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DEALING WITH DEALERS: SOVEREIGN CDS COMOVEMENTS*

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ABSTRACT

A simple measure of commonality in the quotes that dealers give for Sovereign European CDS is a powerful predictor of cross-sectional variation in the correlation of the percentage changes in CDS premia. In fact, these comovements are largely due to the com-

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monalities in quotes and not to fundamentals. These results are consistent with a non-fundamental price pressure mechanism explained from the strategy adopted by the dealers to deal with inventory risk. An instrumental variable analysis confirms that our findings reflect indeed a causal relation between commonality in quotes and CDS comovement.

JEL CLASSIFICATION: G12, G14.
KEYWORDS: Sovereign CDS, comovements, commonalities, dealers.

I. INTRODUCTION

Credit Default Swap (CDS) spreads are widely used by regulators and academics as a key tool to assess the creditworthiness of a bond or an entity because they provide insurance against the default of such underlying security or entity. An increasing body of literature has shown, however, that CDS spreads not only convey information about credit risk, but also about liquidity and counterparty risk, among other factors.[1] Much less attention has been given, however, to the sources of comovement in CDS spreads. Understanding the drivers of these correlations is central to regulatory and policy work, as they are at the heart of systemic risk by definition –stronger interlinks between different entities reveal a higher systemic risk. If this is important among corporate contracts, it is crucial with sovereign CDS, especially in Europe, as a credit event in one country can have a strong impact in the whole Euro area.

The aim of this paper is to understand why CDS spreads of European countries move together (or comove) so much, if the countries are different. We focus on connecting countries through the CDS dealers they have in common. Specifically, we study whether a simple measure of commonality in the quotes that dealers give for Sovereign European CDS helps us to predict the cross-sectional variation in the correlation of the changes in CDS log premia (hereafter CDS log return),[2] controlling for liquidity and default risks, and other country-pair characteristics and macro variables.

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[1] See Longstaff, Pan, Pedersen and Singleton (2005) for liquidity risk in CDS, and Arora, Gandhi, and Longstaff (2012) for counterparty risk.

[2] Our aim is not to analyze the correlation between the CDS returns based on the value of the CDS contract to the investor that would imply the use of risk-free discount factors and risk-neutral survival probability as in Berndt and Obreja (2010). On the contrary, we aim to analyze the correlation in the price change of CDS contracts from the previous month such that the comovements are defined just obeying to the prices quoted in the market. In the interest of writing brevity we refer to the change in the CDS log price as CDS log returns.

CDS market dealers play a crucial role in providing liquidity to the market by disseminating bids and offers to potential clients, seeking to trade credit protection.[3] Although a few papers analyze the effect of the liquidity provision on CDS prices, not much is known about the effect of dealers' liquidity provisions on CDS price comovements. In this paper, we offer new insights on that issue by exploiting available data provided by CMA that consists of intraday quotes for 11 European Monetary Union (EMU) countries. The reason for focusing in the EMU is threefold. First, the levels of contagion among these countries during the current European sovereign debt crisis have been very strong and have persisted for a long period of time. Second, the activity in the EMU sovereign CDS contracts has increased significantly.[4] Third, all the CDS have similar characteristics in terms of currency, restructuring clause, and timing. Although most of the action occur in the European sovereign CDS, we extend our analysis to the whole universe of sovereign CDS contracts to confirm the robustness of our results showing that the findings are not influenced by the strong credit risk contagion among European countries.

CDS data vendors employ their methodologies to offer daily quotes that are obtained after combining the quotes received by different dealers. We test whether the common quotes reported by the same dealer for a given pair of countries affect the correlation of CDS spreads, and find that they do. The effect of the commonality in quotes is significant at any standard significance level and has a very strong forecasting power on the future comovements among sovereign CDS spreads. In fact, the economic impact of the commonality variable is stronger than the one attributable to the remaining explanatory variables, including the traditional fundamental variables.

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[3] The importance of dealers' activity in the CDS market is remarkable. At the end of 2011, dealers accounted for 58% of notional amounts outstanding, and 64% of gross market values in the CDS market. Additional evidence is provided by Robert Pickel, CEO of ISDA, in his testimony to Congress in March 10, 2009, stating that 86% of the Depository Trust & Clearing Corporation (DTCC) trades were dealer-to-dealer trades. Finally, Tang and Yan (2010) also sustain that most CDS contracts are traded through dealers who either trade with other dealers directly or trade through an interdealer broker.

