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It's not time to make a change: Sovereign fragility and the corporate credit risk

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It's not time to make a change: Sovereign fragility and the corporate credit risk

Fabio Fornari† and Andrea Zaghini*

Abstract

Relying on a perspective borrowed from monetary policy announcements and introducing an econometric twist in the traditional event study analysis, we document the existence of an "event risk transfer", namely a significant credit risk transmission from the sovereign to the corporate sector after a sovereign rating downgrade. We find that after the delivery of the downgrade, corporate CDS spreads rise by 36% per annum and there is a widespread contagion across countries, in particular among those which were most exposed to the sovereign debt crisis. This effect exists on top of the standard relation between sovereign and corporate credit risk.

JEL classification: G15,G32, G38.

Keywords: sovereign rating, corporate credit risk, CDS spreads.

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1 Introduction

Amid the turbulent phases of the global financial crisis and the euro-area sovereign debt crisis, the pricing mechanism in several financial markets experienced a significant stress. In particular, government bonds spreads spiked in several countries (Ireland, Italy, Portugal and Spain) and the Greek debt had to be restructured to avoid the outright default and exit of Greece from the monetary union (Battistini et al., 2014; Durrè et al., 2014). Eventually, the deterioration in the sovereign creditworthiness, attested by the impressive number of downgrades delivered by the main credit rating agencies (CRAs), spilled over to the corporate segment. Both banks and firms experienced an increase in their credit risk, which in turn impaired their funding abilities and led to an unprecedented market segmentation (Bedendo and Colla, 2015; Zaghini, 2016; Lee et al., 2016; Augustin et al., 2018).

When adjusting a sovereign rating, CRAs provide valuable information to investors about the credit risk of the sovereign (Binici and Hutchison, 2018). However, since the probability of default of sovereigns affects the whole domestic economy (both financial markets and economic activity), do investors gather any additional information also for the corporate credit risk? We examine this question by exploring the effect of the sovereign downgrades delivered by Fitch, Moody's and S&P on corporate CDS spreads. We focus on the euro area over the period 2006-2018 since it is an ideal framework of analysis. The common currency area is made of countries sharing similar characteristics concerning the legal and institutional framework, but they have a different creditworthiness due not only the some heterogeneity in the rates of growth but also to different attitudes about the fiscal stance and the level of public debt. In addition, they faced a different degree of stress during the euro-area sovereign debt crisis (2010-2012) and a number of downgrades to an extent never witnessed before by advanced economies.

The extensive process of sovereign credit risk assessments by CRAs is disclosed in their published methodologies (Fitch, 2017; Moody's, 2016; S&P,

2014). In addition, each CRA publishes its own calendar about the dates in which the results of their (regular) assessment of each country are publicly delivered. Even when unexpected changes in macroeconomic, institutional or financial market conditions provide room for an update of the calendar, the date of the delivery of the assessment is usually known well in advance. Thus agents have time to form their expectations about the CRA assessment, which are reflected in the market prices prevailing before the announcement. Such framework shares many similarities with the monetary policy communication process. Central banks publish at least one year in advance the calendar of the meetings in which the decisions about the monetary policy stance will be taken. On the day of the official press release, financial markets may either be surprised by the decisions taken or have perfectly anticipated them. The (surprise) effect of the decisions is assessed by looking at the changes in short-term interest rates or other securities' prices (bonds, stocks, exchange rates...) in a window around the event (Kuttner, 2001; Gaspar et al., 2001; Cochrane and Piazzesi, 2002; Gurkaynak et al., 2005; Javadi et al., 2018). In the same way, by comparing the corporate CDS spreads before the CRAs' announcements with those after the announcements, we can identify the surprise effect of a sovereign downgrade delivery on corporate credit risk.

Thus, differently from the existing literature, we study the effects of the event "sovereign downgrade" in itself, looking for a possible spillover to the corporate sector. In other words, we are interested in assessing whether the selected events have an information content for financial and non-financial corporations in addition to the standard transmission channels. We label this potential transmission channel as "event risk transfer" to distinguish it from the standard sovereign to corporate risk transfer documented by the literature.[1]

[1] Note that we are incidentally less exposed to the risk of endogeneity, since we focus on a possible additional effect in the traditional relation between sovereign and corporate credit risk, which clearly originates from the sovereign side, regardless of the reasons behind the decision.

We select 68 unconfounded events (sovereign downgrades which were not surrounded by other CRAs' announcements) from 2006 to 2018 and, by controlling for the sovereign CDS developments and several macro and financial variables, we find that the delivery of a sovereign downgrade has a negative spillover to the corporate credit risk. In the week immediately after a rating change, corporate CDS spreads record an increase of around 0.70% (36% per year) attributable to the downgrade. This increase might well be underestimated since the more unconfounded are the events and the shorter are the time windows around the downgrade, the larger is the estimated pass-through.

Concerning the international spillover, somewhat surprisingly the sovereign downgrades which have a stronger effects on euro-area corporations are those delivered to Austria, Finland, France, Belgium and the Netherlands (which together with Germany and Luxembourg form our core economies aggregate). In addition, a sovereign downgrade in any of the five countries most affected by the 2010-2012 sovereign debt crisis (Greece, Ireland, Italy, Portugal and Spain: the GIIPS group) spills over to the whole group, determining a significant increase in corporate CDS spreads. However, the effect on core economies is different. While Ireland, Portugal and Spain are not able to affect the core economies, a downgrade in Italy can. At the same time, a downgrade in Greece determines an improvement in the CDS spreads of corporations in the core economies, signalling a new cross-country cross-sector "flight to safety" effect from the (weak) domestic sovereign to the (sound) foreign corporate sector. Finally, taking advantage of the cross-sectional heterogeneity, we single out some characteristics that make corporations more sensitive to the sovereign risk transfer: strong links with the sovereign, a business model oriented to the domestic economy and a rating close to that of the sovereign.

Our contribution to the literature is three-fold. First, from a methodological point of view we go beyond the limits of the traditional event-study

approach. Building on the contribution of Gande and Parsley (2005), we devise a more general regression framework that maintains the basic idea of comparing the value of the variable of interest in the periods immediately before and after the events, while allowing to take into account other factors which may have a bearing on the endogenous variable determination over the two time windows. Thus we differ from works relying on the approach based on adjusted spread changes (ASC) with respect to a single reference value before and after the events, usually the median value of the CDS distribution or a market index like the iTraxx (Bedendo and Colla, 2015; Lee et al., 2018). We also differ from those works that employ regressions with time dummies identifying the events, since we focus on the values of the variable under scrutiny and the control variables just in the proximity of the events, without taking into account the whole history of each variable (Arezki et al., 2011).

Second, we contribute to the literature on the risk transmission by taking a different perspective with respect to the works focusing either on the link between sovereign rating changes and sovereign CDS (Gande and Parsley, 2005; Drago and Gallo, 2016; Binici and Hutchison, 2018) or on the relation between sovereign CDS spreads and corporate CDS spreads (Acharya et al., 2014; Bedendo and Colla, 2015). We assess whether a particular negative event concerning the sovereign credit risk (a rating downgrade) has an effect on the credit risk of both financial and non-financial corporations on top of the effect that goes through a possible correlation between sovereign and corporate CDS spreads. In other words, we investigate whether the delivery of the sovereign rating change conveys any additional information to investors about the corporate credit risk (event risk transfer). In addition, by looking at the heterogeneity across events (vertical heterogeneity) we are able to shed light on how different features such as size, rating agency and time period of the events are able to influence the pass-through and the international transmission of the shock brought about by the sovereign downgrade.

Third, the availability of a large cross section of CDS spreads allows to identify some likely channels of risk transmission by exploiting the corporations' characteristics (horizontal heterogeneity). Overall, we support some of the findings of the recent literature. Given that the deteriorating sovereign risk usually presses the government to take fiscal actions which hurt the economy (increasing current and future taxes, reducing public expenditures, cutting subsidies to firms), the weakened aid to the private sector is felt in a more significant way by corporations with strong links to the state, which in normal time enjoy instead an implicit sovereign guarantee (Borisova et al., 2015; Pellegrino and Zingales, 2017; Boubakri and Saffar, 2019). Also corporations that are not able to diversify their revenues over different countries and are tightly linked to the evolution of the domestic demand suffer more from the sovereign downgrade (Arteta and Hale, 2008; Arellano et al., 2018). An additional channel of transmission goes through the habit of CRAs of not rating domestic corporations above the sovereign. This perverse mechanism suggests that corporations with a relatively low credit risk (certified by the very high rating at the sovereign level of very close to it), may suffer a stronger deterioration in the CDS spreads because of the lowering of the rating ceiling (Borensztein, 2013; Almeida et al., 2017).

