailed information lower. These factors make the grouping of information likelier, thereby inducing covariance in emerging markets. Furthermore, for the least developed countries, information costs can be so high and informational benefits so low that investors do not inform themselves at all, thereby precluding 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 $i \in \{M, R\}$. Each country offers an asset with return u_i. 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[12] in such models. Expected utility[13] in vector notation is given by:

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

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 parameter capturing risk aversion. To simplify notation, we define $\hat{\mu} \equiv E(u|S_j)$ and $\hat{\Sigma} \equiv Var(u|S_j)$.

Following the literature, the asset returns $u_i = \theta_i + \epsilon_i$ are normally distributed and feature a learnable component θ_i and an unlearnable component ϵ_i, which are independent of each other. All components of the asset returns are also independent across countries, which is common knowledge. The prior beliefs are:

$$\theta_i \sim N(\mu_{\theta_i}, \sigma^2_{\theta_i}),\ \epsilon_i \sim N(0, \sigma^2_{\epsilon_i}),\ E(u_M u_R) = E(u_M)E(u_R) \tag{2}$$

Investors can purchase signals about the fundamentals, denoted S_j, $j \in \{M, R, B\}$. There are three possible signals, 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 perfectly reveal the learnable component of the asset

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

[13]The budget constraint is already substituted in the utility function.

returns. Conversely, the joint signal is a less precise signal about the learnable component of both country returns. Investors can purchase any combination of the signals being offered, which are defined as:

$$S_i = \theta_i,\ S_B = \theta_M + \theta_R,\ Var(S_B) = \sigma^2_{S_B} = \sigma^2_{\theta_M} + \sigma^2_{\theta_R} \tag{3}$$

The joint signal is a linear combination[14] of the learnable components across countries[15] and therefore inherently less precise than the country specific signals.

The benefit of information will be to reduce the posterior asset variances. In our model, these variances will depend on the type of information that is observed, which only lowers the learnable component of the asset variance. The variance coming from the unlearnable component, $\sigma^2_{\epsilon_i}$, however, will always be present, regardless of the information decision. Hence, $\sigma^2_{\epsilon_i}$, represents a lower bound for the perceived asset variance. We therefore refer to this as term as the fundamental asset variance.

Contagion arises in our model if the more precise country specific signals happen to be more expensive than the joint signal. We will show how this can be the outcome of information markets following Veldkamp (2006a) with endogenous information costs. Signals are produced with a fixed cost χ_j[16] and no marginal cost. Furthermore, it is reasonable to assume that a country specific signal, which is less noisy than a joint signal, is at least as expensive to produce. Hence, we assume $\chi_B = \alpha\chi_i \equiv \alpha\chi,\ 0 < \alpha \leq 1$. Agents cannot resell purchased information and there is free entry[17] in the production of information, which means that the price of a signal will be equal to its average cost[18]. While such a structure generates increasing returns in the production of information, this feature is irrelevant for the results.

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[19] producing a signal S_j solves:

$$\max_{c_j, I_j} \sum_j I_j(c_j\lambda_j - \chi_j) \tag{4}$$

The order of events is as follows. First, agents decide which signals to purchase. Then, the

[14] The results remain unchanged if positive weights are attached to each θ_i.

[15] An alternative interpretation is that the joint signal is a linear combination of the country specific signals.

[16] The parameter of the cost of information production itself – while being exogenous in the context of our model – would depend on cost like the hiring of a journalist to investigate a story but also on the accessibility of information that would be provided as public services, for instance by national statistical offices.

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

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

[19] One could similarly consider an explicit additional actor in the model that produces information, such as the Financial Times.

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 for 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.

Definition 1. *A symmetric market 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) and 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 determined by 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[20] 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.

Proposition 1. *A symmetric market equilibrium is a contagion equilibrium if and only if the joint signal is purchased.*

[20]Since all agents have the same information set, the price does not serve as a signal and is therefore given by equation (6).

Proof. Excess covariance is required for a contagion equilibrium. First, note that with perfect information the covariance will be zero, as the assets 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, $Cov(P_M(S_M), P_R(S_R))$, 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.

Furthermore, observing the joint signal along with two country specific signals is never a symmetric market equilibrium, because in that case the joint signal offers no additional information, but has a positive cost. Consider now the case where only the joint signal S_B is observed. From equation (6) we have:

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

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

Alternatively, if one specific signal for country i is observed along with the joint signal then:

$$P_i(S_i, S_B) = \frac{1}{r}\left[\theta_i - \rho x_i\, \sigma^2_{\epsilon_i}\right]$$

$$P_{-i}(S_i, S_B) = \frac{1}{r}\left[\mu_{\theta_{-i}} + \frac{\sigma^2_{\theta_{-i}}}{\sigma^2_{S_B}}[S_B - E(S_B)] - \rho x_{-i} \left(\sigma^2_{\epsilon_{-i}} + \frac{\sigma^2_{\theta_M}\sigma^2_{\theta_R}}{\sigma^2_{S_B}}\right)\right]$$

The covariance in both cases is therefore:

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

□

Since common information enters the portfolio decision for both assets, there is covariance between the markets, even though they are independent. The intuition for contagion here 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. Furthermore, in this context, a little information in the form of joint signals 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 one of the following conditions holds:*

1. *Average information costs* $\frac{\chi}{\lambda}$ *are intermediate.*
2. *Excess returns* $(\mu_{\theta_i} - p_i r)$ *are intermediate.*
3. *The unlearnable (fundamental) asset variance* $\sigma^2_{\epsilon_i}$ *is intermediate.*

4. The learnable asset variance $\sigma^2_{\theta_i}$ is intermediate and the difference in utility between the joint signal and no information is increasing in $\sigma^2_{\theta_i}$.
5. The learnable asset variance $\sigma^2_{\theta_i}$ is sufficiently low and the difference in utility between the joint signal and no information is nonincreasing in $\sigma^2_{\theta_i}$.

Proof. See appendix. □

The exact ranges for the parameters, i.e. the mathematical definitions of an intermediate range, are discussed in the proof. The general intuition for the result is as follows. 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. Analogously, if benefits from information are very high, which depend on the excess returns and variance terms, then only country specific signals will be purchased. If they are very low, then no information is optimal. Hence, the joint signal is only purchased for intermediate levels of informational costs and benefits. We view these conditions as features of emerging markets, which implies that contagion is more likely for these countries.

We can expect emerging markets to exhibit intermediate levels of informational costs, because the signal prices depend negatively on the number of interested investors λ and positively on information production costs χ. Markets of developed countries, for which there is a lot of interest, will have cheaper information and will be less likely to suffer from the discussed information frictions. Furthermore, we might expect the cost 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. Similarly, 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. Such a case, however, is likelier for least developed countries than for emerging markets.

The intuition for the second and third condition of proposition 2 is similar. The benefit from country-specific signals increases with the excess returns. This is also true for the risk-adjusted excess returns, when the fundamental variance is used, i.e. for $\frac{\mu_{\theta_i} - p_i r}{\sigma_{\epsilon_i}}$. Hence, if some markets promise better (risk-adjusted) returns, it is less likely for investors to group signals of those countries. If countries offer very low (risk-adjusted) returns, then no information can again become optimal. Similarly, informational benefits are decreasing in the fundamental (unlearnable) volatility. This is because the fundamental volatility cannot be reduced through information and very volatile assets provide lower utility to risk averse investors. With a high unlearnable asset variance, any information will only have a limited impact and may not be worth the cost. Hence, no information becomes optimal for a high fundamental asset variance. Conversely, country specific signals become optimal for very low levels and the joint signal can be purchased for intermediate levels of the fundamental asset variances. We believe it is likelier that emerging markets have intermediate levels of excess returns and fundamental variance as compared to very developed or low income countries.