[4] The gross notional amount outstanding by the end of 2008 was $405 billion, while by the end of our sample (October 2011) the gross notional amount outstanding for the 11 European countries was $1,047 billion. In fact, according to data provided by DTCC, France, Italy, and Germany where the top 3 reference entities in terms of the net notional amount outstanding by September 2011, including sovereign and corporate references, being Spain the 5th reference entity. Belgium, Austria and Portugal were in the 11th, 12th, and 14th place, respectively. Compared to the remaining sovereign CDS, the net amount outstanding for the 11 EMU countries in our sample ($108 billion) was 1.33 larger than for the rest of sovereign CDS ($81 billion) by January 2010.

Our analysis also explores cross-sectional variation in the strength of the previous effect. In particular we show that the commonality in the quotes given by dealers has a stronger effect on subsequent correlation when the common dealers have excess inventory risk. Dealers facing inventory risk would be forced to sell or buy CDS to restore the inventory to the desired level. If dealers face inventory risk in two countries at the same time, the joint sales or purchases of CDS for those countries could lead a simultaneous change in the prices of the two CDS. These comovements are largely due to the commonalities in quotes and not to fundamentals.

The relationship between commonality in quotes and CDS log return correlation could also go the other way, so endogeneity is a key concern. For example, dealers could choose to give more quotes to countries whose CDS prices are more correlated. To address this concern, we implement an instrumental variable approach, and use the number of firms whose credit rating was downgraded to the junk category in the European Union as the instrument. The mechanism through which the excess correlation is caused is the role of inventory risk on downgraded bonds on other asset prices. Those downgrades should have a direct effect on the inventory positions of intermediaries in the bond market that could have also been forced to price their heightened inventory risk into prices of all other securities they intermediate. As major intermediaries of bonds also intermediate CDS, this effect is expected to affect the inventory risk of dealers CDS positions. The aim of dealers to restore the CDS inventory to a desired level would force them to accommodate buying and selling and to adjust the quoted prices affecting to the comovements across CDS. This piece of evidence confirms that our finding comes indeed from a causal relation between commonality in quotes and CDS return comovement. This mechanism originated from a downgraded in credit ratings has been found to be an important channel behind the comovements across CDS by Acharya et al (2014) in the context of GM and Ford downgrades to junk category.

Our finding is robust to the exclusion of Greece in the analysis, to the use of pre-crisis and crisis periods, to the use of filtered CDS returns to a market model, to the use of an extended sample that consists of the whole universe of sovereign CDS, and to different definitions of commonality in quotes.

The rest of the paper is organized as follows. In Section 2, we review the literature. In Section 3, we describe our methodology and data sources. Section 4 presents our results. In Section 5 we present our conclusions.

II. LITERATURE REVIEW

Our work links to papers studying the comovements or correlations between the CDS spreads of the EMU countries during the current European sovereign debt crisis. Independently of the econometric methodology employed to measure contagion, these papers document an increasing trend in the comovements of credit risk indicators in the EMU countries since the beginning of the crisis (see Andenmatten and Brill (2011), Zhang, Schwaab, and Lucas (2011), Alter and Schüler (2012), Kalbaska and Gatkowski (2012), Gündüz and Kaya (2013), Manasse and Zavalloni (2013), among others). In this process of contagion, peripheral countries have become more vulnerable to the euro zone contagion and have exhibited stronger comovements between them.

In spite of the growing literature on the drivers of credit risk and CDS returns in European countries in the context of the European sovereign debt crisis; little is known about the determinants of the observed comovements and interlinkages of the countries' levels of credit risk and in CDS returns. The potential set of drivers could be relatively similar to the drivers that explain and predict corporate CDS prices: default, liquidity, risk premium, and counterparty risk factors (see Anderson (2012) or Pu and Zhao (2010)).[5] For example, the role of the default factors is documented by Manasse and Zavalloni (2013), who find that the country macro fundamentals during crisis period explain 80% of the vulnerability of a given country to contagion. Besides macro fundamentals, Alter and Schüler (2012) document that financial sector shocks also affect sovereign CDS spreads in the short-run. In the same line, Dieckmann and Plank (2012) show that the high correlations observed since the beginning of the financial crisis are explained by the state of a country's domestic financial system.

