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Title: How credit ratings affect sovereign credit risk: cross-border evidence in Latin American emerging markets

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Abstract: This article builds upon previous literature by providing a better understanding of how contagion changes in bordering sovereign CDS emerging markets resulting from credit events. To that end, we follow the GVAR methodology using data from Latin American countries. Our findings show evidence for the existence of significant and asymmetric cross-border effects. In particular, a competition effect is observed before the event occurs, indicating that non-event countries suffer (benefit) from upgrades (downgrades) in Brazil, Mexico and Chile (in Argentina and Brazil). In contrast, an imitation effect is observed after rating upgrades in Chile, to the benefit of bordering non-event countries.

- We analyse contagion changes in CDS emerging markets resulting from credit events.
- We use GVAR model for Latin American emerging countries from 2004 to 2014.
- Evidence for the existence of significant and asymmetric cross-border effects.
- A competition effect before the event occurs. Non-event countries suffer (benefit) from upgrades (downgrades).
- An imitation effect after rating upgrades, to the benefit of bordering non-event countries.

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5 **How credit ratings affect sovereign credit risk: cross-border evidence in Latin**  
6 **American emerging markets**  
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23 **Abstract**  
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25 This article builds upon previous literature by providing a better understanding of how  
26 contagion changes in bordering sovereign CDS emerging markets resulting from credit  
27 rating events. To that end, we follow the novel GVAR methodology using data from six  
28 Latin American emerging countries during an extensive sample period from 2004 to  
29 2014. Our findings show evidence for the existence of significant and asymmetric cross-  
30 border effects. In particular, a competition effect is observed before the event occurs,  
31 indicating that non-event countries suffer (benefit) from upgrades (downgrades) in  
32 Brazil, Mexico and Chile (in Argentina and Brazil). In contrast, an imitation effect is  
33 observed after rating upgrades in Chile, to the benefit of bordering non-event countries.  
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## 1. Introduction

One of the most significant financial events of the past decade has been the rapid growth experienced by the OTC credit derivatives market. Since 2008, credit default swaps (hereafter, CDSs)<sup>1</sup> are the most widely traded credit derivative instrument used to efficiently transfer credit risk, offering opportunities for business diversification and the effective hedging of counterparty risk. According to the International Swaps and Derivatives Association (ISDA), the notional outstanding value of the CDS market increased from \$8.4 trillion at the end of 2004 to \$21 trillion at the end of 2013, marking a peak of \$58 trillion at the end of 2007. Nowadays CDSs are considered a good proxy for credit risk, where the probability of default of the reference entity (and therefore the level of risk) is assumed by the counterparty.<sup>2</sup> Furthermore CDSs are the most liquid credit derivative product and account for about half the amount of credit derivatives traded on the derivatives market.

Due to its recognised hedging qualities, the expansion of emerging debt markets might have led to the recent increase of the fraction of the CDS contracts written on high-yield debt obligations. Emerging nations are amongst the largest high-yield borrowers in the world; however, when facing financial distress, countries generally do not enter traditional bankruptcy proceedings (hence don't liquidate their assets), so the nature of default risk is somewhat different to that of a traditional debtor. In practice, countries go through debt restructuring mechanisms in which defaulted bond are exchanged for new longer maturity and lower yield debt instruments.

Furthermore, recent literature has focused on the impact of sovereign credit ratings on sovereign debt, especially for emerging economies. Christopher *et al.* (2012) assert that sovereign ratings enhance the transparency of an emerging country's credit risk profile, whereas Kim and Wu (2008) argue that rating changes within emerging economies have determinant information about the governments' capacity to deal with both, their

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<sup>1</sup> A CDS is essentially an insurance contract that provides protection against the risk of default by a specific reference entity. The CDS spread is the periodic rate that a protection buyer pays on the notional amount to the protection seller for transferring the risk of a credit event for some period.

<sup>2</sup> There are several advantages of using CDS spreads instead of bond spreads. See for instance, Blanco *et al.* (2005), Norden and Weber (2009) and Jorion and Zhang (2009), amongst others.

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4 financial obligations as well as their refinancing conditions, as rating changes provide  
5 information about the institutional quality for financial and economic development.  
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7 Theoretically, both sovereign credit risk levels measured by CDS spreads and  
8 announcements of a credit rating changes should reflect the same information content,  
9 given that both are based on publicly available information.<sup>3</sup> If this were to be true, we  
10 wouldn't expect CDS spreads to react to a rating announcement. However, several  
11 recent papers (Finnerty *et al.*, 2013, amongst others) find that the CDS market  
12 anticipates credit rating news. This literature has focused on analysing endogenic effects  
13 within a country or a firm, and hence little attention has been paid to cross-border  
14 effects. Following Wengner *et al.* (2015), we argue that the study of the response in the  
15 country that the rating event occurs in incomplete, because it does not reveal how much  
16 of the event's information is country-specific and how much is market-wide. In fact  
17 literature has demonstrated that a significant part of sovereign CDS spreads is explained  
18 by common factors such as investors' risk appetite and global economic fundamentals  
19 (Remolona *et al.*, 2008, Longstaff *et al.*, 2008, Eichengreen *et al.*, 2012), so any credit  
20 rating announcement containing new information should have spillover effects on the  
21 CDS spreads of other sovereigns. Cross-border analyses allow us to investigate if non-  
22 event countries (seen as competitors) benefit or not from the rating event in a given  
23 country. In this paper we shall address this issue.  
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38 We use the information contained in CDS contracts of Latin American emerging  
39 economies from 2004 to 2014 to investigate the cross-border spillover effects of the  
40 credit rating events. In particular, we test whether or not the contagion effect amongst  
41 sovereign CDSs has changed depending on rating announcements. The contagion is  
42 measured in terms of return spillovers following a Generalized VAR (GVAR) approach  
43 (Diebold and Yilmaz, 2012). More specifically, we calculate the change in the pairwise  
44 contagion before and after the credit rating event. Finally, we contrast whether they are  
45 statistically significant on average. We distinguish between positive and negative  
46 events, which enables us to analyse whether sovereign CDSs of non-event countries  
47 respond symmetrically to rating upgrades and downgrades in a given country.  
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60 <sup>3</sup> Intuitively, one should expect a negative relationship between them, since the higher the CDS spread,  
61 the lower the credit rating.  
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4 To sum up, we seek to address the following questions: Is there a significant change in  
5 the spillover effect on CDS spreads of non-event sovereign entities due to credit rating  
6 announcements of a given country? Is there a significant change in the contagion before  
7 or after these events? Are the reactions symmetric in response to credit rate upgrades  
8 and downgrades?  
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14 Our results are of economic relevance: portfolio managers and investors could estimate  
15 and evaluate the changes caused by the spillover effects of future credit rating  
16 announcements in one country on the non-event bordering economies. That way, they  
17 could use CDS market information in order to appropriately construct and hedge  
18 portfolios that are sensitive to sovereign credit risk contagion. Moreover, it allows us to  
19 identify the competitive effect produced by credit rating events in emerging cross-  
20 border non-event economies, which plays a pivotal role for discussions of future  
21 regulations. These findings have implications for international diversification and for a  
22 better understanding of the global/regional capital market structure.  
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31 The remaining part of this paper is organised as follows: section 2 reviews the related  
32 literature, section 3 describes the data, section 4 discusses the methodological approach  
33 while section 5 presents the results and section 6 concludes.  
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## 38 **2. Literature review**