Lastly, conditions 4 and 5 of proposition 2 can be explained as follows. As the learnable component of variance, $\sigma^2_{\theta_i}$, increases, the prior variance become high and signals can substantially reduce the asset variance. In that case, no information becomes less beneficial compared to some information. Nevertheless, for the joint signal, where the learnable asset variance of one country is noise for the other country, this increase also results in an increase in the joint signal variance, thereby making it less valuable. The net effect on the joint signal is ambiguous. If the difference in utility between the joint signal and no information increases as a result, then the same arguments as for the excess returns apply. Otherwise, the joint signal becomes sub-optimal for sufficiently high levels of $\sigma^2_{\theta_i}$ and possibly optimal for sufficiently low levels.

In conclusion, the model predicts that developed countries are less likely to be affected by contagion than emerging markets. Furthermore, for the least developed countries, investors may not purchase any information, thereby precluding information driven contagion there. This can explain why contagion episodes are rarely observed among very developed or low income 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. *Let an emerging market country be defined as a country with intermediate levels of either information production costs, information demand, excess returns or fundamental asset variance. Then, a contagion equilibrium is likelier for emerging market countries than for very developed or least developed countries.*

It is worth noting that 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 creates a negative externality. Furthermore, the empirical literature often sees contagion as a regional phenomenon[21]. This could also 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 more similar countries. Hence, the optimal joint signals are likely to contain groups of similar countries, which would lead to (more) contagion among them.

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

4 Empirical Evidence

This section presents empirical evidence supporting the theoretical implications of our model. As discussed, 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 results is 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 causes 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 levels of information costs, excess returns or fundamental volatility – our proposition 2 – which offers an explanation for why contagion affects emerging markets more often. The empirical analysis reflects these novelties by taking joint news into account and testing our two propositions.

4.1 Data Description

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 in more tranquil times. During periods of crisis, however, the steady excess covariance of assets is especially apparent.

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 that are published in the Financial Times (FT), which has become a standard proxy in the literature. 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) and Mondria and Quintana-Domeque (2013). 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 use of 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[22] make it a reasonable proxy for global information about countries concerning mainly news that is relevant for economic top-

[22]See footnote 16 in Mondria and Quintana-Domeque (2013).

ics. 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 also being 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[23]. 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.

This logic carries over to joint news. If demand for country specific information on emerging markets is low and discovery costs of such information are high, then the FT will have few stories with country specific information for emerging markets. It then becomes profitable for the FT to offer joint news stories on emerging markets, because information discovery costs for such broad stories are cheaper than for very detailed ones. Similarly, if emerging markets are relatively less interesting, then a joint news story on many emerging markets may also attract a higher audience per story than country specific news. Therefore, the same forces that drive the existence of joint signals in the model also determine the amount of joint news stories in the FT.

A concern of using FT articles to proxy the signals from our model could be that the FT offers one price for many signals, while the agents in our model purchase signals individually. While imperfect proxies are a concern for all empirical papers on information frictions, we do not believe that this fact represents an issue in our case. First, note that the cost of the signals is irrelevant for the test of proposition 1, which constitutes the bulk of our empirical analysis. Regardless of what signals cost, the model predicts that joint news articles increase covariance. Furthermore, the factors that determine the signal prices in our model are information demand and discovery costs. As discussed, both these factors influence the observed equilibrium news articles. The number of (joint) news articles in the FT therefore reflects those predicted by the model. The fact that our empirical test of proposition 2 indeed finds that information cost and demand factors influence the observed amounts of joint news in the FT is reassuring in this regard.

In our data, an article in the FT is regarded as being a signal about a country if its name, adjective or abbreviation of its currency is featured in the headline or first paragraph. The number of daily newspaper articles is counted using data from the Lexis Nexis Database. Articles are

[23]See Veldkamp (2006a).

sorted into two categories. A story in the FT containing only a reference, i.e. a name, adjective or currency abbreviation, to a single country of our sample, but no reference to any other country from the sample, is considered to be *single news* about the country. To allow for the possibility of signals that are a combination of information about two or more countries, *joint signals* are counted separately. The proxy for a joint signal is an FT article in which references to at least two countries of the group appear in either the headline or the first paragraph. This definition is chosen in order to avoid double counting of joint news and single news.

Importantly, joint news articles are not evaluated in how far each of the included countries plays a role. While this leaves open the exact weights of the joint signals with respect to the included countries, 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. Hence, 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 joint signals through the joint news articles.

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. 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[24] for the groups of Asian and Latin American countries in the sample.

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.

In order to get a measure of importance of joint signals for countries, the ratio of joint news to overall news[25] 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

[24]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.

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

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. The classification[26] 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, such as sports or societal events, can also be seen as attention that is paid to a certain country, it is less likely to be information that is processed by investors with scarce 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 and relevant attention of international investors.

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 the Philippines, as these countries played a prominent role[27] during this episode. Furthermore, we add Mexico to our sample of Latin American countries, due to its economic importance.

One important issue to consider with respect to the countries in our sample and the FT as our proxy for the information processed by investors is the timing 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 the Datastream Global Index, from which the daily 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[28] in the literature. Furthermore, we make use of a number of control variables. To account for fundamental channels of contagion, we

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

[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]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.

collect data on monthly trade flows between the countries 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.

4.2 Estimation

4.2.1 Revisiting the Literature using Joint News

Before turning to direct tests of our model, we first revisit the results of Mondria and Quintana-Domeque (2013) in the context of our data and study the different effects of single news, overall news and joint news in cases of international attention shifts. To this end, we take parts of the empirical study by 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 confirm some of their results regarding attention shifts in times of crisis. Nevertheless, the fact that our sample allows to test for the effects of different types of attention allows for a more complete picture.

To study the attention shift during the Asian crisis we estimate the following equation[29]:

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

where $Attention_{t,i}^{Asia}$ is the attention in absolute or relative[30] 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

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

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

in country j, with j being one of the Latin American countries of our sample. $\mathbf{X}$ 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 crisis in 1994 and 1995 and make 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[31] (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 do find that increases in joint Asian news lead to increased volatilities in Mexico and Brazil, which is significant at the 5% and 10% level, respectively. For our estimation with relative Asian news on the other hand, we can only find a significant effect at the 10% level of single news on Latin American volatility. Hence, if single news about Asia increase relative to single news about Latin American countries, 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.

These results show that it is important to take the 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 attention shifts toward Asia cause 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[32] directed towards the Asian countries, for instance, we see that more overall news shifts away from Latin America seems to increase the uncertainty in the Latin American markets. This is indeed the type of news that the literature has mostly focused on so far.

Nevertheless, examining the composition of overall news shows that these results do 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. This is in line with the predictions from our model. Since single news stories have the best information content, they are also expected to have the biggest impact on volatility according to the model. Hence, a reduction in single news stories on Latin America due to the shift of such stories toward

[31] We additionally estimated equation (7) with two-stage least squares (2SLS) using the amount of non-financial news as an instrument for relative attention. The results can be found in table 8 in the appendix.