We share some of the objectives pursued by these previous papers by analyzing the effect of country specific and global variables referring to default risk, liquidity, and risk appetite on the correlations among EMU sovereign CDS spread changes. Given that previous literature has left a significant part of these correlations unexplained, our aim is to build on previous literature and test whether the CDS market structure and their dealers' activity helps improve the explanatory power on such correlations. The impor-

[5] These factors have also been found to be significant determinants of the EMU sovereign bond and CDS spreads by Geyer, Kossmeier, and Pichler (2004), Beber, Brandt and Kavajecz (2009), Mayordomo, Peña, and Schwartz (2012), Favero, Pagano, and Von Thadden (2010), Bernoth, von Hagen, and Schuknecht (2012), or Badaoui, Cathcart, and El-Jahel (2013), among others.

tance of dealers in the CDS market described above highlights the role of the dealers' activity in the CDS prices comovements.

The inability of fundamentals to fully explain these comovements links to Barberis and Schleifer's (2003) theory according to which assets commove beyond fundamentals, because of market frictions or noise-trader sentiment. Barberis, Schleifer, and Wurgler (2005) provide empirical evidence supporting this friction-based view. Our analysis focuses on the effect of a specific market friction on the CDS prices comovements: inventory risk.

Inventory control and risk-sharing could be a motive behind interdealer trading, as suggested by Ho and Stoll (1983). According to inventory control literature (Garman, 1976, Stoll, 1978, Amihud and Mendelson, 1980, Ho and Stoll, 1983, O'Hara and Oldfield, 1986, among others), dealers accommodate buying and selling by outside investors and adjust their quoted prices to restore their inventories to some desired level and causing price movements.

The effect of inventory costs on OTC markets has been documented by Duffie, Garleanu, and Pedersen (2007) and Jankowitsch, Nashikkar, and Subrahmanyam (2011). Thus, inventory holding costs joint with search frictions and bargaining power have been found to affect the liquidity premium of those assets. Acharya, Amihud, and Bharath (2013) argue that the effect of these frictions is higher in times of financial distress due to binding capital constraints and increased holding and search costs.

Some recent papers have specifically studied the role of inventory risk in CDS markets. Shachar (2013) documents a significant effect of inventory risk on corporate CDS transaction prices of North American financial firms. She examines the role of liquidity provision by dealers in the CDS market, and finds that order imbalances of end-users cause significant price impact, which depend on the sign of the dealers' inventory. The effect of dealers' inventory on the price is even stronger when counterparty risk increases. Gündüz et al. (2013) use CDS transactions data to show that CDS traders adjust their quotes to the order flows they observe being the adjustment of the premium stronger as inventory risk increases. Siriwardane (2014) also uses CDS transaction data to measure CDS sellers' capacity to supply CDS and documents that dealers' risk-bearing capacity affects CDS prices.

Besides the effect of inventory risk on single securities traded by a given dealer facing that risk, it also affects all securities traded by that dealer causing cross-securities price pressure. Ho and Stoll (1983) show that when the dealer trades more than one stock, she not only changes the bid and ask quotes in that stock but also adjusts quotes in other

stocks to reduce her total inventory risk. In the same vein, Andrade, Chang, and Seasholes (2008) use data from the Taiwan Stock Exchange to document that an imbalance in one stock also affects the price of other stocks. This cross-stock price pressure is higher among stocks with more correlated fundamentals such as cash flows than among stocks with less correlated cash flows.

The cross-securities effect of liquidity shocks affecting financial constrained intermediaries has been also documented for fixed income instruments. Acharya, Schaefer, and Zhang (2008) show that GM and Ford downgrades in May 2005 to junk status caused a large number of bond investors and asset managers, those who faced portfolio restrictions to invest only in investment-grade bonds, to liquidate their positions. Due to the slow movement of capital, the market-makers were left with significant inventories of these bonds. Most of the market-makers in corporate bonds are also the liquidity providers in other related segments such as CDS. Thus, the inventory risk faced by market-makers from GM and Ford bonds increased overall corporate CDS spreads and caused excess comovement of CDS across all industries not just in those of auto firms. The authors find that this relationship between liquidity risk and correlation risk is, in fact, causal.