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41 Previous research on the impact of rating changes has focused uniquely on the direct  
42 effect, that is, the impact on CDS markets within the same firm or country where the  
43 event occurs. Hull *et al.* (2004), Norden and Weber (2004), Galil and Soffer (2011) and  
44 Finnerty *et al.* (2013) amongst others, conclude that international sovereign and/or  
45 corporate CDS markets anticipate credit rating events, particularly for downgrades.<sup>4</sup>  
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51 A growing strand of the literature looks at the cross-border spillover effect, measuring  
52 whether the effect of rating announcements also extends to bordering economies. Gande  
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56 <sup>4</sup> Additionally, the literature has analyzed the effect of rating announcements on distinct markets: on bond  
57 markets (Hite and Warga, 1997, Steiner and Heinke, 2001), stock markets (Dichev and Pietroski, 2001,  
58 Behr and Güttler, 2008) or both (Hand *et al.*, 1992). They all find evidence for analogous results: there is  
59 a market response to negative credit rating events, but no (or weak) significant reaction to positive ones.  
60 Hence, downgrades seems to be better anticipated than upgrades.  
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4 and Parsley (2005), Böninghausen and Zabel (2015) and Ferreira and Gama (2007)  
5 analyse the effect on international developed and emerging sovereign bond spreads (the  
6 first two papers) and stocks (latter one). They all find evidence for the existence of  
7 asymmetric spillovers, with a bigger impact of downgrades, concluding that geographic  
8 proximity and emerging market status amplify this effect. In the same line, Christopher  
9 *et al.* (2012) use data from stock and bond markets of nineteen emerging economies and  
10 conclude that co-movements within a region respond heterogeneously to sovereign  
11 ratings information. For the case of bonds in particular, they find a competitive effect  
12 for downgrades, since they lead to investors shifting funds from the downgraded market  
13 to the surrounding region and to a greater extent to countries with higher credit ratings.  
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23 Finally, a few studies have included the CDS market in the analysis of the cross-border  
24 effect of credit rating events. Afonso *et al.* (2012) investigate the impact of sovereign  
25 credit ratings on European Union sovereign bond and CDS spreads, concluding that  
26 spillover effects are mostly insignificant for sovereign CDSs, while they are quite  
27 significant for sovereign bonds. In this latter case, they find that the effect exists  
28 especially for Eurozone countries and from lower rated countries to higher rated  
29 countries. At the international corporate level, Wengner *et al.* (2015)'s findings indicate  
30 significant spillovers on non-event firms. Concretely, downgrades (upgrades) display a  
31 competitive (imitation) effect around the event, with negative ones having a greater  
32 impact. Finally, using sovereign CDS data for twenty-two international emerging  
33 countries, Ismailescu and Kazemi (2010)'s results suggest that positive events are more  
34 likely to spill over to other emerging countries. This finding differs from the existing  
35 and previously mentioned literature related to sovereign debt markets.  
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47 In this paper, we focus our attention on the analysis of spillover effects that a credit  
48 rating event occurring in one emerging country has on the CDS spreads of other  
49 bordering economies. The relationship between sovereign debt and credit ratings plays a  
50 pivotal role, especially for emerging market investments, given the great expansion of  
51 these economies over recent years. We differ from the related papers in different ways.  
52 First, we do not only study the effect surrounding the event, but we also analyse the  
53 impact before and after the event occurs. Second, our paper also contributes to the  
54 related literature in that we focus exclusively on neighbour emerging countries within a  
55 particular area, since we argue that the cross-border spillover effect might be more  
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4 pronounced amongst bordering countries than amongst countries belonging to distinct  
5 emerging areas. In particular, we focus on Latin American emerging markets and on an  
6 extensive sample period from 2004 to 2014. In addition, we provide not only a cross-  
7 sectional study for all available countries in Latin America, but we also look at the  
8 individual national level. The former will inform us as to whether or not an average  
9 spillover effect exists amongst all the countries, and the latter will allow us to identify  
10 which countries are the transmitters of the spillover effects on the non-event countries  
11 within the area. We argue that it seems more likely to find significant cross-border  
12 effects amongst countries within the same area, since they are more likely to be seen as  
13 competitors. Finally, we follow a distinct methodology since we test whether or not  
14 significant spillover effects exist in terms of changes in financial contagion amongst the  
15 six emerging economies. The idea is to see if the existing contagion between CDSs is  
16 significantly affected by credit rating announcements in a given country. The issue of  
17 contagion in financial markets is of fundamental importance (see Celik, 2012, amongst  
18 others) as it has serious consequences for the global economy in relation to monetary  
19 policy, optimal asset allocation, risk measurement, capital adequacy and asset pricing.  
20 To the best of our knowledge this has not been investigated up to now.

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35 Therefore, we contribute to the literature in that we bring together the literature on the  
36 impact of credit rating events on distinct financial markets and the literature on financial  
37 contagion in order to provide a better understanding of how contagion changes in  
38 bordering sovereign CDS markets resulting from credit rating announcements.

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43 Although it is quite an intuitive concept, contagion is difficult to define and measure  
44 empirically. Kaminsky *et al.* (2003), Bae *et al.* (2003) and Longstaff (2010), amongst  
45 others, define contagion as an episode in which there is a significant increase in cross-  
46 market linkages when a shock occurs. According to Forbes and Rigobon (2002),  
47 contagion exists if there is a significant increase in cross-market linkages after a shock  
48 in one country, whereas Bekaert *et al.* (2014) define contagion as the co-movement in  
49 excess of what can be explained by fundamentals taking into account their evolution  
50 over time. Pericoli and Sbracia (2003) review different definitions and related measures  
51 of contagion that are frequently used in the literature,<sup>5</sup> concluding that all

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60 <sup>5</sup> They include changes in the probability of currency crises, volatility spillovers, Markov-switching  
61 models, correlation or co-movements, and changes in the transmission mechanism.