The paper is organized as follows: in Section 2 we describe the dataset; in Section 3 we provide the intuition for our econometric framework and the baseline results on the sovereign to corporate risk transfer; in Section 4 we analyze the two issues of heterogeneity across events and cross-country spillovers; in Section 5 we analyze the channels of transmission; in Section 6 we propose some robustness checks; in Section 7 we draw the conclusions.

2 The evolution of sovereign creditworthiness

Between January 2006 and December 2018 the euro area witnessed 107 rating downgrades (ranging from 1 to 5 notches) and 44 upgrades (also ranging from

1 to 5 notches) delivered by the three main rating agencies (Fitch, Moody's, Standard&Poor's).[2] Table 1 reports the details of the rating changes by country and by rating agency, while Figure 1 shows all the rating upgrades and downgrades by time and size together with the evolution of the average euro-area sovereign rating and the iTraxx 5-year index. It must be noted that while the iTraxx follows closely the chronology of the global financial crisis and the sovereign debt crisis, the delivery of the sovereign downgrades seems to be somewhat delayed. This is due to the fact that the procedure for a rating assessment takes time, whereas market securities are traded on a daily basis.

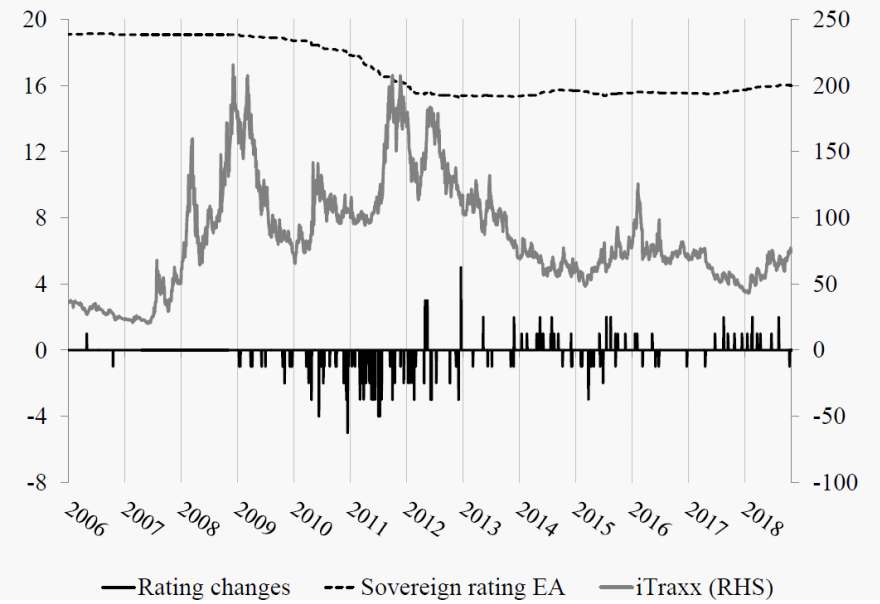
Table 1. Sovereign rating changes by country and rating agency[1]

	Moodys			Fitch			S&P			Total		
	Down	**Up**	**Tot**	**Down**	**Up**	**Tot**	**Down**	**Up**	**Tot**	**Down**	**Up**	**Tot**
Austria	1	0	1	1	0	1	1	0	1	3	0	3
Belgium	1	0	1	2	1	3	1	0	1	4	1	5
Finland	1	0	1	1	0	1	1	0	1	3	0	3
France	2	0	2	2	0	2	2	0	2	6	0	6
Germany	0	0	0	0	0	0	0	0	0	0	0	0
Greece	9	4	13	9	7	16	13	7	20	31	18	49
Ireland	5	4	9	4	3	7	6	3	9	15	10	25
Italy	4	0	4	5	0	5	5	1	6	14	1	15
Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0	1	1	2	1	1	2
Portugal	5	2	7	5	2	7	5	2	7	15	6	21
Spain	5	2	7	4	2	6	6	3	9	15	7	22
Total	33	12	45	33	15	48	41	17	58	107	44	151

1) Units. Down is the number of sovereign downgrades; Up is the number of sovereign upgrades; Tot is the total number of changes.

[2]We restrict our analysis to the 12 countries showing a sufficiently large number of CDS spreads available over time: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain.

Figure 1. Sovereign rating changes and credit risk[1]



1) Rating changes are the sovereign downgrades and upgrades delivered by Fitch, Moody's and Standard&Poors (in notches); Sovereign rating EA is the average of the sovereign ratings of the 12 countries reported in Table 1 linearized between 1 (CC/Ca) and 20 (AAA/Aaa); iTraxx (RHS) is the iTraxx (Europe) index (on the right hand scale).

It is evident that the deterioration in the sovereign creditworthiness is assessed in a similar way by the three rating agencies, not only concerning the countries involved, but also in terms of the number of downgrades delivered (Table 1). The rating agency that has carried out more changes is S&P, with 41 downgrades; the country which witnessed more changes is Greece with 31 downgrades, followed by the other four GIIPS countries: Ireland, Portugal and Spain with 15 and Italy with 14 downgrades. At the end of 2018, only Germany, Luxembourg and the Netherlands were in the same rating class as in 2006, while the rating of Greece had deteriorated by 9 notches and those of Italy, Portugal and Spain between 6 and 7 notches.

The actual time window of sovereign rating downgrades runs from October 19, 2006 to October 19, 2018 (in both dates a downgrade was deliv-

ered to Italy). The period 2009-2013 – characterized by the aftermath of the Lehman Brothers bankruptcy and by the euro-area sovereign debt crisis – includes most of the downgrades (86 out of 107). It is not surprising that over that period the average euro-area sovereign rating drops by 20% (from 19.08 to 15.25) and that the aggregate corporate credit risk, as measured by the iTraxx index, peaks at slightly over 200 basis points. On the other hand, the most recent period 2014-2018 – characterized by improved macroeconomic conditions and non-conventional monetary policy measures – accounts for relatively few downgrades (19) and witnesses both an increase of the average sovereign rating and a more benevolent market assessment of the corporate credit risk.

While rating agencies do not usually coordinate in signalling their intention to consider a rating change and they provide a date for the decision to be released, the actual notifications may well occur at the same time, given that they are typically released when financial markets are closed (week-end days). In addition, a single agency may well deliver more than one sovereign rating change at a given date. Indeed, focusing on the downgrades only, the 107 events were delivered in 94 dates and multiple downgrades occurred in 8 cases (up to 5 countries).[3] While we maintain the 94 dates as the universe of events, to attain a set of "unconfounded events" we further cleaned the initial sample. In particular, considering only downgrades with 5-day windows before and after the event free of any other rating or outlook change (both positive or negative and delivered by any rating agency to any of the country in the panel), we obtain a set of 68 events.[4]

[3]The 8 dates include also two episodes in which a single country withstood a change in the sovereign rating from more than one agency. It happend once for Italy on 16 October, 2006, when Fitch and Standard&Poor's delivered a single notch downgrade, and once for Portugal on 24 March, 2011, which received a 2-notch downgrade by the same two rating agencies.

[4]A rating outlook indicates the potential direction of a rating over the intermediate term, typically six months to two years. The outlook provides information to investors on the potential evolution of a rating, and thus it increases the precision of the rating.

In order to assess the effect of a change in the sovereign rating on the corporate credit risk we rely on CDS spreads. A CDS contract essentially is an insurance against the risk that a corporation defaults on its debt and it provides an accurate measure of the issuer's creditworthiness (Longstaff et al., 2005; Pan and Singleton, 2008; Longstaff et al., 2011). CDS spreads are sourced from CMA (Credit Market Analysis - DataVision from Thomson Reuters), a standard provider of CDS data, largely employed in the literature. In particular, we consider CDS for senior unsecured debt with a 5-year maturity, which is the most liquid in the corporate CDS segment. Since we focus on euro-area countries we consider euro-denominated CDS contracts only.