Given the nature of our data, our aim is to analyze the effect of commonalities in quotes on CDS comovements over and above the effect of fundamental credit risk drivers. We consider a specific market friction – inventory risk – faced by the dealers quoting prices in the CDS market, as the mechanism through which the excess correlation is caused.

III. DATA AND METHODOLOGY

A. Data and Sample

Intraday CDS quotes disaggregated at the contributor or dealer level come from a dataset provided by CMA, for 11 EMU countries (Austria, Belgium, Finland, France, Germany, Greece, Netherlands, Ireland, Italy, Portugal, and Spain), and spanning from January 2008 to October 2011. The same information is employed for other 39 non-EMU countries from January 2010 to October 2011 to deal with the robustness of the results obtained for the EMU countries.

The intraday CDS dealer quotes (both executable and indicative) come from over-the-counter communication between CDS dealers and buy-side institutions, including

hedge funds and investment banks' proprietary trading desks.[6] In fact, the daily data reported by CMA comes from these intraday quotes. CMA collects the buy-side data for every contract and aggregates it to a daily frequency.

CDS quotes employed in this study are 5-year maturity contracts (the most liquid one) denominated in US Dollars. For those observations for which we only have information on the CDS up-front prices but not for the CDS spreads, we calculate the spread following the ISDA CDS Standard Model to convert upfront payments into spreads.[7] To guarantee a minimum level of synchronicity, we exclude quotes outside the main working hours (7am to 8pm GMT+1) and quotes given on Saturdays and Sundays.[8] Information related to control variables comes from other sources, explained in subsequent subsections.

Table I reports the summary statistics of the final sample of CDS quotes and the share of quotes by dealers. Panel A disaggregates at country level the total number of quotes and dealers reporting those quotes for the EMU countries, as well as the daily average. We have more than half a million of quotes for every peripheral country over the whole sample period (i.e., more than 572 quotes on daily average). The total number of quotes in the core countries ranges from 469,751 (France) to 331,887 (Finland). Regarding the number of dealers giving quotes to a certain country we do not observe sizeable differences across countries. We observe that there are around 90 dealers providing quotes to the 11 EMU countries. Panel B contains the aggregate descriptive statistics for the EMU and non-EMU countries using information from January 2010 to October 2011. This panel confirms that the activity on the 11 EMU countries is higher than the one observed for the remaining 39 non-EMU countries both in terms of the total number of quotes and the average daily number of quotes. These figures reinforce the importance of understanding the effect of dealers' common quotes on the comovements of most liquid CDS. In fact, it gives an average of almost 950 quotes for each individual EMU country versus 260 for each individual non-EMU country. The total number of dealers reporting prices and the average number of dealers reporting prices on a daily basis for the two groups of countries are very similar. It points towards a more active quoting behavior of the same group of dealers towards the EMU countries.

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[6] As explained in Qiu and Yu (2012), the process of trading in the CDS market usually begins with clients receiving indicative quotes from dealers through information providers such as Bloomberg. They then initiate a request-for-quote with a single dealer or multiple dealers by phone, email, or through an electronic trading platform. Dealers can respond with competitive binding quotes that often result in actual transactions. They can also respond with non-competitive quotes with wide bid-ask spreads or choose not to provide quotes if they do not wish to trade.

[7] http://www.cdsmodel.com/

[8] Quotes outside these hours, and in weekends, are scarce. In fact, they represent 2.25% of all observations. Due to the low percentage of excluded quotes, we find similar results when we include them in our analysis.

TABLE I: SUMMARY STATISTICS

Table I contains the summary statistics of the final sample of CDS quotes and the dealers' activity. Panel A reports at country level the total number of quotes and the total number of dealers reporting quotes as well as their daily averages for 11 EMU countries from Jan08 to Oct11. Panel B aggregates countries in two areas (EMU and Non-EMU) and reports the number of countries in each area, the total number of quotes and the total number of dealers reporting quotes as well as their daily averages for the sub-period Jan10-Oct11. Panel C summarizes the total number of quotes per dealer and the dealer's market share for the 11 EMU countries from Jan08 to Oct11.