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

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

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

Asia, is expected to increase volatility in Latin America. Notably, we do not find any effect of shifting joint news between Asia and Latin America on the uncertainty in Latin America. Such smaller effects for joint news shifts than for shifts of single news stories are also consistent with our model. This is because joint news stories have lower information content than single news stories, which means that a reduction due to a shift of such stories will have a limited impact on volatility in Latin America.

To further examine the interplay of joint news with the attention shifts hypothesis of Mondria and Quintana-Domeque (2013), we now analyze the effect of Asian volatility on joint news stories for Latin American countries. As stated in proposition 1, we regard joint news to have a special effect on investors. According to our model, we would expect an increase in Asian volatility to increase joint news for Latin America. As Mondria and Quintana-Domeque (2013) point out, increased volatility in Asia increases incentives for more extensive news coverage on Asia. In the context of our model, the resulting increase in 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. To test how the importance of joint news about Latin America changed during the time of increased uncertainty in Asia, we estimate the following equation:

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

$Joint_t^{LA}$ 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.

The results from estimating equation (8) are shown in table 4. We find a positive and significant coefficient of lagged Asian volatility for both of our dependent variables. Increases in the uncertainty in Asia led to more signals about Latin American countries being grouped as well as a higher share of overall attention paid towards Latin America becoming 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 grouped signals may have played a role in these contagion episodes.

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

4.2.2 Testing the Model

We now turn to more direct tests of our model. Our proposition 1 predicts that joint news among countries will lead to excess comovement of asset prices among these countries. To empirically test this prediction we aim to estimate the following equation:

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

where $Cov_{\tau,i,j}$ is either the covariance or the correlation of the stock market prices of countries i and j in time window τ. All countries in our sample are included in this estimation. 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[33] 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 in both cases. $\mathbf{Y}$ is a vector of control variables, such as 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. 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, country-pair fixed effects, and the US interest rates.

[33]We use two alternative measures – joint news and shared news – as a proxy for joint signals in our estimation. 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. Both measure are proxies for joint signals about the countries in our sample with the measure of joint news being more general. All empirical results with the measure of shared news are shown in the appendix and are qualitatively in line with the results presented in the paper.

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.

Table 5: Proposition 1 - OLS

	(1)	(2)	(3)	(4)
	Asset price covariance (level)		Asset price correlation	
Lagged Joint News	0.00000580***	0.00000391***	0.00147**	0.00167***
	(5.50)	(3.75)	(2.40)	(2.71)
Attention (single news)	0.00000176***		-0.000287***	
	(19.77)		(-6.18)	
Attention (overall news)		0.00000193***		-0.000244***
		(23.87)		(-6.09)
Trade flows	7.12e-08**	0.000000128***	-0.0000105	-0.0000148
	(2.39)	(4.25)	(-0.41)	(-0.58)
Market valuation	-4.24e-11***	-3.70e-11***	2.66e-08***	2.59e-08***
	(-21.49)	(-20.16)	(19.86)	(19.25)
Quadratic time trend	0.000504**	0.000509**	0.151	0.153
	(2.30)	(2.35)	(0.98)	(0.99)
3-Month interest rate	-0.0000952***	-0.000121***	-0.00953	-0.00704
	(-2.87)	(-3.65)	(-0.39)	(-0.29)
6-Month interest rate	0.0000379	0.0000722***	-0.00283	-0.00633
	(1.43)	(2.73)	(-0.13)	(-0.29)
Constant	0.000481***	0.000188***	0.250***	0.280***
	(6.76)	(2.62)	(5.10)	(5.66)
Weekday FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Country pair FE	Yes	Yes	Yes	Yes
Observations	28448	28448	28448	28448
Adjusted R^2	0.398	0.409	0.390	0.390

Robust *t* statistics in parentheses

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

An important point about the estimation of equation (9) 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 model in the previous chapter excluded any type of fundamental contagion by having the assets and signals be independent of each other. Nevertheless, this cannot 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 do not only include the trade flows as one of the main fundamental channels of contagion as a control, but 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

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

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, 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 address this possible source of endogeneity, we instrument the amount of lagged joint news of two countries and estimate equation (9) with two-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.

As an instrument for joint news we use the number of worldwide terrorist attacks[35] on a given day. Any terrorist attack will affect the news cycle and therefore affects the number of joint news about certain countries in the FT. We expect that the more terrorist attacks happen, the stronger the consequences for the news market are on a given day. Additionally, we assume that terrorist attacks do not affect the market comovement between two countries. While a direct effect of terrorist attacks on the economy cannot be discounted in general (such as the 9/11 attacks), we do not see any attack of such significance[36] in our sample period. Nonetheless, we exclude any attacks in the countries of our sample to avoid any potential direct effects on the stock markets that we study. Interestingly, there have been attacks on nearly each day of our time frame. Therefore, using this instrument does not result in a loss of observations. Instruments regarding news congestion have also been applied before, for example in Eisensee and Strömberg (2007), who study disaster relief. The occurrence of terror attacks has also been used as an instrument in Garz (2017) in the context of unemployment reports, whereas the number of fatalities has been used in Garz and Pagels (2018) in the context of tax evasion. As an alternative, we also consider lagged Asian volatility as an instrument. The results are similar and can be found in the appendix.

According to proposition 1, we expect the coefficient ω_1 to be significantly positive in our estimation. Tables 5 and 6 show the results of the two specifications that were estimated. 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

[35]This data is provided by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) (2017).

[36]Out of the 1045 days in our sample 67 days are without any reported terrorist attack. The sample average of attacks per day is 5.38 in any country but the countries in our sample. Looking at the number of fatalities of terrorist attacks per day as a measure of the severity of the attacks we see an average of 16.69 fatalities per day in terrorist attacks and only 21 out of 1045 days with more than a hundred fatalities on a given day. We therefore conclude, that global terrorist activities in our sample period were not severe enough to drive asset markets in the countries in our sample.

of overall news. Columns 3 and 4 repeat these estimations with the market return correlation as the dependent variable.

Table 5 shows the results of estimating equation (9) with OLS. As expected in all four specifications the coefficient of interest ω_1 is significant and positive.[37] While we see this result as an indicator of the positive relationship of joint signals and comovement of asset markets, the endogeneity problem as discussed above remains. Therefore, table 6 shows the results of the estimation with 2SLS. The coefficient of interest ω_1 is positive and significant for all specifications. We can clearly reject the hypothesis of weak instruments[38] in our estimation for the specifications with the joint news as the variable of interest.