Table 2. CDS spreads by country and sector[1]

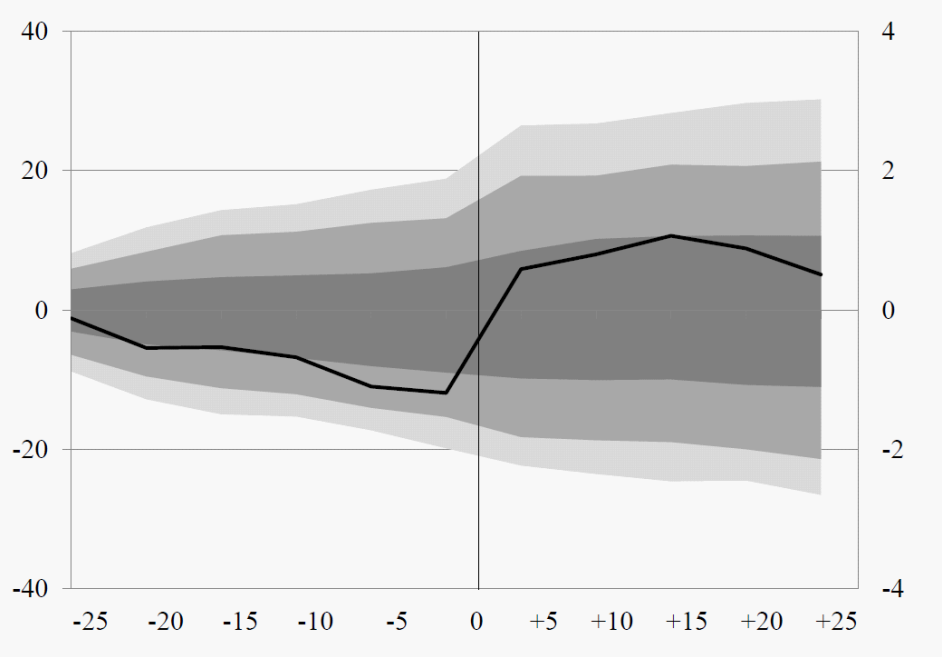
	Banks	Non-banks	All	Average
Austria	5	2	7	5
Belgium	3	3	6	5
Finland	1	9	10	8
France	8	58	66	56
Germany	16	51	67	57
Greece	4	2	6	5
Ireland	5	6	11	9
Italy	11	14	25	20
Luxembourg	1	8	9	8
Netherlands	11	33	44	37
Portugal	7	3	10	9
Spain	12	13	25	21
TOTAL	84	202	286	240

1) Number of CDS spreads (in units). Banks are the credit institutions; Non-banks are all other corporations; All is the sum of all corporations; Average is the average number of CDS spreads available per event.

Table 2 reports for each country the number of CDS spreads available over the 2006-2018 period, split across banks and non-banks. There are many CDS for France and Germany (66 and 67, respectively), whereas just

few CDS are available for smaller countries. For example, Austria, Belgium, Greece and Luxembourg have less than 10 CDS each. The share of banks' CDS spreads in the sample varies a lot: from 10% in Finland to over 60% in Austria, Greece and Portugal. Of course, many of CDS spreads are not available over the whole period and are therefore used only over the events for which they were traded. The number of CDS spreads per event ranges from 180 to 264 and it stands at an average of 240 items (last column of Table 2).

Figure 2. CDS reaction to sovereign rating downgrades[1]



1) Percentage points. The figure shows the average (RHS) and the percentiles (from 5th to 95th; LHS) of the cumulated CDS rate of change from 30 days before the event to 25 days after the event, jointly across the 68 unconfounded events.

Taking as time zero the day of the rating downgrade, we compute the CDS rate of growth in the 5-day windows before and after each events. Pooling together all the 68 unconfounded events Figure 2 reports the cumulated

change from 30 days before the event to 25 days after the event and the standard percentiles of the distribution (5th, 10th and 25th both positive and negative).

Three circumstances stand out. First, corporate CDS spreads increased immediately after the downgrade delivery. There is a clear jump in the average cumulated rate of growth on the first window after the event date (time +5 in Figure 2). This suggest that the event conveys new information to market participants and that indeed sovereign credit risk deterioration spills over to corporate credit risk. Second, there is not any anticipation of the events. On average the CDS spreads were even declining before the delivery date. Thirdly, there is a lot of heterogeneity across events. On the event date the cumulated CDS change ranges in the central 90% of the distribution between -22% and 26%. Part of the heterogeneity can be explained by the fact that rating downgrades concerned not only the countries most exposed to the sovereign debt crisis (i.e., the GIIPS group), but also others with more sound fiscal balances (Austria, Belgium, Finland, France). In addition, the euro-area corporate sector includes CDS spreads from all the 12 countries, thus including also countries never affected by a rating change as Germany and Luxembourg or rarely as the Netherlands (just one downgrade in the period under analysis).

While providing useful preliminary evidence on the relation between sovereign and corporate credit risk, the simple CDS spreads' dynamics can be influenced by several other factors. Thus, in order to isolate the information content of the delivery of the sovereign downgrade, in the next Section we will rely on a fully fledged econometric framework.

3 The regression approach

To assess the CDS spreads' dynamics around sovereign downgrades, we devise a regression analysis which builds on the traditional event study approach.

In particular, the basic idea of the event study methodology is that the event is an exogenous source of news and that the behavior of the variable under analysis immediately after the event differs from the behavior immediately before just because of the occurrence of the event. Thus, a comparison of the value of the variable (or more often, the mean of a cross-section distribution) after and before the event would reveal the direction and the size of the effect caused by the event.

Usually, in the literature dealing with CDS spreads, to obtain a framework as close as possible to the hypothesis that the event is the only cause of the observed change, a very short time window is used before and after the event. While the iTraxx index or the median CDS spread are used as the benchmarks from which the abnormal returns around the event are computed (Bedendo and Colla, 2015; Drago and Gallo, 2016; Lee et al., 2018), other additional factors, which may have a bearing on the CDS spreads, cannot be used. We instead propose a framework which maintains the comparison of CDS spread dynamics in the immediate vicinity of the event, but also allows the introduction of control variables.[5]

We move forward from the original contribution in Gande and Parsley (2005) – who built a regression by stacking the variables of interest just on the dates in which the events occurred – by splitting the dependent variable and each control variable over two distinct windows around the event. In particular, we rely on the rate of growth of CDS (the dependent variable) and any other control variable in the 5-day windows before and after the CRAs' delivery date and we stack them event by event. Although the "before the event" and "after the event" values are ordered in time, when we stack the variables by event we do not have time contiguity as the events occurred at

[5] To our knowledge, while very different in the methodology and the dimension of the dataset employed, the exercise closest to our is proposed by Bedendo and Colla (2015). They assess the effect of a sovereign downgrade (for a total of 19 events in four countries) on non-financial companies headquartered in that country by comparing the cross-sectional averages of corporate CDS spreads abnormal returns with respect to the iTraxx. In Table 2 (page 40) they report a statistically significant effect around the downgrades.

discrete time points. In other words, in the spirit of Gande et Parsley (2005), when setting up the dataset we do not consider the values of the variables between the events (i.e., the time dimension is lost), but differently from the original contribution we maintain, for each event, the reference to a period immediately before it and a period immediately after it, which can be used to control for all other confounding factors. Analytically, we have the following pooled panel:

$$[y^b_{i,k}\ y^a_{i,k}]' = \mu_0 D_b + \mu_1 D_a + \sum_j \alpha_j [x^b_{(j)i,k}\ x^a_{(j)i,k}]' + [\varepsilon^b_{i,k}\ \varepsilon^a_{i,k}]' \qquad (1)$$

where $[y^b_{i,k}\ y^a_{i,k}]'$ is the column vector of the dependent variable (weekly rate of change of the generic i-th CDS spread), in which the values alternate before (b) and after (a) the event k, μ_0 and μ_1 are the coefficients of the two intercepts "before" and "after", namely they refer to a dummy D_b which takes 1 before each events and 0 after, and a dummy D_a which is the opposite and takes 0 before and 1 after each event, $[x^b_{(j)i,k}\ x^a_{(j)i,k}]'$ is the column vector of the generic $x_{(j)}$ regressor, in which the values alternate before and after event k and $[\varepsilon^b_{i,k}\ \varepsilon^a_{i,k}]'$ is the vector of residuals.

As in the standard event study methodology, we aim at estimating and testing the significance of the difference between the rate of growth in the 5-day after the events and the rate of growth in the 5-day before the events. Thus in equation (1) the coefficients of interest are μ_0 and μ_1. However, differently from the traditional approach, we can exploit the econometric setup and control for the development in all the desired control variables $\left(x_{(j)}\right)$ around the rating events, especially key financial indicators and macroeconomic news that may affect the behavior of the CDS spreads. At the same time, we can introduce *ad hoc* dummy variables which track selected features of the events or characteristics of the corporations to investigate the possibility of different effects of CRAs downgrades. In other words, we have a much more flexible instrument of analysis that exploits the heterogeneity

across the events as well as across the CDS distribution.