Panel A: Descriptive statistics. Sample: January 2008 - October 2011

EMU Countries	No. Quotes		No. Dealers	
	Aggregate	DailyAverage	Aggregate	DailyAverage
Austria	448773	591	90	28
Belgium	449147	580	90	28
Finland	331887	464	90	27
France	469751	625	91	28
Germany	386181	521	89	27
Greece	598638	772	93	29
Ireland	606506	782	92	28
Italy	581538	731	91	28
Netherlands	347764	473	89	27
Portugal	624875	802	92	28
Spain	682032	862	93	28

Panel B: Descriptive statistics. Sample: January 2010 - October 2011

Areas	No. Countries	No. Quotes		No. Dealers	
		Aggregate	DailyAverage	Aggregate	DailyAverage
Non-EMU	39	4656079	8931	48	26
EMU	11	4803901	9216	53	29

Panel C: Share of quotes by dealers

Dealer	Number of Quotes	
Top 15	Total	Share
1	303851	5.50%
2	298052	5.40%
3	274772	5.00%
4	268195	4.90%
5	264496	4.80%
6	262095	4.70%
7	240076	4.30%
8	221383	4.00%
9	204477	3.70%
10	200736	3.60%
11	183192	3.30%
12	183031	3.30%
13	182606	3.30%
14	166659	3.00%
15	164469	3.00%
1-10	2538133	45.90%
11-20	1609411	29.10%
21-30	873379	15.80%
31-40	335378	6.10%
41-50	110119	2.00%
51-95	60672	1.10%

Panel C shows that not all dealers are equally active reporting prices to the EMU countries. Concretely, the 10 most active dealers provide 45.9% of the total number of quotes in our sample and the 30 most active dealers cover the 90.8% of the total number of quotes.

Comovements in the sovereign CDS are computed as the monthly correlation of daily sovereign CDS log returns for countries *i* and *j* in month *t,* (ρ_{ij}), for the sample of 11 EMU countries (55 different country-pairs) and for the period of January 2008 to October 2011. Figure 1 shows the median of ρ_{ij}, jointly with the 5th and 95th percentiles. From the beginning of the sample to the Lehman Brothers collapse we observe a wide dispersion across correlation ranging from -0.45 to 0.96. Since September 2008, the median of the correlations fluctuates steadily between 0.5 and 0.9. The 5th and 95th bands show a small dispersion in March 2009, due to the implementation of the economic stimulus package in the US, and in May 2010, due to the Greek bailout request. However, we observe a greater dispersion since May 2010, where there is a sizeable decrease of correlations in the 5th percentile. This comes as a consequence of the disproportionately large increase of the Greek and other peripheral CDS premia in comparison to the core countries CDS premia.

Table II reports the descriptive statistics of the monthly correlation of daily sovereign CDS log returns for countries *i* and *j* in month jointly with alternative specifications of this correlation. The inclusion of Greece increases the average level of the CDS premium due to the high level of credit risk in the Greek CDS after 2010. Nevertheless, the inclusion/exclusion of Greece from the sample does not lead to strong differences in the level of the commonalities in quotes. These commonalities, as well as the correlation between CDS log returns, exhibit an upward trend from the levels observed in 2008 that remain high from 2009 onwards. The same pattern is observed for both daily and monthly frequencies that additionally are not much different from each other.

Figure 1: Comovements in Sovereign CDS

This figure depicts the comovements in sovereign CDS log-returns (ρ_{ij}). It represents the monthly correlation of daily sovereign CDS log returns for the 11 EMU countries considered (i.e., 55 different country-pairs) for the period of January 2008 to November 2011. The chart shows the median correlation (dashed line), together with their 5th and 95th percentile (shaded area).