Table 6: Proposition 1 - IV with Terrorist attacks

	(1)	(2)	(3)	(4)
	Asset price covariance (level)		Asset price correlation	
Lagged Joint News	0.0000470***	0.0000460**	0.0609***	0.0614***
	(2.61)	(2.53)	(3.06)	(3.08)
Attention (single news)	0.00000160***		-0.000523***	
	(14.06)		(-5.49)	
Attention (overall news)		0.00000164***		-0.000658***
		(11.12)		(-4.53)
Trade flows	0.000000107***	0.000000151***	0.0000414	0.0000182
	(3.08)	(4.57)	(1.22)	(0.58)
Market valuation	-3.92e-11***	-3.46e-11***	3.11e-08***	2.93e-08***
	(-16.08)	(-15.96)	(14.24)	(15.03)
Quadratic time trend	0.000714***	0.000716***	0.453**	0.447**
	(3.01)	(3.04)	(2.26)	(2.24)
3-Month interest rate	-0.0000910***	-0.000112***	-0.00349	0.00614
	(-2.63)	(-3.22)	(-0.13)	(0.22)
6-Month interest rate	0.0000306	0.0000583**	-0.0133	-0.0260
	(1.09)	(2.05)	(-0.53)	(-1.01)
Constant	0.000358***	0.000119	0.0737	0.182***
	(3.93)	(1.47)	(0.89)	(2.71)
Weekday FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Country pair FE	Yes	Yes	Yes	Yes
Observations	28448	28448	28448	28448
1st stage F-statistics	29.8854	29.9691	29.8854	29.9691
Olea-Pflueger (10 % level)	yes	yes	yes	yes
Olea-Pflueger (5 % level)	yes	yes	yes	yes

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

We therefore find support for our proposition 1. An exogenous increase in news that covers more than a single country, which is unrelated to economic fundamentals, results in higher comovement of market returns for these countries, which is the contagion channel proposed in our model. The economic significance of this effect is also not negligible with a one standard deviation

[37]As a robustness test we also estimated equation 9 with different time windows. While we saw some cases in which the coefficient ω_1 was no longer significant for the specifications using the covariance as a dependent variable, ω_1 remained strongly positive and significant for the specifications with the correlation as the dependent variable.

[38]The F-statistic of the first stage regressions are at least 29.885 for our instrument of number of terrorist attacks. Using the critical values for robust weak instrument tests proposed by Olea and Pflueger (2013) we can reject the null hypothesis of the bias in the estimator being greater than 10 % of the worst case bias on at least a 5% level for all four specifications.

increase of lagged joint news resulting in an increase of the market return covariance of 0.2726 to 0.2785 standard deviations and an increase between 0.4991 and 0.5032 standard deviations of the correlation. We conclude that this is an effect of economic significance.

We now proceed with a test of proposition 2, i.e. we test how factors that determine information costs and benefits can affect the existence of joint news and therefore cause contagion. The higher importance of joint signals for countries might be the consequence of either intermediate information cost, excess returns or fundamental volatility. 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 on day t. Our main variables of interest are proxies for the cost of information production, $Cost_{t,i}$, the excess market return, $Return_{t-1,i}$, and fundamental volatility, $Vola_{t-1,i}$.

As shown in proposition 2, if information cost are too high (or benefits too low), we expect investors to not inform themselves at all. Conversely, very low costs (and high benefits) lead investors to prefer the more informative specific signals. Given that some information exists for the countries in our sample, a no information equilibrium is unlikely to be the case for them. Our model then implies that higher information costs or fundamental volatility, as well as lower asset return, should increase the presence of joint news. Nevertheless, for cases with an excessively high information cost (or excessively low interest due to low informational benefits), we may observe less joint news as a result of less news overall. The ratio of joint news to overall news, however, should not be affected in this case. We would then again expect higher costs and volatilities to increase joint news, with an opposite effect of returns.

Our proxies for information production costs are the distance[39] to London – where the FT is edited – in km. We also include the squared distance to account for possible non-linear effects from the reduction in overall joint news for very high cost levels. Another possible reason for the relationship to be non-linear is that costs do not increase linearly with increasing distance. This would be captured by the quadratic term as well. Additionally, we include a dummy for a country having English – being the language of the FT – as an official[40] 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.

As a proxy for excess market returns we use the lagged daily return of the stock market of the

[39] 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).

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

respective country. In the absence of a no information equilibrium, condition 2 of proposition 2 predicts a negative coefficient of the lagged asset returns. The quadratic value is also included in order to capture any non-linear effects, which could arise from very low returns resulting in no information whatsoever and therefore less joint news as a result.

We also include the lagged volatility of the respective stock market and expect the coefficient to be positive. Note that the actual market volatility is most closely resembled by the fundamental asset volatility in our theoretical part, $\sigma^2_{\epsilon_i}$. Given that investors inform themselves in some way, this will mainly leave the unlearnable component of the asset variance as remaining for the informed investors. Additionally, similar to volatility that can be diversified away by means of portfolio selection, the fundamental asset volatility is what drives investors' views on assets and therefore their decision on how to inform themselves about any given asset. In the absence of no information equilibria, the higher the fundamental volatility is, the larger should be on average the role of joint news for a given country in line with condition 3. This relationship may also be non-linear, in which case we expect the coefficient of the quadratic term to be negative.

We additionally 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 $\mathbf{Z}$ also 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 7 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 joint news ratio as the dependent variable.

Our results find support for the effects of the three measures that can cause the grouping of signals according to proposition 2. The first estimation shows that the relationship between our proxy for costs and the absolute number of joint news has an inverted U-shape. Both coefficients have the expected sign and are significant on at least a 5% level. This supports the condition 1 of proposition 2 that intermediate cost of information result in more joint news. In general, however, we conclude from the results that, given that agents inform themselves, higher costs result in a higher share of joint news. Furthermore, we find negative and significant coefficients on at least a 1% level 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.

For our measure of excess returns, we find an expected negative and significant coefficient on at least a 5% level for the first estimation with the absolute number of joint news. Hence, given that agents choose to acquire information, lower asset returns result in more joint signals being processed. Countries with higher stock market returns are less likely to appear in joint news. We do not find a significant effect of the lagged market return on the joint news ratio, but observe the expected negative sign of the coefficient. However, the coefficient of the quadratic asset return is insignificant in both estimations. Our third variable of interest, the lagged stock market volatility also shows the expected positive sign of the coefficient and is significant on at least a 1% level in both estimations. We interpret this as countries with a higher fundamental volatility being more likely to be covered in joint news in both absolute and relative terms as predicted by our condition 3 of proposition 2. The quadratic terms of the volatilities are, as expected, negative and highly significant at the 1% level, supporting an inverted U-shape of the relationship as well.

Additionally, we find some support for a colonial history with the UK negatively affecting joint news, which we see as a control for more inherent investor interest in countries. Countries that are of higher interest for investors have a higher share of more specific single news or less absolute joint 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, which can lead to contagion. This helps explain why episodes of non-fundamental contagion are less likely to affect more advanced or low income economies[41], our corollary 1, which are generally seen by investors as markets with higher interest and lower informational costs.

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. 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.

[41] One notable point is that our sample consists of countries that are all classified as emerging economies. Therefore, we see this result as supporting proposition 2 which states how the cost of information, excess returns and fundamental uncertainty affect the prevalence of joint news for countries. While we cannot test our corollary 1 directly, we see the results of the test of proposition 2 as a strong support for the same drivers affecting also low income and advanced economies which together with corollary 1 explains the observation that contagion is mainly affecting emerging economies.