Given the 286 CDS spreads in our sample, for each rating event we have at most 572 observations, i.e. the 5-day rate of change of each CDS spread in the time windows before and after the event. Focusing on the selected 68 unconfounded downgrades, we thus have a maximum of 572*68 = 38,896 observations for the pooled regressions: one half of the observations refers to changes in the windows before the events and the other half to changes in the windows after the events.

Table 3 Summary statistics[1]

	Obs	Mean	STD	Max	Min	Median
Corporate CDS	30,604	-0.119	6.787	198.106	-31.722	-0.181
iTraxx	30,604	-0.631	6.403	17.188	-26.102	-0.215
Macro news US	30,604	-2.240	12.559	31.800	-42.400	-2.900
Macro news EU	30,604	1.961	13.891	44.300	-30.700	1.000
Vixx	32,644	-0.360	2.869	7.700	-10.990	-0.360
CISS	30,604	-0.002	0.053	0.202	-0.174	-0.005
NEER38	30,604	0.043	0.898	2.577	-2.533	0.104
Slope of yield curve	30,604	0.003	0.088	0.296	-0.272	0.002
Stock market Index	30,604	0.115	2.399	7.853	-8.168	0.296
Sovereign CDS	30,604	3.781	15.043	92.279	-27.308	1.078

1) Corporate CDS are the 5-year CDS spreads in euro of single-name euro-area corporates; iTraxx is the iTraxx-Europe index; Macro news US and Macro news EA are macroeconomic surprise indices by Citi for the US and the euro area, respectively; Vixx is the Vixx Index; CISS is the CISS Index; NEER38 is the euro nominal effective exchange rate; Slope of yield curve is the OIS 10-year minus the OIS 1-year; EA Stock Index is the euro-area Total Market Index by Thomson Reuters Datastream; EA Sovereign CDS are the 5-year CDS spread of euro-area sovereigns. Percentage changes over weekly (5-day) windows.

As already explained in Section 2, not all CDS are contemporaneously available; in addition, we dropped all the stale CDS (i.e. those for which the change in both the before and after windows is nil) and the top and bottom 1% of data. Thus the overall sample reduces to 30,604 observations.

We employ in the analysis a large set of regressors to control for all the sources of systematic difference between CDS spreads. In particular, given that we aim at assessing the surprise effect due to the sovereign downgrade, we include among the explanatory variables also the (percentage) change occurred in each sovereign CDS spread around the events. In other words, we control for the traditional relationship between sovereign and corporate credit risk analyzed by the previous literature at the country level. The other regressors include: the euro-area stock index (Total Market Index, as computed by Thomson Reuters Datastream); the euro-area and US macro-economic surprise indices, as computed by Citi; the VIX Index, which is an index designed to produce a measure of constant 30-day expected volatility of the US stock market (sourced from Bloomberg); the CISS index (Composite Indicator of Systemic Stress), which is the systemic stress indicator for the euro-area financial markets proposed by Hollo et al. (2012) and updated at the daily frequency by the ECB; the nominal effective exchange rate of the euro with respect to the 38 main trading partners of the euro area (NEER38), also computed by the ECB; the slope of the yield curve, computed as the OIS 10-year rate minus the OIS 1-year rate. Table 3 reports the descriptive statistics of the mentioned variables.

We run all regressions according to equation (1) via pooled OLS with robust standard errors clustered by country and with fixed effect by sector.[6] As shown in Table 4 (column 1), when all events are pooled together and no control variables are considered, the values of μ_0 is not statistically significant while μ_1 is relatively small (0.274) but significantly different from zero ($p < 0.10$), which in a way closely replicate the evidence of the fan chart reported in Figure 2.

[6] We group corporations into 11 business groups according to the FTAG4 classification: Oil and Gas, Basic Materials, Industrials, Consumer Goods, Health Care, Consumer Services, Telecommunications, Utilities, Banks, Other Financials and Technology

Table 4 Pooled OLS regressions[1]

	(1)	(2)	(3)	(4)	(5)
Constant before	-0.1027	0.0397	-0.1528 **	-0.1046 *	
	(0.13205)	(0.13065)	(0.07307)	(0.06191)	
Constant after	0.2741 *	0.7371 ***	0.5430 ***	0.5957 ***	0.6616 ***
	(0.17403)	(0.18765)	(0.12482)	(0.12707)	(0.06824)
iTraxx		0.6213 ***	0.5225 ***	0.5222 ***	0.4453 ***
		(0.03238)	(0.02491)	(0.02502)	(0.02057)
EA Sovereign CDS			0.0121	0.0096	0.0304 **
			(0.00966)	(0.00952)	(0.01253)
EA Stock Index			-0.4499 ***	-0.4715 ***	-0.4448 ***
			(0.03324)	(0.03328)	(0.02951)
Lagged Y				0.0412 ***	0.0620 ***
				(0.00888)	(0.01222)
Macro & Financial controls	NO	NO	YES	YES	YES
FE by sector	YES	YES	YES	YES	YES
FE by event	NO	NO	NO	NO	YES
R^2	0.002	0.345	0.359	0.361	0.387
Observations	30,604	30,604	30,604	30,604	30,604

1) Dependent variable: CDS spread percentage change over 5-day windows before and after each event; robust standard errors clustered by country (in parentheses); symbols ***, ** and * denote statistical significance at 1%, 5% and 10%, respectively. iTraxx is the iTraxx-Europe index; EA sovereign CDS is the sovereign 5-year CDS spread in euro; EA Stock Index is the Total Market Index, as computed by Datastream, Thomson Reuters; Lagged Y is the rate of change of CDS spreads in the window from 6 to 10 days before each event. Macro and Financial controls include euro-area and US macroeconomic surprise indices; the VIX Index, the CISS Index; the euro nominal effective exchange rate; the slope of the yield curve (OIS 10-year minus OIS 1-year).

Following the previous literature, a first control that can be introduced in the regression is the change in the iTraxx, which should capture market-wide variation in CDS spreads due to changes in fundamental credit risk, liquidity, and CDS market-specific shock (Acharya et al., 2014). With this control in place, the value of the key parameter μ_1 is estimated at 0.737 and statistically significant ($p < 0.01$), thereby indicating that the corporate CDS rate of growth, conditional on the movements of the iTraxx, tends to increase in the aftermath of a sovereign downgrade (column 2).

However, since the iTraxx index is the mean of a selection of CDS spreads, it cannot be considered as fully exogenous and thus it is advisable to control for additional variables that could have been behind the movement in the CDS spreads before and after the rating events reported in Table 3.

The additional regressors have a downsizing effect on both the intercepts (μ_0 and μ_1), while maintaining almost unchanged the difference between the two coefficients (column 3). Thus the key result of the existence of an "event risk transfer" after the delivery of a sovereign downgrade is confirmed and this happens on top of what can be explained on the basis of a large set of financial and macroeconomic indicators and especially on top of the standard direct link between sovereign and corporate CDS spreads.

As a further step of the analysis, we create in the model a sort of dynamic effect by introducing the lagged dependent variable, i.e. the rate of change of the CDS spreads in the 5-day window immediately before the "before the event" period.[7] While the effect of the lagged variable is positive and significantly different from zero, the difference between the two intercepts remains unchanged (column 4).

Finally, fixed effects by events are introduced in the estimation process. Indeed, each event is characterized by a different average level of the dependent variable, but in regressions (1) to (4) we considered the downgrades as a single set, i.e. there is a single constant "before" and a single constant "after" averaging the CDS spread changes across the events. Instead, the regression in column (5) is run by taking into account this heterogeneity, at the cost of losing a unique estimate of the constant "before". The coefficient on the dummy tracking the 5-day window after the event is still significantly different from zero and its value is in line with the previous regressions.

Overall, the baseline regressions reported in Table 4 support the hypothesis that sovereign rating downgrades convey information for the CDS market,

[7] In other words, the additional regressor refers to the change in CDS spreads in the period from 6 to 10 days before each event.

finding that, in turn, confirms the existence of a risk transfer from the sovereign to the corporate sector. Not only the estimated change in the CDS rate of growth is statistically significant, the effect is also large from an economic point of view: the increase in CDS dynamics stands at around 36% at annual level.