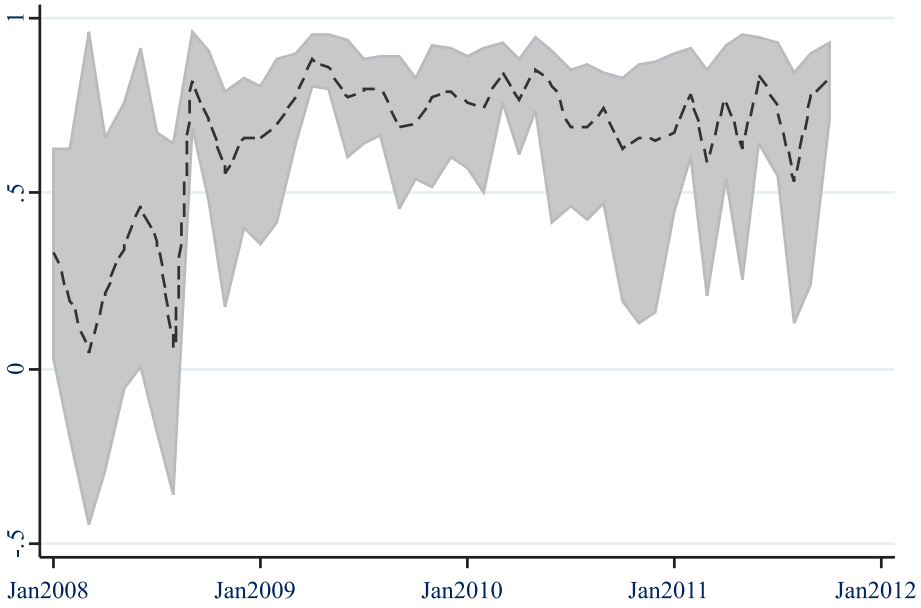


TABLE II: SUMMARY STATISTICS (CONT'D)

This table reports summary statistics on the daily CDS spread level (CDS), the daily CDS spread log return (CDS Log Ret.), the monthly correlation of the daily CDS log return (Correlation CDS Log Ret.) for all pairs of the EMU countries and the daily and monthly commonality in quotes (CQ) for such countries. Panel A reports the information for the 11 EMU countries listed in Table 1 while Panel B excludes Greece. Panels C and D break down the mean and std. dev. per year. Panel C refers to the 11 EMU countries and Panel D excludes Greece.

Panel A: ALL COUNTRIES

Variable	Freq	Mean	SD	Min	Median	Max
CDS	Daily	180	420	4.5	71	6752
CDS Log Ret.	Daily	0.00	0.06	-0.63	0.00	0.64
Correlation CDS Log Ret.	Monthly	0.65	0.26	-0.58	0.72	0.98
CQ	Daily	0.75	0.17	-0.15	0.79	0.98
CQ	Monthly	0.79	0.12	-0.08	0.82	1.00

Panel B: ALL COUNTRIES but GREECE

Variable	Freq	Mean	SD	Min	Median	Max
CDS	Daily	124	171	4.5	67	1309
CDS Log Ret.	Daily	0.00	0.06	-0.63	0.00	0.64
Correlation CDS Log Ret.	Monthly	0.66	0.26	-0.58	0.73	0.98
CQ	Daily	0.76	0.16	0.10	0.80	0.98
CQ	Monthly	0.80	0.11	-0.08	0.82	1.00

Panel C: SUBPERIODS

		2008		2009		2010		2011	
Variable	Freq	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CDS	Daily	40	41	91	65	183	207	446	803
CDS Log Ret.	Daily	0.01	0.08	0.00	0.05	0.00	0.05	0.00	0.04
Correlation CDS Log Ret.	Monthly	0.41	0.34	0.76	0.12	0.71	0.17	0.70	0.18
CQ	Daily	0.59	0.17	0.82	0.08	0.81	0.11	0.77	0.19
CQ	Monthly	0.75	0.16	0.81	0.09	0.82	0.09	0.78	0.13

Panel D: SUBPERIODS (ALL b Gr)

		2008		2009		2010		2011	
Variable	Freq	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CDS	Daily	36	36	83	60	133	118	264	284
CDS Log Ret.	Daily	0.01	0.08	0.00	0.05	0.00	0.05	0.00	0.04
Correlation CDS Log Ret.	Monthly	0.41	0.35	0.76	0.12	0.73	0.15	0.73	0.15
CQ	Daily	0.58	0.17	0.82	0.07	0.81	0.10	0.82	0.11
CQ	Monthly	0.75	0.16	0.81	0.08	0.82	0.09	0.81	0.08

B. Measuring Commonality in Quotes

i. *Commonality in quotes reported by the same dealer for a given pair of countries.*