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4 methodologies are drawn by limitations and caveats. In this study, we define contagion  
5 as the change in the propagation mechanism when a shock occurs and we measure it in  
6 terms of return spillovers using the GVAR methodology of Diebold and Yilmaz (2012).  
7 This approach is particularly suited to our purposes, as it enables us to compute pairwise  
8 contagion change in a non-event bordering country resulting from a credit rating  
9 announcement. To our knowledge, this paper is the first to work with the novel GVAR  
10 method in order to document spillover effects in Latin American sovereign CDS  
11 markets caused by credit rating announcements.  
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### 19 **3. Data**

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22 Our daily dataset consists of sovereign CDS spreads for Latin American emerging  
23 countries and was obtained from Datastream. We selected US dollar denominated,  
24 senior tier, 5-year CDS quotes, since these contracts are generally considered to be the  
25 most liquid ones and constitute the majority of the entire CDS market (Jorion and  
26 Zhang, 2007 and Eichengreen *et al.*, 2012). Covering almost a decade, we work with  
27 data from April 22, 2004 to January 27, 2014 and look at six Latin American emerging  
28 markets; namely: Argentina, Brazil, Chile, Colombia, Mexico and Peru.<sup>6</sup> Hence, our  
29 dataset results in 15,288 daily panel observations for a time period of 2,548 days.  
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38 Descriptive statistics of the CDS data for each country are reported in Table 1, while  
39 Figure 1 illustrates the daily time evolution of all the countries in our sample (Panel A)  
40 and the average CDS spreads through all of them (Panel B). The mean CDS spreads  
41 varied significantly by country ranging from 69.17 bps for Chile to 1,016.35 bps for  
42 Argentina. Two sharp increases in CDS premiums are observed during the sample  
43 period; the first corresponds to the 2008 global credit crisis, affecting all countries and  
44 Argentina in particular, and the second sharp increase occurs at the end of the sample  
45 period and reflects the Argentinian credit risk troubles.  
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53 Finally, we collect rating announcement events from S&P's Sovereign Rating and  
54 Country Transfer and Convertibility Assessment Histories. Table 2 shows S&P's rating  
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59 <sup>6</sup> Following FTSE country classification as of September 2014, we cover all the types of emerging  
60 countries: advanced emerging (Brazil and Mexico), secondary emerging (Chile, Colombia and Peru) and  
61 frontier emerging (Argentina).  
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4 categories, where we transform them into a discrete variable from 1 to 22. Literature has  
5 shown that S&P rating changes occur more frequently; hence, S&P provides us with a  
6 larger data set, which is less anticipated by market participants and precedes  
7 announcements of other rating agencies (Gande and Parsley, 2005, Reisen and Von  
8 Maltzan, 1999). In this study, rating events consist of changes in ratings and/or  
9 outlooks. Positive (negative) events are upgrades (downgrades) of S&P's letter credit  
10 ratings or revisions in the sovereign country's credit outlook.<sup>7</sup>  
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17 Table 3 displays the distribution of credit rating events per country and per year. We  
18 observe 49 credit rating events for the six emerging markets in our sample, where rating  
19 upgrades clearly dominate with 40 observations in contrast to 9 downward observations.  
20 Chile, Colombia and Peru do not show negative events, while for Argentina, rating  
21 downgrades seem to be predominant. Twenty-one of the 40 positive events were  
22 reported in the first four years only, specifically until 2008. The global financial crisis  
23 of 2008 is accompanied by four downgrades reported in 2008 and 2009, affecting  
24 Argentina and Mexico. After the climax of the crisis, positive events dominate again  
25 with 16 credit rate upgrades against 4 downgrades, 3 of them affecting Argentina during  
26 2012 and 2013, a period characterised by the decline of Argentinian credit quality.  
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36 Figure 2 shows the credit rating evolution over time for each country. Overall, three  
37 main groups are observed. First, Chile stands out as the Latin American country with  
38 the highest quality credit (investment grade). Its S&P rating is around A on average  
39 over time, which means a strong payment capacity according to S&P. Next, Brazil,  
40 Colombia, Mexico and Peru are countries placed at the limit between investment grade  
41 and non-investment grade categories, which means that overall these countries are likely  
42 to fulfil their obligations, but there is ongoing uncertainty. Finally, Argentina is the  
43 Latin American country with the worst rating category over time. In fact, its S&P rating  
44 is around CCC, standing for a very high credit risk.  
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#### 54 **4. Methodology**

55 The methodology follows a two-stage empirical procedure. In the first stage, we use  
56 sovereign CDS spreads, more precisely CDS log-returns, as an indicator of sovereign  
57 credit risk and measure the contagion effect amongst each pair of countries over time in  
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61 <sup>7</sup> Credit Watches are not included because none of them occur during our sample period.  
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4 a rolling framework. To do that we follow the GVAR methodology developed by  
5 Diebold and Yilmaz (2009, 2012) and consider the *net pairwise return spillover*  
6 indices,<sup>8</sup> which measure the actual contagion between each pair of sovereign CDS  
7 return series and is given by equation (A.4). In particular, this index  $NPS_{i \rightarrow j}^G$  indicates  
8 that country  $i$  is a net transmitter (receiver) of sovereign CDS return spillovers to (from)  
9 country  $j$ .

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16 The second stage of the empirical procedure consists of measuring the impact of credit  
17 rate announcements for a given country on the cross-border contagion between  
18 sovereign CDSs. In particular, we calculate the change in the pairwise contagion before  
19 and after each credit rating event,<sup>9</sup> known as the prior and post effect:

$$20 \quad \text{Prior-effect} = NPS_{i \rightarrow j_t}^G - NPS_{i \rightarrow j_{t-x}}^G, \quad \text{for } x = 1, 2, \dots, 25 \quad (1)$$

$$21 \quad \text{Post-effect} = NPS_{i \rightarrow j_{t+x}}^G - NPS_{i \rightarrow j_t}^G, \quad \text{for } x = 1, 2, \dots, 25 \quad (2)$$

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32 where  $t$  is the day of the credit rating event, and  $x$  denotes the number of days in the  
33 window before and after the event, where we test whether cross-border contagion  
34 amongst sovereign CDSs has significantly changed before and/or after a sovereign  
35 credit rating announcement in a given country.<sup>10</sup> More concretely, we test if prior and  
36 post effects are significantly different from zero on average using a standard  $t$ -test. First,  
37 we take into account all the available countries and events in the sample, to see if cross-  
38 border contagion changes amongst CDSs due to sovereign credit rating events do exist  
39 when considering the six emerging markets all together. Second, we test the  
40 significance of prior and post effects of sovereign rating news for each country within  
41 the Latin American area. We argue that it seems more likely to find significant effects  
42 amongst the countries belonging to the same region, since they are more likely to be  
43 seen as competitors. Moreover, we distinguish between positive and negative events,  
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55 <sup>8</sup> For a more in-depth explanation of the GVAR methodology and construction of contagion measures,  
56 see Appendix A.