While in equation (1) each control variable can be distinguished in the "before" and "after" time windows, the α_j coefficient on each control variable is constrained to be unique. However, as done for the constant, we can release this constraint by letting two coefficients load on the two time windows for each regressor:

$$[y^b_{i,k}\ y^a_{i,k}]' = \mu_0 D_b + \mu_1 D_a + \sum_j \alpha^b_j [x^b_{(j)i,k}\ ]' + \sum_j \alpha^a_j [x^a_{(j)i,k}\ ]' + [\varepsilon^b_{i,k}\ \varepsilon^a_{i,k}]' \quad (2)$$

In this way we can have a more precise estimate of the change in the CDS spreads dynamics. Table 5 shows the results for regressions (3), (4) and (5) in Table 4, where the coefficients are split between the two time windows. The difference between μ_0 and μ_1 slightly increases, suggesting an even larger effect of the sovereign downgrades on corporate CDS spreads, as of around 45% per annum. The split coefficients on the control variables have different sizes but always the same sign (when significantly different from zero), suggesting slightly different quantitative impacts on CDS spreads, even though the direction of the effect remains the same. In particular, for the coefficient of the lagged growth rate of CDS spreads, we have a significant positive sign only in the period before the events. This can be interpreted as a sort of momentum dynamics ahead of a rating event: the growth rate from 6 to 10 days before the event is positively related to the dynamics in the 5-day before the event. This correlation however does not survive after the event, confirming that the sovereign downgrade is a novel source of information for the corporate sector.

Table 5 Regressions with split regressors[1]

	(3 before)	(3 after)	(4 before)	(4 after)	(5 before)	(5 after)
Constant	-0.2302 ***	0.6587 ***	-0.1555 ***	0.6848 ***		0.8514 ***
	(0.06069)	(0.15517)	(0.05873)	(0.15835)		(0.12268)
iTraxx	0.5080 ***	0.5506 ***	0.50318 ***	0.5499 ***	0.4033 ***	0.4318 ***
	(0.02555)	(0.02733)	(0.02552)	(0.02718)	(0.02856)	(0.02249)
EA Sovereign CDS	0.0336 **	0.0127	0.03024 **	0.012438	0.0641 ***	0.0165 *
	(0.01619)	(0.01398)	(0.00153)	(0.01481)	(0.01601)	(0.0098)
EA Stock Index	-0.1448 ***	-0.7544 ***	-0.1824 ***	-0.75626 ***	-0.0646	-0.9765 ***
	(0.02702)	(0.06724)	(0.02603)	(0.06818)	(0.04443)	(0.07714)
Lagged Y			0.0870 ***	-0.00026	0.1009 ***	0.0230
			(0.00965)	(0.01136)	(0.01174)	(0.01484)
Macro & Financial c	YES		YES		YES	
FE by sector	YES		YES		YES	
FE by event	NO		NO		YES	
R^2	0.369		0.373		0.399	
Observations	30,604		30,604		30,604	

1) Dependent variable: CDS spread percentage change over 5-day windows before and after each event; robust standard errors clustered by country (in parentheses); symbols ***, ** and * denote statistical significance at 1%, 5% and 10%, respectively. For the variable definitions see Table 3.

All in all, from several estimates of equations (1) and (2) we gathered a strong evidence that the delivery of a downgrade from one of the three main rating agencies has an information content for the corporate credit risk. Furthermore we find that this event risk transfer is economically relevant (up to 46% at annual level). Thus, by taking a different perspective, our findings complete the broad literature that suggests that a deterioration of the sovereign creditworthiness spills over to the corporate sector (Acharya et al., 2014; Bedendo and Colla, 2015; Augustin et al., 2018). Indeed, we find that even a single event concerning the sovereign, such as the delivery of a downgrade, is used by market participants to adjust the corporate credit risk.

In the next sections we will exploit the flexibility of the proposed econometric framework to check whether the different sources of heterogeneity (both by events and by corporations) are able to affect the sovereign to corporate pass-through. In addition, we will investigate the possibility of

cross-country spillovers.

4 Event heterogeneity and spillovers

While baseline results are clearly in favour of a pass-through of risk from the sovereign to the corporate sector, the strong heterogeneity of the effect of the sovereign downgrades reported in Section 2 (Figure 2) encourages to investigate the possible reasons behind it. As a first step we look at the heterogeneity stemming from the characteristics of the events. In particular, we look at the order in the sequence of the downgrades, the dimension of the downgrade, the level of the outlook (the medium-term assessment provided by rating agencies in addition to the rating) before the downgrade, the rating agency delivering the downgrade and the period in which the downgrade occurs. Analytically, this is done by multiplying both D_b and D_a by *ad hoc* dummy variables tracking the characteristic of interest.

The first panel in Table 6 reports that the first downgrade delivered by any of the three CRAs to each of the sovereigns has a much stronger impact than the subsequent downgrades (around three times stronger). Given that the time span of the analysis includes the two waves of the global financial crisis and the sovereign debt crisis, this evidence may suggests that the initial assessment of a sovereign creditworthiness deterioration acted as a sort of "wake-up" call also for the euro-area corporate sector, in a way recognizing the involvement of an additional country in the set of those affected by the crisis.

As regards the size of the downgrade, somewhat contrary to expectations, the estimated coefficient on the 1-notch event is slightly higher than the multi-notch coefficient after the event (second panel of Table 6). This result implies that while the size of the downgrade might well signal the magnitude of the sovereign creditworthiness deterioration, what matter for the event risk transfer to the corporate sector is just the direction of the rating change.

Table 6 Selected effects[1]

	Before	After
First downgrade	-0.1444	1.4998 ***
	(0.1479)	(0.1259)
Other downgrades	-0.2425	0.4177 ***
	(0.3439)	(0.2041)
Downgrade by 1 notch	-0.1980 ***	0.6221 ***
	(0.0620)	(0.0767)
Downgrade by more than 1 notch	-0.1413 **	0.4312 ***
	(0.0752)	(0.1075)
Moody's	-0.0357	1.2353 ***
	(0.3064)	(0.2511)
Fitch	-0.0890	0.3279 *
	(0.1145)	(0.1732)
S&P	-0.2591	1.3610 ***
	(0.4319)	(0.3351)
Outlook change before the event	-0.1834 **	0.6443 ***
	(0.0841)	(0.1521)
No change before the event	0.0720	1.1917 ***
	(0.1936)	(0.2824)
Calm period	-0.1026	0.7916 ***
	(0.1236)	(0.1241)
Risk-on period	0.0888	0.5577 ***
	(0.0636)	(0.0636)
Risk-off period	-0.3555 ***	0.7784 ***
	(0.1047)	(0.1049)
Observations	30,604	

1) Dependent variable: CDS spread percentage change over 5-day windows before and after each event; robust standard errors clustered by country (in parentheses); symbols ***, ** and * denote statistical significance at 1%, 5% and 10%, respectively. Each panel of the table shows the estimates of the two constants of equation (1) in which both D_b and D_a and multiplied by a complete set of mutually exclusive dummy variables tracking the characteristics of interest. See Table 4 column (4) for the included regressors.

From the third panel of Table 6 it emerges that the downgrades delivered by Moody's and S&P have a relatively similar and large impact of more than 1 per cent per week on the CDS spreads' growth. At the same time, the impact of Fitch downgrades is more muted. Since Fitch is never the first to deliver a downgrade to any sovereign in our sample, this squares well with the previous evidence about the position in the downgrade sequence.

A further check concerns whether the level of the outlook associated to the rating (negative, positive, neutral) or a change in the outlook delivered before the rating downgrade have a bearing on the sovereign to corporate risk transfer. While the level of the outlook at the moment of the rating change turns out not to significantly affect the risk transfer (result not shown), a negative change in the outlook (either from positive to neutral or from neutral to negative), delivered by any of the three rating agencies in a 15-day window before the rating downgrade, leads to a weaker pass-through with respect to the case in which there are no outlook changes (fourth panel of Table 6). In line with the findings of Binici and Hutchison (2018), this evidence could imply that a change in the outlook tends to (partially) anticipate the effect of the sovereign downgrade. Instead, when there are no anticipations about the decision to be taken, the downgrade effect on corporate CDS is much stronger than the baseline estimation (62%).