Our main variable of interest measures the correlation between the number of daily quotes reported by dealers to a given pair of countries formed by countries *i* and *j* in month *t*. We label this variable *Commonality in Quotes (CQ)*, and define it as:

$$CQ_{ijt} = \sum_{d=1}^{D_t} \omega_{dt} corr\left(NQ_{idt,NQjdt}\right) \in [-1,1] \quad (1)$$

where NQ_{idt} and NQ_{idt} are the number of daily quotes given to country *i* and country *j* respectively by dealer *d* in a given month *t* and D_t is the total number of dealers reporting quotes to both countries *i* and *j* in month *t.* In case dealer *d* does not report quotes on a country at certain date, we impute a zero value for that date. The *Commonality in* Quotes is a weighted average of the monthly correlation between the number of daily quotes reported by dealer *d* to countries *i* and *j* in which the weight assigned to dealer *d* in month *t* (ω_{dt}) is defined as follows:

$$\omega_{dt} = \frac{\min(TQ_{idt}, TQ_{jdt})}{\sum_d^D \min(TQ_{idt}, TQ_{jdt})} \quad (2)$$

where TQ_{idt} and TQ_{jdt} are the total number of quotes given by dealer *d* to countries *i* and *j* at month *t*, respectively such that the numerator of Equation (2) measures the importance of dealer *d* giving common quotes to countries *i* and *j*. If a dealer gives 1 quote to France, and 10 quotes to Spain, we say that France and Spain only share «1 common quote» from that dealer, the minimum of the two. The denominator is the sum of the numerator to ensure that the sum ω_{dt} of across all dealers in each month is equal to one.

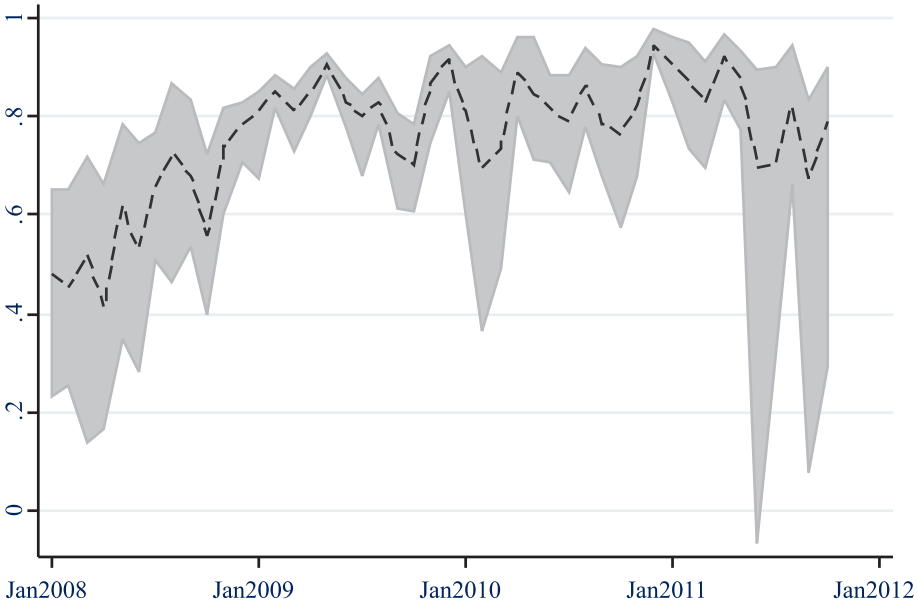
This measure captures how connected two countries are, depending on the activity of the dealers dealing with CDS for those two countries. For example, if there is a big dealer giving the same number of quotes to both Spain and France, the CDS spreads of those two countries might move together because they are determined by the same dealer.

Figure 2 shows the median of the variable *Commonality in Quotes* obtained from Equation (1), together with its 5th and 95th percentile bands. We observe that from the beginning of the sample to May 2009 the median performs an upward trend increasing from 0.48 to 0.91 while the 5th and 95th percentiles tighten reaching the tightest point in

May 2009. There is a clear and significant time-series, and cross-sectional variation in this variable.

FIGURE 2: COMMONALITIES IN QUOTES

This figure depicts the commonalities in quotes (CQ) obtained as $\Sigma_{d=1}^{D_t}\omega_{idt}corr\left(NQ_{idt}, NQ_{jdt}\right)$, where NQ_{idt} and NQ_{jdt} are the number of daily quotes given to country i and country j respectively by dealer d in a given month t and D_t is the total number of dealers reporting quotes to both countries i and j in month t. The CQ is a weighted average of the monthly correlation between the number of daily quotes reported by dealer d to countries i and j in which the weight assigned to dealer d in month t (ω_{dt}) (is defined as the number of common quotes given by a dealer to countries i and j relative to the total number of number of common quotes to those countries. In case dealer d does not report quotes on country i on a certain date we impute a value zero for that date. The chart shows the median correlation (dashed line), together with their 5th and 95th percentile (shaded area).