57 <sup>9</sup> The rolling GVAR analysis leads to the loss of the first three credit rating events (all positive): the two  
58 reported in 2004 for Brazil and Peru, and the first one reported in 2005 for Mexico. Hence, we finally  
59 work with 46 credit rating announcements in total: 37 upwards and 9 downwards.

60 <sup>10</sup> The maximum value of 25 days is selected to avoid losing those events that are close to the beginning  
61 and the end of the sample period.

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4 which enables us to analyse whether sovereign CDSs of non-event countries respond  
5 symmetrically to rating upgrades and downgrades in a given country.  
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9 If the prior (post) effect is revealed to be statistically significant for the window  $[t-x, t]$   
10  $([t, t+x])$ , we would find evidence for the existence of a significant change in the cross-  
11 border contagion of sovereign credit risk  $x$  days before (after) the rating event. A  
12 significant and positive (negative) effect means an increase (decrease) of cross-border  
13 contagion of sovereign credit risk due to a rating event.  
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19 The use of rating upgrades and downgrades separately allows us to identify whether  
20 countries within the same area are seen as direct competitors. If upgrades in a given  
21 country lead to a significant and positive (negative) change in cross-border contagion, it  
22 indicates that non-event countries benefit (suffer) from the rating event. The opposite is  
23 given for downgrades. If downgrades in a given country lead to a significant and  
24 positive (negative) change in cross-border contagion, it indicates that non-event  
25 countries suffer (benefit) from the rating event.  
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## 32 **5. Empirical results**

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36 Table 4 displays the credit rating events' prior and post significant effect on average  
37 through all the countries and all the events, while distinguishing between positive and  
38 negative events. We observe that the sovereign CDSs of the six Latin American  
39 countries under study experience a significant change in the cross-border contagion of  
40 sovereign credit risk due to a rating event.  
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47 Regarding the prior-effect, we notice that they are always negative, indicating that  
48 cross-border contagion decreases prior to the event. With regard to downgrades, the  
49 prior-effect is significant for all periods analysed, while the upgrades have a significant  
50 effect only in the short-term (from 3 to 8 days prior to the event) and with a smaller  
51 impact in absolute value. These findings indicate that bordering non-event countries  
52 suffer (benefit) from upgrades (downgrades), which reflect a competition effect before  
53 the event occurs.  
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4 The sign of significant post-effects is always positive, indicating that after the event  
5 cross-border contagion increases significantly, and is basically due to positive credit  
6 rating announcements. This post-effect emerges three days after the event and it is more  
7 pronounced (in terms of magnitude) 20 days after the event. Finally, it is notable that  
8 upgrades benefit bordering non-event countries, indicating an imitation effect after the  
9 positive event occurs.  
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16 In a next step, we study whether there is any particular country that leads the cross-  
17 border spillover effect to all others, with the purpose of isolating each transmitting  
18 countries. Table 5 displays the results. When the effects are significant, one observes  
19 that their estimated sign is consistent with the sign previously obtained on average  
20 across all countries. The significant prior (post) effects are always negative (positive)  
21 indicating a decrease (rise) in contagion, before (after) the event occurs.  
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28 If we take a deeper look, the competition effect previously observed prior to the event  
29 for downgrades is transmitted by Argentina and Brazil. Both countries display  
30 significant values for all periods analysed, however, the impact is greater in the short  
31 term (from 3 to 5 days) in the Argentinian case and in the long term (from 15 to 25  
32 days) in the Brazilian case. On the other hand, the competition effect previously  
33 observed prior to the event for upgrades is due to Brazil and Mexico and to a greater  
34 extent to Chile, all of them in the short term (from 3 to 5 days). In addition to that, it is  
35 noticeable that Chile is the only transmitter (in the short term) of upgrades after the  
36 event occurs, with an imitation effect, meaning that after the rating events, only positive  
37 news in Chile have a significant impact on bordering countries in terms of an increase in  
38 contagion.  
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48 To sum up, we find evidence that sovereign CDSs react to rating announcements  
49 concerning other sovereigns. The effect is asymmetric, with negative news having a  
50 quantitatively different impact than positive announcements; a finding in line with  
51 previous related literature on sovereign debt markets (Gande and Parsley, 2005,  
52 Böninghausen and Zabel, 2015, Christopher *et al.*, 2012, amongst others<sup>11</sup>). This result,  
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59 <sup>11</sup> Wengner *et al.* (2015) find the same result using corporate CDSs. Ismailescu and Kazemi (2010) find  
60 the opposite result using sovereign CDSs of emerging countries. However, they use a distinct  
61 methodology and a very heterogeneous sample of international emerging economies.  
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4 although expected, is notable because only nine downgrades are observed in the sample.  
5 The Argentinian case is worthy of consideration, it has the worst credit qualification,  
6 linked to a very high credit risk according to S&P. In fact, the last new rating for  
7 Argentina was a rating change to CCC+ in September 2013, which finished with a  
8 CCC- rating level in August 2014. The case of Brazil is particularly remarkable. Its only  
9 outlook downgrade in June 2013 had a considerably significant impact in all periods  
10 and magnitudes. This rating event occurred in the last part of the sample. It was a  
11 negative revision of its credit quality BBB, leading to a BBB- in June 2014, being quite  
12 near the limit of the speculative grade status. Finally, these downgrade transmissions are  
13 just observed in the days before the rating announcement and the effect is one of  
14 competition. These findings indicate that non-event rival countries benefit from reduced  
15 refinancing capacity of the event country (due to its negative rating event) and they may  
16 be able to capture new borrowers from the displaced country within the area. In addition  
17 to that, the event countries correspond with the lower credit quality rating, indicating  
18 that the spillover goes from lower rated countries to higher rated ones, as pointed out by  
19 Christopher *et al.* (2012) and Afonso *et al.* (2012). In contrast, regarding upgrades, it  
20 stands out that amongst the high number of positive rating news observed in the sample,  
21 practically only the four occurring in Chile display a significant effect, both prior and  
22 post the event. Chile is the country with the greatest credit quality, having a strong  
23 payment capacity according to S&P (around A on average). The impact is one of  
24 competition before the positive event occurs in Chile, and of imitation after it. It  
25 indicates that positive rating news in Chile negatively affects bordering non-event  
26 countries before the event, but positively after it.  
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45 Figure 3 shows the evolution over time of the *net directional contagion* from a given  
46 country to all other countries. It indicates if the isolated country is a transmitter or  
47 receiver of contagion when the measure is positive or negative, respectively.<sup>12</sup> Overall,  
48 previous results are confirmed. Rating downgrades in Argentina go with a decrease in  
49 contagion before the event occurs. What are remarkable are the negative events of 2012.  
50 Although Argentina is shown to be a receiver of contagion from bordering countries  
51 over time, before 2012 the contagion decreases a lot and it starts to increase after 2012,  
52 before the rating downgrades occur. In the case of Brazil, we observe how both rating  
53 upgrades and downgrades go with a decrease in contagion before the event occurs. In  
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61 <sup>12</sup> The particular expression for the *net directional measure* is given by equation (A.5) in Appendix A.  
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4 particular, three upgrades stand out: February 2006, May 2007 and November 2011. On  
5 the other hand, the only downgrade (and outlook) in Brazil, in June 2013, has a  
6 significant impact. During June 2013 Brazil becomes a receiver of contagion, whereas  
7 its role is that of a transmitter during the rest of the sample period. Finally, Chile  
8 displays a decrease in contagion before the upgrades and a decrease after them. The  
9 most notable event is the credit rating change of December 2007.  
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## 15 **6. Conclusions**