Another possible source of heterogeneity across events is due to the time in which the downgrade is delivered. However, no single yearly dummy turns out to be statistically significant (result not shown). We then check whether sovereign downgrades which occur in periods of stressed market conditions have a different impact on corporate CDS spreads (fifth panel of Table 6). To this aim, we divide the time span into three categories: low, medium and high stressed market conditions. In particular, a period of low market stress (risk-on) is one in which the VIX index is declining, a period of high market stress (risk-off) is one in which the VIX index is increasing, and a period of calm is one in which the VIX index fluctuates around a low level. Results show that the most stressed period (risk-off) is the one in which the effect of a sovereign downgrade on corporate risk is the smallest. By contrast, the two periods of calm or decreasing volatility (risk-on) are characterized by the largest risk pass-through, suggesting that downgrades were less expected and as such they conveyed more information to financial markets.

A final source of heterogeneity which is worth investigating comes from

the country originating the event, namely the country whose credit rating was reduced. In addition, by contemporaneously looking at the country originating the event and the nationality of the corporate CDS spreads, we can investigate the cross-country spillover of a sovereign downgrade to other countries' corporate credit risk. This is done as follows: for each country in the GIIPS group and the core countries as a whole, we run two regressions over the entire sample. In the first regression the "constant after" (D_a) is interacted with two complementary dummies tracking the originating country and the rest of the sample. In this way we disentangle the effect of the downgrade on all euro-area corporate CDS spreads according to the origin of the event (the first column of Table 7). Then, a second regression is run to distinguish the effect of the downgrade on the private sector of the two core and GIIPS groups. The variable tracking the origin of the event is further interacted with two complementary dummies tracking the corporations belonging to the GIIPS and core groups, respectively (the last two columns of Table 7). In other words the effect estimated for the euro area in the first set of regressions is split in core and GIIPS.[8]

From the first column in Table 7 we can see that when the event originates from a core country, the effect on the euro-area corporate credit risk is much larger than when it originates from the remaining countries. Indeed the change in corporate CDS spreads after a core event is more than three times larger than any event stemming from a GIIPS country. In addition, the effect is felt differently across countries: even if it originates in a core economy the corporate credit risk deteriorates more in the GIIPS countries (second and third column).

[8]For each GIIPS country it was possible to create a dummy separating the domestic downgrades from the other downgrades because of the large number of downgrades delivered to each GIIPS sovereign. Instead, the downgrades delivered to the single core economies were not enough and thus they were grouped together. The full set of 12 regressions is available upon request.

Table 7 Cross-country spillover[1]

	Euro area	GIIPS	Core
Core economies	1.4029 ***	1.8464 ***	1.2543 **
	(0.1684)	(0.4245)	(0.3161)
Greece	0.3153 ***	1.4062 ***	-0.2719 **
	(0.0765)	(0.2147)	(0.1190)
Ireland	0.3633 **	1.2073 ***	0.0528
	(0.1773)	(0.3275)	(0.1103)
Italy	0.5103 ***	1.1102 ***	0.3136 **
	(0.2021)	(0.4086)	(0.1516)
Portugal	0.3509 *	1.5569 ***	-0.0755
	(0.2059)	(0.6380)	(0.1440)
Spain	0.0744	0.0624	0.0786
	(0.2012)	(0.4196)	(0.2297)
Observations	30,604	30,604	

1) Dependent variable: CDS spread percentage change over 5-day windows before and after each event; robust standard errors clustered by country (in parentheses); symbols ***, ** and * denote statistical significance at 1%, 5% and 10%, respectively. The LHS panel shows the estimated coefficient of the interaction of the "constant after" (D_a) with a dummy tracking the country of origin of the event (reported by column). The RHS panel shows the estimated coefficients of the interaction of the "constant after" (D_a) with the two Core and GIIPS groups of countries when the event is originated in the country reported by column. See Table 4 column (4) for the included regressors.

Concerning the sovereign downgrades in the GIIPS countries, they are able to affect the whole euro-area corporate credit risk even though to a different extent. While Greece, Ireland and Portugal have a similar impact (ranging between 16% and 19% at annual level), Italy exerts a stronger pass-through of around 27% and, somewhat puzzling, Spain dose not seem to deliver any significant effect. The latter results is confirmed when looking at the cross-country decomposition: neither the core nor the GIIPS economies are affected by a sovereign downgrade in Spain. On the contrary, there is a very strong spillover among the other GIIPS countries. The delivery of a

rating reduction in any of the GIIPS economy is able to strongly affect the corporate sector credit risk in the whole group of country, to an extent often not far from that of the core economies. Completely different is the reaction of the corporate credit risk in the core economies, which usually are not affected by a downgrade in the GIIPS group. There are two major exceptions. On the one hand, an event in Italy is able to induce an acceleration also in the core CDS spreads, thus showing a relevant role for Italy in the transmission of shocks across the euro area. On the other hand, the estimated coefficients for Greece suggest that a deterioration in the sovereign creditworthiness is able to induce a change in the opposite direction (i.e. a positive spillover) in core countries' corporate risk: CDS spreads in those economies improved after the event. This *prima facie* puzzling result can instead be easily interpreted as a "flight to safety" effect. At times of uncertainty on weaker economies, investors shift towards countries with sounder fiscal balances, not only at the sovereign but also at the corporate sector level.

All in all, while our results about the contagion across countries are broadly in line with the evidence stemming from the literature analyzing the transmission of distress from one sovereign to another (De Grauwe and Ji, 2013; Giordano et al., 2013; Benzoni et al., 2015; Corsetti and Dedola, 2016), we document that the transmission of shocks may also occur from the domestic sovereign sector to the foreign corporate sector, and that the sign of the transmission changes depending on the fiscal soundness of the countries involved.

5 Channels of transmission

A second source of heterogeneity which may affect the strength (and the direction) of the event risk transfer is due to the features of the corporations. This analysis leads us to deal with the possible channels of risk transmission stemming from the sovereign event. However, our analysis is not an attempt

to test these theories, which are not mutually exclusive, but simply to identify the main drivers of the event risk transfer more generally.

Conceptually, sovereign distress may spill over into the corporate sector directly through expected increases in taxation, reductions in subsidies, the decreased value of implicit and explicit government guarantees, or through impairments in credit provision of banks affected by sovereign risk (Gennaioli et al., 2014; Acharya et al., 2014; Adelino and Ferreira, 2016). In addition, a sovereign downgrade may have a significant effect on the real economy when transmitted to the corporate sector by increasing the firms' cost of capital and hampering investment even across countries (Brutti and Saurè, 2015; Almeida et al., 2017; Bahaj, 2019). While the econometric framework proposed in the previous sections is not suited to investigate the above-mentioned broad channels of transmission of the credit risk, which usually unfold over long time spans, we can instead focus on firm- and sector-specific features that reinforce of loosen the response of CDS spreads to the "event risk transfer" and are behind at least three other channels of transmission. Channels which we name below as: the dependence channel, the domestic channel and the rating channel.

The first channel how increased sovereign risk may be transmitted to domestic corporations relates to the business linkages that a company has with the government (dependence channel). Indeed, governments are often shareholders in domestic companies of strategic relevance and government-controlled firms enjoy both direct and indirect debt guarantees from the state. Thus, politically connected firms are more likely to be bailed out than similar unconnected firms (Borisova et al., 2015; Boubakri and Saffar, 2019). On the other hand, when concerns about the creditworthiness of the sovereign arise, the value of the state guarantees deteriorates. If a sovereign government experiences a negative shock, we would expect a stronger transmission to the credit risk of companies characterized by large public ownership. In addition, some sectors of the economy are linked to the sovereign not because

of the government ownership but mainly because the state is among their most important customers (Pellegrino and Zingales, 2017). Again, we would expect a stronger deterioration of credit risk after a sovereign downgrade for corporations more dependent on the state.

A second firm-specific characteristic which may increase the strength of the sovereign-to-private credit risk pass-through is related to a low foreign activity and therefore a strong dependence on the domestic market (domestic channel). In particular, we expect firms whose output is mainly oriented to the domestic market to be more sensitive to sovereign risk. Indeed, following a deterioration of sovereign creditworthiness, governments may decide to engage in restrictive monetary or fiscal measures to restore their rating, which can lead to a significant contraction in domestic demand. This, in turn, increases the credit risk of corporations whose business strongly relies on domestic demand in both emerging markets (Arteta and Hale, 2008) and advanced economies (Arellano et al., 2018).