Table 7: Proposition 2

	(1) Joint news (amount)	(2) Joint news (% overall)
Distance to London (km)	0.00129**	0.135***
	(2.22)	(8.00)
Squared distance	-6.26e-08**	-0.00000635***
	(-2.24)	(-7.82)
English (official)	-0.192***	-12.54***
	(-3.67)	(-6.95)
Lagged asset return (%)	-1.982**	-31.77
	(-2.38)	(-1.51)
Squared lagged asset return	4.430	78.20
	(1.05)	(0.71)
Lagged asset volatility	19.56***	213.0***
	(7.96)	(3.56)
Squared lagged asset volatility	-82.29***	-1145.4***
	(-4.23)	(-2.89)
Lagged market value (million USD)	0.379	-13.20
	(0.77)	(-1.01)
Colonial history	-0.0835	-6.845***
	(-1.35)	(-3.92)
Lagged attention (overall news)	0.0180**	-0.200
	(2.05)	(-1.11)
Quadratic time trend	-0.256*	-4.207
	(-1.78)	(-0.91)
3 months US interest rate	0.581***	15.35***
	(3.11)	(2.84)
6 months US interest rate	-0.613***	-16.76***
	(-3.62)	(-3.40)
Constant	-5.829*	-669.7***
	(-1.96)	(-7.75)
Weekday dummies	Yes	Yes
Year dummies	Yes	Yes
Observations	8239	6207
Adjusted R^2	0.049	0.043

Robust *t* statistics in parentheses

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

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. For the least developed countries, however, a little information can be worse than none, as no information keeps a country safe from information driven contagion in our context.

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.

References

Bollerslev, T. (1987). A conditionally heteroskedastic time series model for speculative prices and rates of return. *The review of economics and statistics*, 69(3):542–547.

Boyer, B. H., Kumagai, T., and Yuan, K. (2006). How do crises spread? evidence from accessible and inaccessible stock indices. *The Journal of Finance*, 61(2):957–1003.

Calvo, G. A. (2004). Contagion in emerging markets: When wall street is a carrier. In Bour, E., Heymann, D., and Navajas, F., editors, *Latin American Economic Crises. International Economic Association.* Palgrave Macmillan, London.

Calvo, G. A. and Mendoza, E. G. (2000a). Capital-markets crises and economic collapse in emerging markets: An informational-frictions approach. *The American Economic Review*, 90(2):59–64.

Calvo, G. A. and Mendoza, E. G. (2000b). Rational contagion and the globalization of securities markets. *Journal of international economics*, 51(1):79–113.

Claessens, S. (2005). Taking stock of risk management techniques for sovereigns. *World Bank Policy Research Working Paper No. 3570.*

Claessens, S. and Forbes, K. J. (2004). International financial contagion: An overview of the issues and the book. *International Financial Contagion*, 3:18.

Dornbusch, R., Park, Y. C., and Claessens, S. (2000). Contagion: understanding how it spreads. *The World Bank Research Observer*, 15(2):177–197.

Eichengreen, B., Rose, A., and Wyplosz, C. (1996). Contagious currency crises: First tests. *Scandinavian Journal of Economics*, 98(4):463–84.

Eisensee, T. and Strömberg, D. (2007). News droughts, news floods, and u. s. disaster relief. *The Quarterly Journal of Economics*, 122(2):693–728.

Fang, L. and Peress, J. (2009). Media coverage and the cross-section of stock returns. *The Journal of Finance*, 64(5):2023–2052.

Forbes, K. J. (2012). The "big c": Identifying contagion. *NBER Working Paper No. 18465*.

Forbes, K. J. and Rigobon, R. (2002). No contagion, only interdependence: Measuring stock market comovements. *The Journal of Finance*, 57(5):2223–2261.

Forbes, K. J. and Warnock, F. E. (2012). Capital flow waves: Surges, stops, flight, and retrenchment. *Journal of International Economics*, 88(2):235–251.

Garz, M. (2017). Effects of unemployment news on economic perceptions evidence from german federal states. *Regional Science and Urban Economics*. doi: 10.1016/j.regsciurbeco.2017.11.006.

Garz, M. and Pagels, V. (2018). Cautionary tales: Celebrities, the news media, and participation in tax amnesties. *CESifo Working Paper Series No. 6795*.

Grossman, S. J. and Stiglitz, J. E. (1980). On the impossibility of informationally efficient markets. *The American economic review*, 70(3):393–408.

Hameed, A., Morck, R., Shen, J., and Yeung, B. (2015). Information, analysts, and stock return comovement. *The Review of Financial Studies*, 28(11):3153–3187.

Hutchison, M. M. and Noy, I. (2006). Sudden stops and the mexican wave: Currency crises, capital flow reversals and output loss in emerging markets. *Journal of Development Economics*, 79:225–248.

Kodres, L. E. and Pritsker, M. (2002). A rational expectations model of financial contagion. *The Journal of Finance*, 57(2):769–799.

Kräussl, R. (2005). Do credit rating agencies add to the dynamics of emerging market crises? *Journal of Financial Stability*, 1(3):355–385.

Mayer, T. and Zignago, S. (2011). Notes on cepiis distances measures: The geodist database. Retrieved from `http://www.cepii.fr/cepii/en/bdd_modele/download.asp?id=6`, 17.10.2017.

Mondria, J. and Quintana-Domeque, C. (2013). Financial contagion and attention allocation. *The Economic Journal*, 123(568):429–454.

Mondria, J., Wu, T., and Zhang, Y. (2010). The determinants of international investment and attention allocation: Using internet search query data. *Journal of International Economics*, 82(1):85–95.

National Consortium for the Study of Terrorism and Responses to Terrorism (START) (2017). Global terrorism database. Technical report, National Consortium for the Study of Terrorism and Responses to Terrorism (START). Retrieved from `https://www.start.umd.edu/gtd`, 22.11.2017.

Olea, J. L. M. and Pflueger, C. (2013). A robust test for weak instruments. *Journal of Business & Economic Statistics*, 31(3):358–369.

Pasquariello, P. (2007). Imperfect competition, information heterogeneity, and financial contagion. *The Review of Financial Studies*, 20(2):391–426.

Perry, G. and Lederman, D. (1998). *Financial Vulnerability, Spillover Effects, and Contagion: Lessons from the Asian Crises for Latin America*. World Bank Publications.

Reinhart, C. M. and Rogoff, K. S. (2009). *This time is different: eight centuries of financial folly*. Princeton University Press, Princeton.

Van Nieuwerburgh, S. and Veldkamp, L. (2010). Information acquisition and under-diversification. *The Review of Economic Studies*, 77(2):779–805.

Veldkamp, L. and Wolfers, J. (2007). Aggregate shocks or aggregate information? costly information and business cycle comovement. *Journal of Monetary Economics*, 54:37–55.

Veldkamp, L. L. (2006a). Information markets and the comovement of asset prices. *The Review of Economic Studies*, 73(3):823–845.

Veldkamp, L. L. (2006b). Media frenzies in markets for financial information. *The American economic review*, 96(3):577–601.

Veldkamp, L. L. (2011). *Information choice in macroeconomics and finance*. Princeton University Press.

Wiederholt, M. et al. (2010). Rational inattention. *The New Palgrave Dictionary of Economics (Online Edition ed.)*.

Yuan, K. (2005). Asymmetric price movements and borrowing constraints: A rational expectations equilibrium model of crises, contagion, and confusion. *The Journal of Finance*, 60(1):379–411.

Appendix

Proof of Proposition 2

We must find all conditions under which the joint signal is purchased in a symmetric market equilibrium. From proposition 1, it then follows that a contagion equilibrium exists if and only if these conditions hold.