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19 This paper focuses on sovereign CDS markets, and investigates cross-border spillover  
20 effects, in terms of changes in contagion, due to credit rating announcements in six  
21 Latin American emerging economies during the wide sample period from 2004 to 2014.  
22 More specifically, we focus on measuring the effect in terms of impact on contagion  
23 that rating announcements in a particular country have on sovereign CDS spreads of  
24 other countries located in the same region. The contagion is measured using the novel  
25 GVAR approach of Diebold and Yilmaz (2012). In particular, we first calculate the  
26 change in the pairwise contagion before and after each credit rating event using  
27 different windows of days. Next, we test whether or not they are significant on average,  
28 that is, whether or not contagion from the event country to bordering non-event  
29 countries has changed due to rating events. Additionally, we distinguish between  
30 positive and negative events in order to determine whether the reactions are symmetric  
31 in response to rating upgrades and downgrades.  
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43 Our results generally show evidence for the existence of a significant change in the  
44 cross-border contagion of sovereign credit risk due to rating events in a given country.  
45 More specifically, the reactions are not symmetric in response to positive and negative  
46 announcements. Prior-effect results indicate that bordering non-event countries suffer  
47 (benefit) from upgrades (downgrades). It reflects a competition effect before the event  
48 occurs. Argentina and Brazil are the transmitters in the case of downgrades, indicating  
49 that the spillover goes from lower rated countries to higher rated ones. On the other  
50 hand, Brazil, Mexico and to a greater extent Chile, are the countries transmitting the  
51 competition effect observed before upgrades occur. Finally, regarding post-effects it is  
52 notable that upgrades benefit bordering non-event countries, indicating an imitation  
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4 effect after positive events occur. As the only transmitter of this effect, Chile has a  
5 significant impact on the bordering countries in terms of an increase in contagion.  
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9 This study might have quite useful applications: after the recent global financial crisis,  
10 regulatory authorities were focused on measuring and controlling credit risk contagion  
11 given its significant impact on financial stability. In this sense, the quantification of the  
12 impact in terms of contagion produced by credit rating events on bordering non-event  
13 emerging economies is crucial. It permits the identification of the competition effect  
14 produced by negative and positive rating events in cross-border emerging economies.  
15 This information is also useful for investors and portfolio managers in order to  
16 appropriately construct and hedge investment portfolios of emerging countries sensitive  
17 to sovereign credit risk. Additionally, given the importance and the increase of the CDS  
18 market, which is considered a reasonable proxy of credit risk, these results may also be  
19 helpful for future regulators when implementing new capital adequacy frameworks for  
20 individual countries and portfolios in the sovereign credit risk market.  
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31 As an interesting further research, we propose to extend our paper in order to analyse  
32 the impact of sovereign credit rating events on bordering economies in terms of  
33 contagion, while distinguishing between systematic and idiosyncratic contagion. To do  
34 this, the idea is to follow the recent paper of Ballester *et al.* (2014) in order to see not  
35 only whether rating news implies a change in contagion in non-event countries, but also  
36 if the effect is linked to global emerging factors (systematic contagion) or linked to  
37 emerging specific factors (idiosyncratic contagion).  
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## Appendix A

The GVAR methodology developed by Diebold and Yilmaz (2009, 2012) consists of a VAR-based spillover index particularly suited for the investigation of systems of highly interdependent variables. Spillovers are measured from a particular variance decomposition associated with an  $N$ -variable vector autoregression framework, which allows us to parse the forecast error variances of each variable into parts that are attributable to the various system shocks. The major advantage of this approach is that it eliminates the possible dependence of the results on ordering, in contrast to the traditional Cholesky factorisation.<sup>13</sup> In addition to that, it includes directional contagion indicators from/to a particular series, focusing not only on total spillovers.

First, a covariance stationary  $N$ -variable VAR( $p$ ) is estimated

$$x_t = \sum_{i=1}^p \phi_i x_{t-i} + \varepsilon_t \quad (\text{A.1})$$

where  $\varepsilon \sim (0, \Sigma)$  is a vector of independently and identically distributed disturbances and  $x_t$  denotes a  $N$ -variable vector of CDS log-returns. To ease the analysis, the model is written as the moving average representation  $x_t = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i}$ , where the  $N \times N$  coefficient matrices are estimated by  $A_i = \phi_1 A_{i-1} + \phi_2 A_{i-2} + \dots + \phi_p A_{i-p}$ , with  $A_0$  being the identity matrix and  $A_i = 0$  for  $i < 0$ .

Next, the variance decompositions are computed. The variance shares defined as the fractions of the  $H$ -step-ahead error variances in forecasting  $x_i$  that are due to shocks to  $x_j$ , for  $H = 1, 2, \dots$ , are given by

$$\theta_{j \rightarrow i}^G(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_i' A_h e_j)^2}{\sum_{h=0}^{H-1} (e_i' A_h \Sigma A_h' e_i)}, \text{ for } i, j = 1, 2, \dots, N \quad (\text{A.2})$$

where  $\sigma_{jj}$  is the standard deviation of the error term for the  $j^{\text{th}}$  equation, i.e. the squared root of the diagonal elements of the variance-covariance matrix  $\Sigma$  and  $e_i$  is the vector with 1 as the  $i^{\text{th}}$  element and 0 otherwise. As the shocks of each variable are not

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<sup>13</sup> This problem is circumvented by exploiting the generalized VAR framework of Koop *et al.* (1996) and Pesaran and Shin (1998), amongst others.

orthogonalised, the row sum of the variance decomposition is not equal to 1. Thus, each entry of the variance decomposition matrix can be normalised by the row sum as

$$\tilde{\theta}_{j \rightarrow i}^G(H) = \frac{\theta_{j \rightarrow i}^G(H)}{\sum_{j=1}^N \theta_{j \rightarrow i}^G(H)} \times 100, \text{ for } i, j = 1, 2, \dots, N \quad (\text{A.3})$$

where the multiplication by 100 is expressing the result in percentage terms. Note that, by construction  $\sum_{j=1}^N \tilde{\theta}_{j \rightarrow i}^G(H) = 100$  and  $\sum_{i,j=1}^N \tilde{\theta}_{j \rightarrow i}^G(H) = N \times 100$ .