The third channel of risk transmission is related to the binding of the explicit or implicit sovereign rating ceiling (Borensztein et al., 2013; Almeida et al., 2017). The underlying idea is that CRAs rely on a general rule of never rating a corporation above the sovereign.[9] This in turn implies that after a sovereign downgrade CRAs might tend to decrease also corporate ratings when these ratings are near the sovereign rating (Hill et al., 2018). We then expect that corporations showing rating at the sovereign level may suffer a larger adjustment in their CDS spreads after a sovereign downgrade.

To investigate the working of each transmission channels we create *ad hoc* dummies which take 1 if the firm characteristics are positively related to that channel and 0 otherwise. We then interact the relevant dummy for each channel with the "constant after" to assess the (possibly) different effect of sovereign downgrades on corporate CDS spreads.

[9] Until 1997 the ceiling policy was strictly followed by CRAs. In April 1997 Standard & Poor's was the first agency to relax this constraint, followed later on by Fitch (in 1998) and Moody's (in 2001).

Table 8 Channels of transmission[1]

	(1)	(2)	(3)	(4)	(5)
Constant before	-0.1527 **	-0.1528 **	-0.1550 ***	-0.1522 **	-0.1570 **
	(0.07313)	(0.07311)	(0.07315)	(0.07342)	(0.07303)
Constant after * positive	0.9624 ***	0.6880 ***	0.8125 **	0.6948 ***	1.1034 ***
	(0.24743)	(0.16348)	(0.12971)	(0.13483)	(0.21089)
Constant after * negative	0.5260 ***	0.2306 ***	0.1193	0.1573 **	0.4780 ***
	(0.12427)	(0.06614)	(0.07688)	(0.07812)	(0.11824)
Positive - negative	0.4365	0.4574	0.6933	0.5375	0.6255
	[0.061]	[0.005]	[0.001]	[0.001]	[0.001]
Macro & Financial controls	YES	YES	YES	YES	YES
FE by sector	YES	YES	YES	YES	YES
R^2	0.359	0.360	0.361	0.360	0.360
Observations	30,604	30,604	30,604	30,604	30,604

1) Dependent variable: CDS spread percentage change over 5-day windows before and after each event; robust standard errors clustered by country (in parentheses); symbols ***, ** and * denote statistical significance at 1%, 5% and 10%, respectively. The top panel shows the estimated coefficients of the "constant before" (D_b) and the interaction of the "constant after" (D_a) with two dummies tracking whether the corporations' characteristics are positively or negatively related to the channel of transmission under analysis. The dummies relate to: (1) the share of public ownership; (2) the public sector dependence score by Pellegrino and Zingales (2017); (3) the share of foreign revenues over total revenues; (4) the tradable sectors; (5) the firm rating being in a range of 0.5 notches around that of the sovereign. The lower panel shows the difference between the positive and negative interaction of the "constant before" and the *p*-value of the test of statistical significance. See Table 4 column (4) for the included regressors.

In particular, to assess the strength of the pass-through for corporations involved in the sovereign channel of risk transmission, we rely on two indicators: the share of public ownership and the public sector dependence score by Pellegrino and Zingales (2017). As regards public ownership, we set up a dummy which takes 1 for government ownership exceeding 5% and 0 otherwise.[10] In the sample we have an average of 25 corporations per event breaching the threshold. As concerns the sectorial dependency on gov-

[10] We relied on a share in the government ownership ranging between 3 and 10 per cent without a significiant change in the results.

ernment inputs, we identify 8 sectors (out of the 22 ranked by Pellegrino and Zingales) as highly dependent on government. Accordingly, we set up a dummy which takes 1 if the corporation belongs to one of them and 0 otherwise. It turns out that the dummy tracks down an average of 76 corporations per event.[11] Table 8 (columns 1 and 2) shows that for both indicators the effect goes in the expected direction: the increase in CDS spreads after a sovereign downgrade is larger for corporations showing a stronger link to the government. The difference is statistically significant and economically relevant: corporations linked to the government via ownership or business relationship face an additional deterioration in the credit risk in the range 22-24 percent at annual level with respect to other corporations.

To check the working of the domestic channel in the euro area we set up two indicators. The first concerns the share of foreign revenues with respect to total revenues (sourced from Datastream and Orbis), the second relies on the standard classification of tradable and non-tradable sectors (Mano and Castillo, 2015). In the latter case we set up a dummy which takes 1 for non-tradable sectors and 0 otherwise, while in the former case we device a dummy which takes 1 for corporations showing a foreign share smaller than the median value and 0 otherwise. As done for the assessment of the sovereign channel, we interact the two dummies with the "constant after". Columns (3) and (4) of Table 8 report the estimation results. Both indicators suggest that also the domestic channel of risk transmission is at work. The difference between corporations constrained on the domestic market and those which have access to international markets are not only statistically significant but also sizable from an economic points of view: the pass-through is stronger by 28-36 percent per annum.

Finally, the last channel we look at stems from the attitude of CRAs not

[11] The original 8 sectors of high dependence selected according to the Pellegrino and Zingales (2017) score are mapped to the following 5 sectors of our classification: Basic Materials, Utilities, Industrials, Telecommunications and Technology. Adding or shedding one sector does not qualitatively change the results of the analysis.

to rate a corporation above the sovereign (rating channel). We thus construct a dummy which takes 1 for corporations in a range of 1 notch around the sovereign rating (from 0.5 above to 0.5 below the sovereign rating) and zero otherwise. Not surprisingly, we have an average of just 12 corporations per event in the selected range. Column (5) of Table 8 shows that for the latter group the deterioration in CDS spreads after a sovereign downgrade is twice larger than for other corporations (65% vs 33%).

Summing up, our evidence suggests that, even in a context of strong heterogeneity, some features of corporations make them more sensitive to the event risk transfer stemming from a deteriorated credit risk of the sovereign. The features investigated indicate that market agents negatively assess strong links with the sovereign, the inability of corporation to do business with the rest of the world and (paradoxically, since it is a constraint stemming not from the corporations but from CRAs) a rating close to that of the sovereign.

6 Robustness

In this section we provide some robustness checks concerning two issues: i) the selection of the events and the breadth of time windows over which calculate the effect on CDS spreads; ii) the measure of the CDS change over the selected time windows.

As concerns the selection of the events, Table 9 reports the regression estimates when the larger universe of 94 dates and two smaller samples of 61 and 51 events are employed. For the ease of comparison also the coefficients of the baseline regression in Table 4 (column 4) over the 68 unconfounded events are reported. The sample of 61 events sheds from the unconfounded set 7 dates which were free of other rating or outlook changes but were delivered to more than one country or to the same country by more than one rating agency. Instead, by enlarging to 10 days the period free of any other intervention by rating agencies we get the smaller sample of 51 events.

Even though the number of observations changes a lot across samples, the statistical significance of the coefficient μ_1 always remains strong ($p < 0.01$). At the same time, there seems to be a negative relation between the size of the sample and the strength of the risk transfer: the smaller the sample the larger the estimate. The difference between μ_0 and μ_1 almost doubles from the set of all the 94 available dates (column 1) to the smaller set of 51 events (column 4). Indeed, the size of the difference in the coefficients μ_0 and μ_1 is rather large in the 51-event regression, implying an increase in the CDS rate of growth of over 50% per years. This would suggest that the more unconfounded are the episodes, the stronger is the risk pass-through.

Table 9 Robustness checks by sample size[1]

	94	**68**	**61**	**51**
Constant before	-0.1401 ***	-0.10457 *	-0.2104 ***	-0.3657 ***
	(0.05099)	(0.06191)	(0.08026)	(0.07828)
Constant after	0.4772 ***	0.5957 ***	0.6416 ***	0.6952 ***
	(0.14791)	(0.12707)	(0.15527)	(0.17834)
iTraxx	0.5096 ***	0.5222 ***	0.5172 ***	0.5357 ***
	(0.02398)	(0.02502)	(0.02768)	(0.02923)
EA Sovereign CDS	0.0127	0.0096	0.0103	0.0984
	(0.01166)	(0.00952)	(0.01253)	(0.00914)
EA Stock Index	-0.6859 ***	-0.4715 ***	-0.4734 ***	-0.4699 ***
	(0.02601)	(0.03328)	(0.03072)	(0.03714)
Lagged Y	0.0671 ***	0.0412 ***	0.0312 ***	0.0368 ***
	(0.01052)	(0.00888)	(0.00984)	(0.00995)
Macro & Financial controls	YES	YES	YES	YES
FE by sector	YES	YES	YES	YES
FE by event	NO	NO	NO	NO
R^2	0.383	0.361	0.355	0.356
Observations	42,644	30,604	27,488	22,898

1) Dependent variable: CDS spread percentage change over 5-day windows before and after each event; robust standard errors clustered by country (in parentheses); symbols ***, ** and * denote statistical significance at 1%, 5% and 10%, respectively. Each column of the table reports the estimated values of equation (1) for a different size of the sample of events. For the variable definitions see Table 3.