The equilibrium asset demands and prices are given by equations (5) and (6), which ensure that the asset market clears. Note that agents are small relative to the market and take prices as exogenously given when optimizing. What remains to be found are the signal demand and supply choices.

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 $c_j = \chi_j/\lambda_j$. Recall that $\chi_B = \alpha\chi_i \equiv \alpha\chi,\ 0 < \alpha \leq 1$.

Having established the informational costs, we now turn to utility and the informational benefits. Plugging in the optimal asset demands, utility becomes:

$$U = E\Big[\frac{1}{2\rho}(\hat{\mu} - pr)'\hat{\Sigma}^{-1}(\hat{\mu} - pr) - c_j\Big] \tag{11}$$

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

Here $\sigma^2_{u_i|S_j}$ denotes the conditional asset variances. Let B denote the gross signal benefit before costs, i.e. $U(S_j) = B(S_j) - c_j$. We therefore denote the gross benefit of purchasing the joint signal $B(S_B)$, that of two specific signals $B(S_M, S_R)$ and that of no signal B^0. Writing out the expectation yields:

$$B(S_M, S_R) = \frac{1}{2\rho}E\Big[\frac{(\hat{\mu}_{\theta_M} - p_M r)^2}{\sigma^2_{u_M|S_M}} + \frac{(\hat{\mu}_{\theta_R} - p_R r)^2}{\sigma^2_{u_R|S_R}}\Big] \tag{12}$$

$$B(S_B) = \frac{1}{2\rho} E\Big[\frac{(\hat{\mu}_{\theta_M} - p_M r)^2}{\sigma^2_{u_M|S_B}} + \frac{(\hat{\mu}_{\theta_R} - p_R r)^2}{\sigma^2_{u_R|S_B}}\Big] \tag{13}$$

$$B^0 = \frac{1}{2\rho}\Big[\frac{(\mu_{\theta_M} - p_M r)^2}{\sigma^2_{\theta_M} + \sigma^2_{\epsilon_M}} + \frac{(\mu_{\theta_R} - p_R r)^2}{\sigma^2_{\theta_R} + \sigma^2_{\epsilon_R}}\Big] \tag{14}$$

Solving the expectations, we have:

$$B(S_M, S_R) = \frac{1}{2\rho}\Big[\frac{(\mu_{\theta_M} - p_M r)^2 + \sigma^2_{\theta_M}}{\sigma^2_{\epsilon_M}} + \frac{(\mu_{\theta_R} - p_R r)^2 + \sigma^2_{\theta_R}}{\sigma^2_{\epsilon_R}}\Big] \tag{15}$$

$$B(S_B) = \frac{1}{2\rho}\Big[\frac{\sigma^2_{S_B}(\mu_{\theta_M} - p_M r)^2 \ + \ \sigma^4_{\theta_M}}{\sigma^2_{\epsilon_M}\sigma^2_{S_B} \ + \ \sigma^2_{\theta_M}\sigma^2_{\theta_R}} + \frac{\sigma^2_{S_B}(\mu_{\theta_R} - p_R r)^2 \ + \ \sigma^4_{\theta_R}}{\sigma^2_{\epsilon_R}\sigma^2_{S_B} \ + \ \sigma^2_{\theta_M}\sigma^2_{\theta_R}}\Big] \tag{16}$$

It follows that the gross benefits of the other possible signal combinations are simply given by combinations of equations (14) – (16). To compare these benefits, we look at the differences between various gross benefit levels. Let $\Delta B1 \equiv B(S_M, S_R) - B(S_i, S_B)$, $\Delta B2 \equiv B(S_M, S_R) - B(S_B)$ and $\Delta B3 \equiv B(S_B) - B^0$. This yields:

$$\Delta B1 = \frac{1}{2\rho}\left[\frac{\sigma^2_{\theta_M}\sigma^2_{\theta_R}}{\sigma^2_{\epsilon_{-i}}(\sigma^2_{\epsilon_{-i}}\sigma^2_{S_B} \ + \sigma^2_{\theta_M}\sigma^2_{\theta_R})}\left[(\mu_{\theta_{-i}} - p_{-i} r)^2 + \sigma^2_{\theta_{-i}} + \sigma^2_{\epsilon_{-i}}\right]\right] > 0 \tag{17}$$

$$\Delta B2 = \frac{1}{2\rho}\left[\frac{\sigma^2_{\theta_M}\sigma^2_{\theta_R}}{\sigma^2_{\epsilon_M}(\sigma^2_{\epsilon_M}\sigma^2_{S_B} \ + \sigma^2_{\theta_M}\sigma^2_{\theta_R})}\left[(\mu_{\theta_M} - p_M r)^2 + \sigma^2_{\theta_M} + \sigma^2_{\epsilon_M}\right] + \right.$$
$$\left.\frac{\sigma^2_{\theta_M}\sigma^2_{\theta_R}}{\sigma^2_{\epsilon_R}(\sigma^2_{\epsilon_R}\sigma^2_{S_B} \ + \ \sigma^2_{\theta_M}\sigma^2_{\theta_R})}\left[(\mu_{\theta_R} - p_R r)^2 + \sigma^2_{\theta_R} + \sigma^2_{\epsilon_R}\right]\right] \equiv \Delta B2_i + \Delta B2_{-i} > 0 \tag{18}$$

$$\Delta B3 = \frac{1}{2\rho}\Big[\frac{\sigma^4_{\theta_M}}{\sigma^2_{\epsilon_M}\sigma^2_{S_B} \ + \sigma^2_{\theta_M}\sigma^2_{\theta_R}}\Big(\frac{(\mu_{\theta_M} - p_M r)^2}{\sigma^2_{\theta_M} + \sigma^2_{\epsilon_M}} + 1\Big) +$$
$$\frac{\sigma^4_{\theta_R}}{\sigma^2_{\epsilon_R}\sigma^2_{S_B} \ + \ \sigma^2_{\theta_M}\sigma^2_{\theta_R}}\Big(\frac{(\mu_{\theta_R} - p_R r)^2}{\sigma^2_{\theta_R} + \sigma^2_{\epsilon_R}} + 1\Big)\Big] \equiv \Delta B3_i + \Delta B3_{-i} > 0 \tag{19}$$

From these equations it follows that $B(S_M, S_R) > B(S_B, S_i) > B(S_B) > B^0$. Furthermore, we can also infer the following relationships regarding the purchase of only one country specific signal: $B(S_M, S_R) > B(S_B, S_i) > B(S_i) > B^0$. The comparison between one country specific signal and one joint signal is ambiguous and depends on the parameters.

We can now find the optimal signal choices by comparing utilities for different signals, i.e. by comparing the informational costs and benefits. First note that purchasing all three signals can be ruled out as an equilibrium, since the joint signal has a positive cost, but no added benefit if the two specific signals are observed. This is because the specific signals already perfectly reveal the learnable components of the asset returns, whereas the unlearnable components can never be learned. Therefore, the joint signal adds no value in this case.