Note also that return spillovers show the degree of variation in CDS log-returns of  $i$ , which is not due to the historical information of the CDS log-returns of  $i$  and  $j$  but to shocks (innovations) in CDS log-returns of  $j$ . This indicator takes higher values as the intensity of the contagion effect, caused by the specific shocks of  $j$ 's CDS log-returns, increases. In the extreme case in which there are no spillovers from one series to the other, the indicator is equal to zero.

Using the above normalised variance contributions, we can then construct *net pairwise return spillover* indices using a 200-day rolling windows,<sup>14</sup> which measure the actual contagion between each pair of return series, and are defined by

$$NPS_{i \rightarrow j}^G = \tilde{\theta}_{i \rightarrow j}^G(H) - \tilde{\theta}_{j \rightarrow i}^G(H), \text{ for } i, j = 1, 2, \dots, N \quad (\text{A.4})$$

It is simply the difference between the gross return shocks transmitted from  $i$  to  $j$  and those transmitted from  $j$  to  $i$ . Hence, it is positive (negative) when the impact of  $i$ 's shocks is higher (lower) than vice versa, indicating that  $i$  is a net transmitter (receiver) of return spillovers to (from)  $j$ .

Finally, the *net directional return spillover* indices measure the spillover transmitted by country  $i$  to all others.

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<sup>14</sup> At each rolling window, the lag  $p$  of the GVAR model is determined using the likelihood ratio test and the Akaike information criterion, which confirms that  $p$  varies over time. The forecast horizon  $H=10$  is selected using the *total return spillover* index of the GVAR, which measures the contribution of spillovers of return shocks across all the series to the total forecast error variance (Diebold and Yilmaz, 2012). This forecasting horizon is commonly used in similar studies (see for example Ballester *et al.*, 2014).

$$NDS_{i \rightarrow all}^G(H) = \sum_{\substack{j=1 \\ i \neq j}}^N \tilde{\theta}_{i \rightarrow j}^G(H) - \sum_{\substack{j=1 \\ j \neq i}}^N \tilde{\theta}_{j \rightarrow i}^G(H), \text{ for } i = 1, 2, \dots, N \quad (\text{A.5})$$

Is the difference between the gross return shocks transmitted by  $i$  to all other countries and those received by  $i$  from all other countries. Positive (negative) values of the *NDS* index indicate that country  $i$  is, in net terms, a transmitter (receiver) of return spillover effects.

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**Table 1: Descriptive statistics of the daily CDS spreads**

This table presents the descriptive statistics for the daily 5-year sovereign CDS spreads expressed in basis points from April 22, 2004 to January 27, 2014 for six Latin American emerging markets: Argentina, Brazil, Chile, Colombia, Mexico and Peru.

	Mean	Std.Dev.	Min.	Max.
Argentina	1,016.35	1,024.02	1.50	4,961.65
Brazil	193.83	136.58	61.10	900.20
Chile	69.17	51.87	7.10	315.00
Colombia	184.49	105.86	64.70	613.30
Mexico	119.17	72.59	28.70	606.70
Peru	167.00	91.60	59.90	611.20
<i>Average</i>	291.67	197.15	70.63	1,116.82

**Table 2: S&P's rating categories**

This table presents Standard & Poor's rating categories and the transformation of them into a discrete variable from 1 to 22.

Characterisation of debt and issuer		S&P's rating	Numerical transformation
Investment grade	Highest quality	AAA	22
	High quality	AA+	21
		AA	20
		AA-	19
	Strong payment capacity	A+	18
		A	17
		A-	16
	Adequate payment capacity	BBB+	15
		BBB	14
		BBB-	13
Non-Investment grade	Likely to fulfil obligations, ongoing uncertainty	BB+	12
		BB	11
		BB-	10
	High credit risk	B+	9
		B	8
		B-	7
	Very high credit risk	CCC+	6
		CCC	5
		CCC-	4
		CC	3
Near default with possibility of recovery	SD	2	
Default	D	1	



**Table 3: The distribution of credit rating events**

This table presents the distribution of credit rating events distinguishing between rating upgrades (*U*) and downgrades (*D*) per country and per year, from April 22, 2004 to January 27, 2014 for six Latin American emerging markets: Argentina, Brazil, Chile, Colombia, Mexico and Peru. Rating downgrades are displayed in bold, whereas revisions of ratings (outlooks) are shown in italics.

	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Total <i>U/D</i>	Total
2004		17-Sep				4-Jun	2 / 0	2
2005	1-Jun	8-Nov			11-Jan	11-Jul 1-Nov 3-Nov	6 / 0	6
2006	23-Mar 2-Oct <b>3-Nov</b>	28-Feb 22-Nov	14-Dec	22-Feb		20-Nov	7 / 1	8
2007		16-May	18-Dec	5-Mar	2-Jul 8-Oct	23-Jul	6 / 0	6
2008	25-Apr <b>11-Aug</b> <b>31-Oct</b>	30-Apr				14-Jul	3 / 2	5
2009					<b>11-May</b> <b>14-Dec</b>		0 / 2	2
2010	13-Sep		16-Dec	7-Jul		23-Aug	4 / 0	4
2011		23-May 25-Aug 17-Nov		16-Mar		30-Aug	5 / 0	5
2012	<b>23-Apr</b> <b>5-Nov</b>		26-Dec	15-Aug		29-Aug	3 / 2	5
2013	<b>10-Sep</b>	<b>6-Jun</b>		24-Apr	12-Mar 19-Dec	19-Aug	4 / 2	6
<i>Total U/D</i>	5 / 6	9 / 1	4 / 0	6 / 0	5 / 2	11 / 0	40 / 9	49
<i>Total</i>	11	10	4	6	7	11	49	49

**Table 4: The credit rating events' prior and post effect across all countries**

This table presents the credit rating events' prior and post effect on average across all the countries and all the events, distinguishing between rating upgrades (*U*) and downgrades (*D*). For any rating event in a given country occurring at time *t*, we test if prior and post effects are significantly different from zero on average for the windows  $[t-x, t]$  and  $[t, t+x]$  respectively, where *x* denotes the number of days in the window before and after the event. In particular, since the general conclusions hold, the table shows the results obtained for some selected values of *x*, that is  $x = 1, 3, 5, 8, 10, 15, 20, 25$ . As well, the table only reports results that are significant at the 10% level (\*), at the 5% level (\*\*) or at the 1% level (\*\*\*). The sample period ranges from April 22, 2004 to January 27, 2014 and the countries are the following: Argentina, Brazil, Chile, Colombia, Mexico and Peru.