A second check concerns the size of the windows around the 68 unconfounded events used to assess the effect of the sovereign downgrades on corporate CDS spreads. In Table 10 we propose the estimation results for two larger windows than in Section 3, i.e. 10 and 15 days and also for a very short window of just 1 day around the events. Again, the baseline result for the 5-day windows is also reported.

Table 10 Robustness checks by time window length[1]

	1 day	5 days	10 days	15 days
Constant before	-0.1242 *	-0.10457 *	-0.0965	-0.0853
	(0.07155)	(0.06191)	(0.0986)	(0.0861)
Constant after	0.7558 ***	0.5957 ***	0.4973 ***	0.4474 ***
	(0.11905)	(0.12707)	(0.08173)	(0.09732)
iTraxx	0.5680 ***	0.5222 ***	0.5917 ***	0.5138 ***
	(0.02334)	(0.02502)	(0.02758)	(0.02863)
EA Sovereign CDS	0.0136	0.0096	0.0093	0.0118
	(0.01096)	(0.00952)	(0.01051)	(0.00989)
EA Stock Index	-0.3540 ***	-0.4715 ***	-0.4540 ***	-0.5187 ***
	(0.10031)	(0.03328)	(0.11131)	(0.12371)
Lagged Y	0.0552 ***	0.0620 ***	0.0528 ***	0.0516 ***
	(0.01848)	(0.01222)	(0.01367)	(0.01202)
Macro & Financial controls	YES	YES	YES	YES
FE by sector	YES	YES	YES	YES
FE by event	NO	NO	NO	NO
R^2	0.410	0.361	0.366	0.347
Observations	42,644	30,604	30,604	30,604

1) Dependent variable: CDS spread percentage change over 5-day windows before and after each event; robust standard errors clustered by country (in parentheses); symbols ***, ** and * denote statistical significance at 1%, 5% and 10%, respectively. Each column of the table reports the estimated values of equation (1) for a different length of the windows before the events. For the variable definitions see Table 3.

The event risk transfer seems to increase as the window gets smaller: the estimated μ_1 coefficient is the largest for the shortest 1-day window and thereafter declines through the 5- 10- and 15-day windows. This suggests

that much of the surprise is already incorporated in the CDS spread prices in the early days after the rating change.

All in all, the robustness checks confirm the finding of the existence of an "event risk transfer", namely that sovereign rating changes were not fully anticipated and therefore they convey additional information also for the risk assessment of euro-area corporations. In addition, we find that after the delivery of the sovereign downgrade this risk transfer is relatively fast and it is stronger when the events are less confounded.

Table 11 Pooled OLS regressions (absolute changes)[1]

	(1)	(2)	(3)	(4)	(5)
Constant before	-1.3168 ***	-0.3738 *	-0.9553 ***	-0.8939 ***	
	(0.30089)	(0.22511)	(0.07307)	(0.29442)	
Constant after	0.6321 *	2.2611 **	1.9068 **	1.9822 **	2.3046 ***
	(0.38079)	(0.89538)	(0.12482)	(0.88801)	(0.65849)
iTraxx		1.1893 ***	1.0328 ***	1.0291 ***	0.9159 ***
		(0.14671)	(0.02491)	(0.11732)	(0.10694)
EA Sovereign CDS			-0.0010 **	-0.0010 **	-0.0003
			(0.00016)	(0.00021)	(0.00031)
EA Stock Index			-0.9168 ***	-0.9549 ***	-0.7422 ***
			(0.14268)	(0.16663)	(0.12461)
Lagged Y				0.0256	0.0221
				(0.02821)	(0.03257)
Macro & Financial controls	NO	NO	YES	YES	YES
FE by sector	YES	YES	YES	YES	YES
FE by event	NO	NO	NO	NO	YES
R^2	0.003	0.159	0.166	0.167	0.186
Observations	30,534	30,534	30,534	30,534	30,534

1) Dependent variable: CDS spread absolute change over 5-day windows before and after each event; robust standard errors clustered by country (in parentheses); symbols ***, ** and * denote statistical significance at 1%, 5% and 10%, respectively. iTraxx is the iTraxx-Europe index; EA sovereign CDS is the sovereign 5-year CDS spread in euro; EA Stock Index is the Total Market Index, as computed by Datastream, Thomson Reuters; Lagged Y is the rate of change of CDS spreads in the window from 6 to 10 days before each event. Macro and Financial controls include euro-area and US macroeconomic surprise indices; the VIX Index, the CISS Index; the euro nominal effective exchange rate; the slope of the yield curve (OIS 10-year minus OIS 1-year).

A final check concerns the use of the percentage increases in CDS spreads

in the weeks around the sovereign downgrades. While the use of the percentage change is the most common in the literature, due to the very large heterogeneity in the size of CDS spreads, a possible alternative would be to rely on the absolute changes. Thus, Table 11 replicates the regressions proposed in Table 4 when the dependent variable is switched to the absolute (instead of percentage) weekly changes in CDS spreads in the two windows before and after each event and the regressors are adjusted accordingly.

The value of interest is again the difference between the two intercepts μ_0 and μ_1, and can be interpreted directly in basis points. First, we notice that the change in the period after the sovereign downgrades is always significantly positive confirming the existence of an "event risk transfer". In addition, the magnitude of the overall change ranges between 1.9 and 2.9 basis points. Given an average of 230 basis points in the CDS spread over the sample under investigation we have that following a sovereign downgrade the annual percentage increase in corporate CDS spreads is not below 44%, a value slightly larger but in line with the previous regressions.

7 Conclusions

In the paper we provide an analysis of the consequences of a sovereign rating downgrade on the corporate credit risk. We rely on an unexplored perspective borrowed from the monetary policy communication and a novel econometric approach. In particular, we look at the effect of the delivery of sovereign downgrades by the three main CRAs on a large cross-section of euro-area corporate CDS spreads.

We device a regression framework in which the pros of the event study methodology are maintained and most of the cons eliminated. In our model the variable under investigation and the control variables are confined to two windows of 5 days before and 5 days after the events. In this way the control variables help disentangling the effect of the sovereign downgrade on the CDS

spreads behavior just around the event.

Relying on 68 unconfounded events, we find that sovereign downgrades have indeed an information content for the credit risk of euro-area corporations and that this effect exists on top of the standard relation between sovereign and corporate CDS spreads. We label this effect as "event risk transfer".

By controlling for several macro and financial variables and the evolution of sovereign CDS spreads, it turns out that the rate of growth of corporate CDS spreads after the events significantly increases by a rate between 34% and 37% per year, according to the most conservative set of regressions. This range may well be underestimated since the less confounded are the events and the shorter is the time windows around the events, the larger is the estimated event risk transfer.

In addition, by exploiting the flexibility of the econometric framework we investigate how the vertical and horizontal heterogeneity affect the strength of the pass-through. The vertical heterogeneity refers to the different characteristics of the events: we find that the sovereign to corporate spillover is stronger for the first downgrade, when the downgrade is delivered in a tranquil period and when no changes in the outlook precede the delivery. The horizontal heterogeneity concerns instead the different features of the corporations and it is employed to shed light on the possible channels of risk transmission. We find that strong business links with the sovereign, the inability of corporations to do business with the rest of the world and a rating assessment close to that of the sovereign make corporations more exposed to the risk transfer.

Finally we analyze the possibility of international contagion. The sovereign downgrades leading to a stronger pass-through are those delivered to the core economies (Austria, Finland, France, Belgium and the Netherlands), which however affect more the GIIPS countries than the core economies themselves. Concerning the five countries most involved in 2010-2012 sovereign

debt crisis (Greece, Ireland, Italy, Portugal and Spain), we find that a sovereign downgrade in any of the GIIPS country strongly affects the whole group with the exception of Spain, suggesting a significant contagion within this restricted set of countries. However, only the downgrades delivered to Italy are able to spill over also to the core economies. At the same time downgrades in Greece lead to an improvement in the corporate credit risk in core economies. In other words, we report evidence of a cross-country cross-sector "flight to safety" effect.

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