We first show that a contagion equilibrium exists in general. This is the case if purchasing the joint signal alone or purchasing the joint signal along with a country specific signal yields at least as much utility as the other possible symmetric signal choices. Let $\rho = \alpha = 0.5$ and $\chi/\lambda = 1.5$, $\sigma^2_{\theta_{-i}} = \sigma^2_{\epsilon_{-i}} = (\mu_{\theta_{-i}} - p_{-i}r)^2 = 1 \ \forall i$. The utility from purchasing only the joint signal is then $U(S_B) = 1.25$, while the utilities for all other signal combinations are lower. We have $U(S_M, S_R) = U(S_i) = U^0 = 1$ and $U(S_B, S_i) = 0.75 \ \forall i$.

What remains is to find the conditions under which the joint signal is purchased in a symmetric equilibrium. The information markets then clear with $\lambda_B = \lambda$, I_B=1.

Consider different information prices for a given level of gross benefits. There exists a clear ranking of gross signal benefits $B(S_M, S_R) > B(S_B, S_i) > B(S_B) > B^0$. Furthermore, the ranking of the signal prices is analogous to that of the gross benefits. We have $c(S_M, S_R) \geq c(S_i, S_B) > c(S_B) > 0$. Therefore, for sufficiently low average information costs, e.g. as $\chi/\lambda \to 0$, the two specific signals are chosen. Similarly, for sufficiently high information prices, e.g. $\chi/\lambda \to \infty$, no information can become optimal. Therefore, for sufficiently high or low information costs, a contagion equilibrium is not possible. It follows that such an equilibrium can only be possible if the information costs are intermediate.

We now turn to specifying the intermediate cost range in which the joint signal is purchased. Suppose first that $B(S_B) \geq B(S_i) \ \forall i$ and consider the cases for which purchasing only the joint signal is optimal. Since $c(S_B) \leq c(S_i)$ it follows that the joint signal weakly dominates purchasing one specific signal. In that case, we do not need to consider the purchase of only one specific signal. A contagion equilibrium where only the joint signal is observed is then optimal if $U(S_B) \geq U(S_M, S_R)$ and $U(S_B) \geq U^0$. This is the case if $\frac{\chi}{\lambda} \in [\frac{\Delta B2}{2-\alpha}, \ \frac{\Delta B3}{\alpha}]$. If, on the other hand, $B(S_B) < B(S_i)$, the joint signal alone can still be optimal for an appropriate range of $\frac{\chi}{\lambda}$ with $\alpha < 1$, since it has the lower cost. In this case, a contagion equilibrium is still possible for and only for intermediate values of the average information costs. This is because we have shown that a contagion equilibrium exists and that it cannot exist for sufficiently high or low average information costs. Since a single country specific signal can now become optimal in parts of the aforementioned intermediate cost range, the exact range for contagion will then be a subset of the aforementioned range and can be analogously solved by comparing the informational benefits and costs. Note that there may be multiple disjoint subsets if $B(S_i) \neq B(S_{-i})$.

Similarly, purchasing the joint signal along with one country specific can also result in contagion and is optimal if $U(S_B, S_i) \geq U(S_M, S_R)$, $U(S_B, S_i) \geq U^0$, $U(S_B, S_i) \geq U(S_i)$ and $U(S_B, S_i) \geq U(S_{-i})$, which holds if $\frac{\chi}{\lambda} \geq \frac{\Delta B1}{1-\alpha}$, $\frac{\chi}{\lambda} \leq \frac{\Delta B2_i + \Delta B3}{1+\alpha}$, $\frac{\chi}{\lambda} \leq \frac{\Delta B3_{-i}}{\alpha}$ and $\frac{\chi}{\lambda} \leq \frac{\Delta B2_i + \Delta B3_i - \Delta B2_{-i}}{\alpha}$ respectively. Here we make use of the previously introduced notation $\Delta B2 \equiv \Delta B2_i + \Delta B2_{-i}$ and $\Delta B3 \equiv \Delta B3_i + \Delta B3_{-i}$. Again, we see that the joint signal can be optimal for an intermediate range of average informational costs. We do not compare the utility between purchasing only the joint signal and purchasing the joint signal along with a country specific signal, because either one leads to a contagion equilibrium. As long as one of these options is preferred to any option without a joint signal, a contagion equilibrium is ensured.

Consider now different benefit levels for given costs. The benefit differences are monotonically increasing in the excess returns and decreasing in the variance of the unlearnable component:

$$\frac{dB(S_M, S_R)}{d(\mu_{\theta_i} - p_i r)} > \frac{dB(S_B)}{d(\mu_{\theta_i} - p_i r)} > \frac{dB^0}{d(\mu_{\theta_i} - p_i r)} > 0 \tag{20}$$

$$\frac{dB(S_M, S_R)}{d\sigma^2_{\epsilon_i}} < \frac{dB(S_B)}{d\sigma^2_{\epsilon_i}} < \frac{dB^0}{d\sigma^2_{\epsilon_i}} < 0 \tag{21}$$

Furthermore, we can infer the following properties:

$$\frac{dB(S_M, S_R)}{dz_i} = \frac{dB(S_B, S_i)}{dz_i} = \frac{dB(S_i)}{dz_i} \tag{22}$$

$$\frac{dB(S_B)}{dz_i} = \frac{dB(S_B, S_{-i})}{dz_i} \tag{23}$$

$$\frac{dB(S_{-i})}{dz_i} = \frac{dB^0}{dz_i} \tag{24}$$

where $z_i \in \{(\mu_{\theta_i} - p_i r),\ \sigma^2_{\epsilon_i}\}$. Due to the monotonicity, a similar argument to before can be made, which gives rise to conditions 2 and 3 of proposition 2. As the excess returns increase and the variance of the unlearnable component decreases, the benefit of specific information to joint signals and of joint signals to no information is increasing. Therefore, if informational benefits are so large that the specific signals always outweigh the given costs, then only country specific signals are purchased. Conversely, if they are so low that the cost of information is never justified, then no information is purchased. Hence, for sufficiently high or low values of $(\mu_{\theta_i} - p_i r)$ or $\sigma^2_{\epsilon_i}$ no contagion equilibrium is possible. Furthermore, since we have shown that a contagion equilibrium exists in general, it follows that for intermediate information benefits, i.e. for intermediate values of $(\mu_{\theta_i} - p_i r)$ or $\sigma^2_{\epsilon_i}$, a contagion equilibrium is possible. The intermediate ranges can be found by solving the system $U(S_B) \geq U(S_M, S_R)$, $U(S_B) \geq U^0$ and $U(S_B) \geq U(S_i)$ as well as by solving $U(S_B, S_i) \geq U(S_M, S_R)$, $U(S_B, S_i) \geq U^0$, $U(S_B, S_i) \geq U(S_i)$ and $U(S_B, S_i) \geq U(S_{-i})$ for $(\mu_{\theta_i} - p_i r)$ and $\sigma^2_{\epsilon_i}$.