All countries	Prior-effect		Post-effect	
	<i>U</i>	<i>D</i>	<i>U</i>	<i>D</i>
<i>x</i> = 1		-0.20***		
<i>x</i> = 3	-0.21***	-0.49***	0.19**	
<i>x</i> = 5	-0.17***	-0.74***	0.27**	0.24**
<i>x</i> = 8	-0.18***	-0.58***	0.22**	
<i>x</i> = 10		-0.59***		
<i>x</i> = 15		-0.74***	0.26**	
<i>x</i> = 20		-0.77***	0.57**	
<i>x</i> = 25		-0.66***	0.34**	

**Table 5: The credit rating events' prior and post effect for the individual countries**

This table presents the credit rating events' prior and post effect on average from each country to the rest of the non-event countries, distinguishing between rating upgrades (*U*) and downgrades (*D*). For any rating event in a given country occurring at time *t*, we test if prior and post effects are significantly different from zero on average for the windows  $[t-x, t]$  and  $[t, t+x]$  respectively, where *x* denotes the number of days in the window before and after the event. In particular, since the general conclusions holds, the table shows the results obtained for some selected values of *x*, that is  $x = 1, 3, 5, 8, 10, 15, 20, 25$ . As well, the table only reports the cases where the results are significant at the 10% level (\*), at the 5% level (\*\*) or at the 1% level (\*\*\*). The sample period ranges from April 22, 2004 to January 27, 2014 and the countries are the following ones: Argentina, Brazil, Chile, Colombia, Mexico and Peru.

Panel A:	<i>Prior-effect</i>
Argentina	<i>D</i>
$x = 1$	-0.18***
$x = 3$	-1.32***
$x = 5$	-1.32***
$x = 8$	-0.76***
$x = 10$	-0.81***
$x = 15$	-1.18***
$x = 20$	-0.86***
$x = 25$	-0.69***

Panel B:	<i>Prior-effect</i>	
Brazil	<i>U</i>	<i>D</i>
$x = 1$		-0.43***
$x = 3$		-0.77**
$x = 5$	-0.21**	-0.90**
$x = 8$		-0.96**
$x = 10$		-0.99**
$x = 15$		-1.19**
$x = 20$		-1.45**
$x = 25$		-1.27**

Panel C:	<i>Prior-effect</i>	<i>Post-effect</i>
Chile	<i>U</i>	<i>U</i>
$x = 3$	-0.88**	0.42***
$x = 5$	-0.76**	0.95**

Panel D:	<i>Prior-effect</i>	<i>Post-effect</i>
Mexico	<i>U</i>	<i>D</i>
$x = 3$	-0.12***	0.09**

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**Figure 1: Daily time evolution of CDS spreads**

The figures represent the daily time evolution of the six emerging countries' CDS spreads (Panel A), and the daily time evolution of the emerging market average CDS spreads (Panel B), calculated as the average CDS spreads of all the six emerging countries. The sample period ranges from April 22, 2004 to January 27, 2014 and the countries are the following ones: Argentina, Brazil, Chile, Colombia, Mexico and Peru. The scale in Argentina ranges from 0 to 5,000; for all other countries the scale ranges from 0 to 1,000 and the average CDS spread (Panel B) ranges from 0 to 1,200.

Panel A: Emerging countries' sovereign CDS spreads

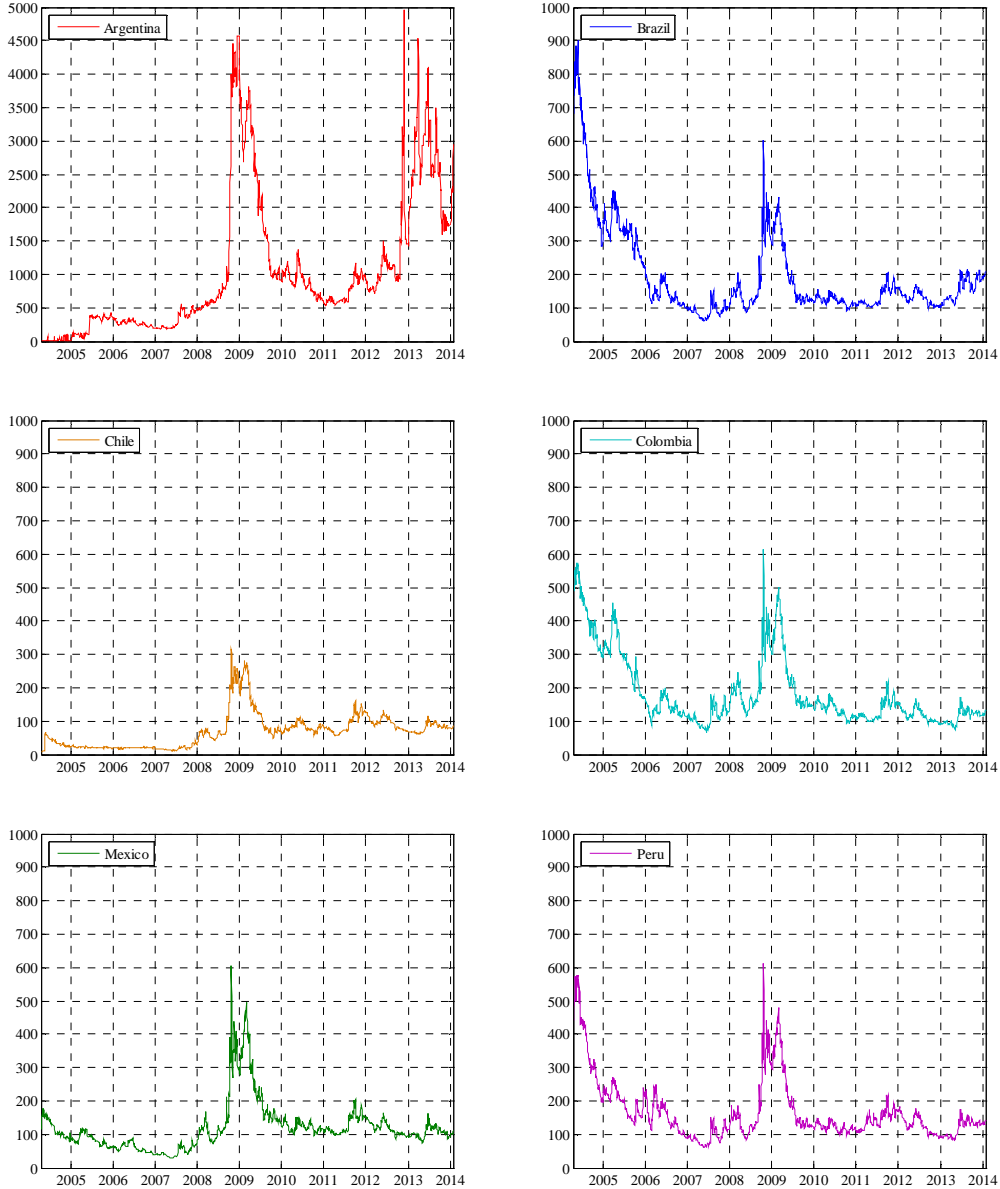
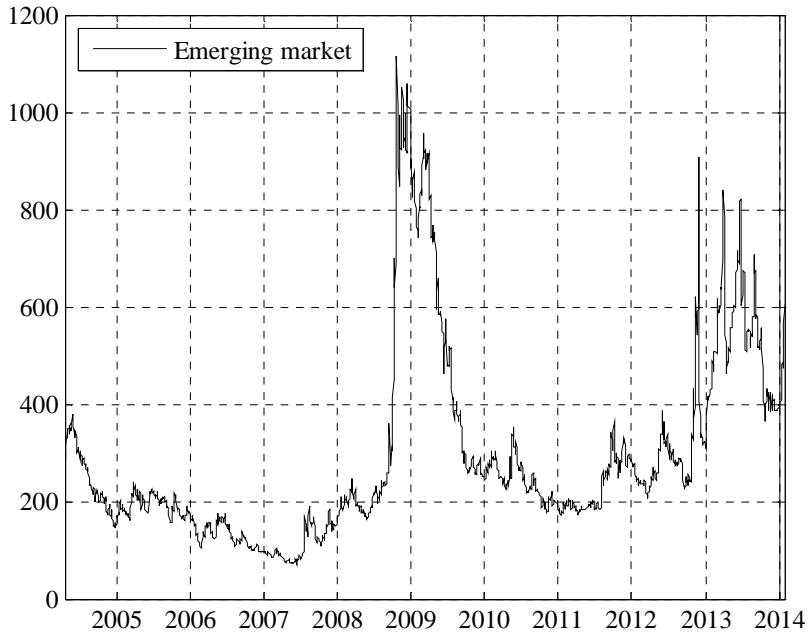


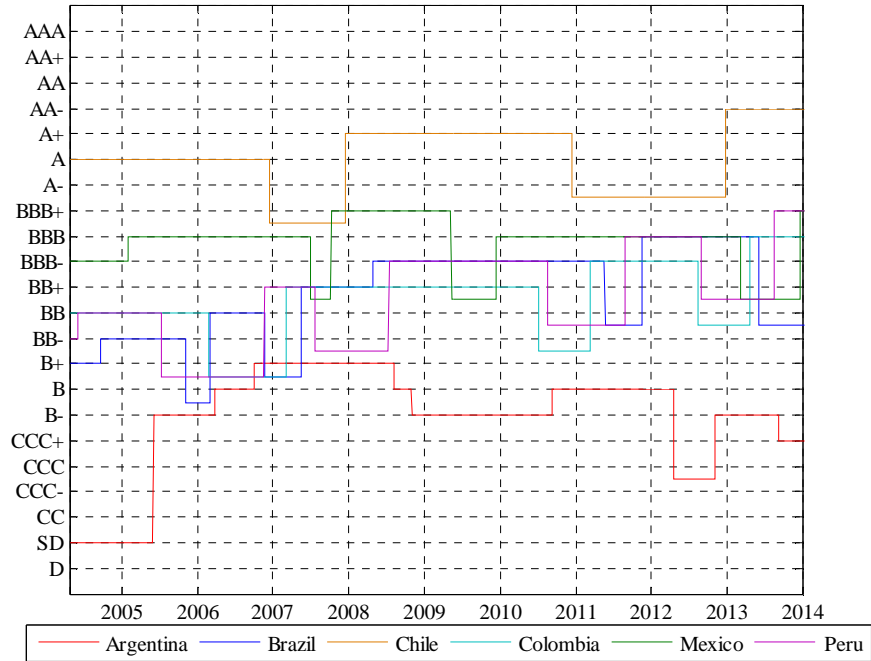
Figure 1: Daily time evolution of CDS spreads (cont.)

Panel B: Emerging market average CDS spreads



**Figure 2: Daily time evolution of S&P's Credit Rating**

This figure represents the daily time evolution of S&P's credit rating for the six emerging countries. A rating change (outlook) of category is displayed as an increase (if upgrade) or decrease (if downgrade) of 1 (0.5). The sample period ranges from April 22, 2004 to January 27, 2014 and the countries are the following ones: Argentina, Brazil, Chile, Colombia, Mexico and Peru.

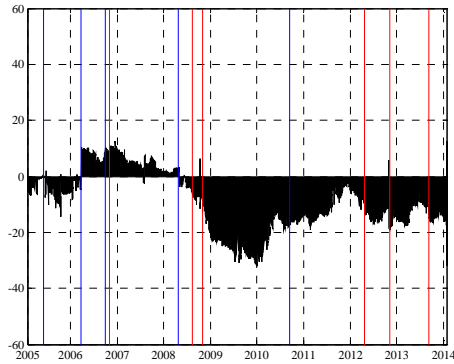


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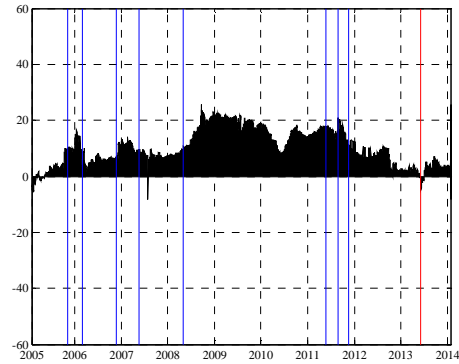
**Figure 3: Net-Directional Contagion from a given country to all others**

This figure reports the time evolution of the *net directional return spillover* index for contagion (in percentage) transmitted from a given country to all others. Positive (negative) values indicate that the corresponding country is, in net terms, a transmitter (receiver) of contagion to all others. As well, the figure only reports the countries where the previously tested *prior-* and *post-effects* have been significant (Table 5): Argentina (Panel A), Brazil (Panel B), Chile (Panel C) and Mexico (Panel D). Rating upgrades (downgrades) are displayed in blue (red). The sample period ranges from April 22, 2004 to January 27, 2014, but the index starts on January 27, 2005 since a 200-day rolling window is used to get the evolution over time.

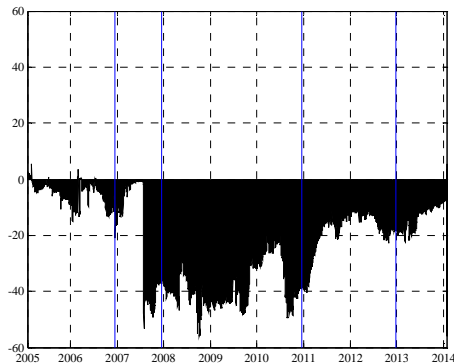
Panel A: Argentina



Panel B: Brazil



Panel C: Chile



Panel D: Mexico