The only remaining elements of the gross benefit functions not yet discussed are the $\sigma^2_{\theta_i}$ terms. We have:

$\frac{dB(S_M,S_R)}{\sigma^2_{\theta_i}} = \frac{dB(S_i)}{\sigma^2_{\theta_i}} > 0$, $\frac{dB(S_B)}{d\sigma^2_{\theta_i}}, \frac{dB(S_B,S_i)}{d\sigma^2_{\theta_i}}, \frac{dB(S_B,S_{-i})}{d\sigma^2_{\theta_i}} \gtreqless 0$, $\frac{dB^0}{d\sigma^2_{\theta_i}} = \frac{dB(S_{-i})}{\sigma^2_{\theta_i}} < 0$, $\frac{d\Delta B_1}{\sigma^2_{\theta_i}}, \frac{d\Delta B_1}{\sigma^2_{\theta_{-i}}} > 0$, $\frac{d\Delta B_2}{\sigma^2_{\theta_i}} > 0$

The intuition for these derivatives is as follows. As the learnable component of variance increases, any kind of information increases in value, as information serves to decrease this variance. Furthermore, the prior information is now noisier, making no informational update less valuable. For the joint signal, however, where the learnable asset variance of one country is noise for the other country, this increase also results in an increase in the joint signal variance, thereby making it less valuable. Therefore, as $\sigma^2_{\theta_i}$ increases, the specific signals increase in value and no information becomes worse. The effects on the joint signal are ambiguous and require a comparison of the excess returns across countries, among other things.

This leads to two cases each for the joint signal alone and the joint signal with a country specific signal. If the difference in utility between the joint signal and no information is increasing in $\sigma^2_{\theta_i}$, i.e. if $\frac{d\Delta B_3}{d\sigma^2_{\theta_i}} > 0$, $\frac{dB(S_B,S_i)}{d\sigma^2_{\theta_i}} > \frac{dB^0}{d\sigma^2_{\theta_i}}$ and $\frac{dB(S_B,S_{-i})}{d\sigma^2_{\theta_i}} > \frac{dB^0}{d\sigma^2_{\theta_i}}$ then:

$$\frac{dB(S_M,S_R)}{d\sigma^2_{\theta_i}} > \frac{dB(S_B,S_i)}{d\sigma^2_{\theta_i}}, \frac{dB(S_B,S_{-i})}{d\sigma^2_{\theta_i}}, \frac{dB(S_B)}{d\sigma^2_{\theta_i}} > \frac{dB^0}{d\sigma^2_{\theta_i}}$$

in which case the same arguments apply as for the excess returns and the joint signal can become optimal for intermediate levels of $\sigma^2_{\theta_i}$.

Suppose now that the difference in utility between the joint signal and no information is weakly decreasing in $\sigma^2_{\theta_i}$. Then, as $\sigma^2_{\theta_i}$ increases, the joint signal becomes (weakly) worse compared to one or two country specific signals and to no information. In that case, a contagion equilibrium does not exist for sufficiently large $\sigma^2_{\theta_i}$. Similarly, the joint signal can become optimal for sufficiently low levels of $\sigma^2_{\theta_i}$. □

Empirical Appendix

Table 8 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 8: 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
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Tables 9 and 10 repeat our estimation of equation (9) with shared news as a proxy for joint signals. While all coefficients of interest show the expected sign and are significant on at least a 5 % level, we cannot reject the weak instrument hypothesis for this specification.

Tables 11 and 12 show the result of estimating equation (9), i.e. testing our proposition 1, with an alternative instrument, the lagged volatility in the stock market of the group of Asian countries in our sample. For this estimation we restrict the sample to only country pairs within Latin America. The exclusion restriction requires that comovement within Latin America is not affected by previous Asian volatility. Furthermore, our results from table 4 indicate that Asian volatility should be a strong instrument.

We can clearly reject the weak instrument hypothesis for this case. The estimated effects of an increase of joint or shared news on the comovement of asset prices are qualitatively the same as in our main specification, with somewhat larger quantitative effects. According to these results, a one standard deviation increase of lagged shared news results in an increase of the market return covariance of about 1.12 standard deviations and an increase in the correlation of about 1.33 standard deviations. A change of one standard deviation of joint news results in approximately a 0.74 standard deviation increase in covariance and a 0.88 standard deviation increase in correlation.

Table 9: Proposition 1 - OLS (Alternative)

	(1)	(2)	(3)	(4)
	Asset price covariance (level)		Asset price correlation	
Lagged Shared News	0.0000633***	0.0000531***	0.0142***	0.0153***
	(7.40)	(6.30)	(3.50)	(3.75)
Attention (single news)	0.00000175***		-0.000290***	
	(19.69)		(-6.25)	
Attention (overall news)		0.00000190***		-0.000248***
		(23.73)		(-6.21)
Trade flows	7.32e-08**	0.000000129***	-0.0000102	-0.0000147
	(2.47)	(4.31)	(-0.40)	(-0.57)
Market valuation	-4.20e-11***	-3.67e-11***	2.67e-08***	2.60e-08***
	(-21.34)	(-20.02)	(19.92)	(19.30)
Quadratic time trend	0.000496**	0.000507**	0.148	0.150
	(2.27)	(2.34)	(0.96)	(0.97)
3-Month interest rate	-0.0000951***	-0.000120***	-0.00952	-0.00698
	(-2.88)	(-3.64)	(-0.39)	(-0.29)
6-Month interest rate	0.0000377	0.0000713***	-0.00283	-0.00639
	(1.43)	(2.71)	(-0.13)	(-0.30)
Constant	0.000475***	0.000185***	0.249***	0.280***
	(6.68)	(2.58)	(5.09)	(5.66)
Weekday FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Country pair FE	Yes	Yes	Yes	Yes
Observations	28448	28448	28448	28448
Adjusted R^2	0.401	0.411	0.390	0.390

Robust t statistics in parentheses

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

Table 10: Proposition 1 - IV with Terrorist attacks (Alternative)

	(1)	(2)	(3)	(4)
	Asset price covariance (level)		Asset price correlation	
Lagged Shared News	0.000658**	0.000646**	0.853**	0.863**
	(2.04)	(1.99)	(2.15)	(2.16)
Attention (single news)	0.00000137***		-0.000824***	
	(6.01)		(-3.12)	
Attention (overall news)		0.00000130***		-0.00111***
		(3.82)		(-2.70)
Trade flows	0.000000141**	0.000000170***	0.0000848	0.0000436
	(2.42)	(3.37)	(1.19)	(0.70)
Market valuation	-3.41e-11***	-3.05e-11***	3.78e-08***	3.48e-08***
	(-6.82)	(-7.26)	(6.45)	(7.07)
Quadratic time trend	0.000701***	0.000698***	0.436	0.422
	(2.58)	(2.61)	(1.59)	(1.54)
3-Month interest rate	-0.0000883**	-0.000103***	0.0000572	0.0170
	(-2.25)	(-2.58)	(0.00)	(0.42)
6-Month interest rate	0.0000270	0.0000477	-0.0180	-0.0401
	(0.82)	(1.37)	(-0.51)	(-1.05)
Constant	0.000258*	0.0000801	-0.0560	0.131
	(1.75)	(0.76)	(-0.33)	(1.17)
Weekday FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Country pair FE	Yes	Yes	Yes	Yes
Observations	28448	28448	28448	28448
1st stage F-statistics	6.78472	6.73539	6.78472	6.73539
Olea-Pflueger (10 % level)	no	no	no	no
Olea-Pflueger (5 % level)	no	no	no	no

Robust t statistics in parentheses

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

Table 11: Proposition 1 - Asian volatility

	(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
Olea-Pflueger (10 % level)	yes	yes	yes	yes
Olea-Pflueger (5 % level)	yes	yes	yes	yes

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

Table 12: Proposition 1 - Asian volatility (alternative)

	(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
Olea-Pflueger (10 % level)	no	no	no	no
Olea-Pflueger (5 % level)	no	no	no	no

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