ii. *Commonality in quotes reported by the same dealer for a given pair of countries depending on her trading willingness*

We now turn to a more disaggregated version of the commonality in quotes. One of the motives behind interdealer trading is the inventory control and risk-sharing. According

to Ho and Stoll (1983), to adjust changes in inventory, the dealer raises or lowers both the bid and ask price relative to the true price without changing the distance between them. We do not have the exact inventory positions of the dealers but consistent with previous literature on market microstructure we consider that a positive (negative) inventory leads to a decrease (increase) of both bid and ask prices. Thus, if a given dealer gives low (high) bid and ask prices for two countries, she might be tackling some inventory-related problem, and might be willing or forced to sell (buy) part of it. For instance, a dealer who is willing to buy CDS but not to sell gives high bid and ask prices to ensure the purchase and to deter additional buyers such that she can bring her inventory to the preferred position. This willingness towards a joint sale or joint buy of the CDS of a given pair of countries could lead to a larger comovement. If that dealer is large enough, the CDS spreads quoted for the two countries would change simultaneously due to the liquidation conducted by the dealer but not because of the two countries' similarities in fundamentals.

To capture the effect of this trading based on inventory risk, we break down the variable *Commonality in Quotes* in two variables. *Commonality in Quotes from Inventory Risk (CQ^{IR})* is defined as in Equation (1), but using quotes from those dealers facing inventory risk. We consider that a dealer *d* faces inventory risk on countries *i* and *j* when her average bid price and ask price in month *t* are below the 33rd percentile of the distribution of all dealers' bid prices and ask prices for both countries; or when her average bid price and ask price are above the 66th percentile of those distributions.[9] In this specification we do not separate dealers depending on whether they need to sell or to buy CDS to control their inventory but just consider the dealers that aim to reduce (increase) their inventory at the same time in two countries forming a pair. The second variable captures the combinations that do not come from inventory risk, i.e., all the other combinations in which both the average bid price and ask price quoted by dealer *d* are not below (above) the percentile 33rd (66th) of bid prices and ask prices for countries *i* and *j*, and we label it as *Commonality not from Inventory Risk (CQ^{NIR})*:

$$CQ_{ijt}^{l} = \sum_{d=1}^{D_t^l} \omega_{dt} corr\left(NQ_{idt}^{l}, NQ_{jdt}^{l}\right) \in [-1,1] \; l = IR, NIR \tag{3}$$

[9] We use these percentiles to guarantee a minimum number of observations to compute the correlations. We require that the dealers give quotes in at least five days to consider their quotes in the computation of the commonality measure and so, in the later analysis.

where l denotes whether the dealer d reporting CDS quotes to countries i and j faces inventory risk (IR) either towards selling in both countries i and j or towards buying in both countries. The dealers who do not face inventory risk denoted as NIR. Thus, we have a commonality variable for each of the two previous possibilities. The notation is similar to the one employed in the baseline commonality variable but now NQ^{l}_{dt} and NQ^{l}_{jdt} are the number of quotes given to country i and country j respectively by dealer d with a level of inventory risk l in a given month t. Regarding the weights (ω^{l}_{dt}), they are obtained as in Equation (2) but considering separately the dealers in the category of inventory risk l to countries i and j at time t, respectively. D^{l}_{t} denotes the total number of dealers in each of the two categories denoting the degree of information l reporting quotes to both countries i and j in month t. This variable will enable us to know whether the comovements are affected by the activity of the dealers facing inventory risk or whether the ones who do not face that risk are pushing the levels of contagion with their quoted prices.

In addition and to disentangle the effects of those dealers being either long or short relative to its desired inventory, we split the measure on two measures CQ^{IR} of commonality in quotes.

The first measure of commonality in quotes is obtained for those dealers facing inventory risk who are net long credit risk and so, they are willing to buy CDS and less willing to sell protection. These dealers are supposed to give high bid and ask quotes relative to other dealers. The corresponding commonality measure is obtained on a monthly basis from dealers whose bid price and ask price are above the 66th percentile of the distribution of all dealers' bid and ask for each of the two countries in a given pair and is denoted as CQ^{IRB}.

The second measure of commonality is obtained from dealers who face inventory risk and are short credit risk. These dealers are expected to give low bid and ask quotes and so, the commonality measure for each pair of countries is obtained from those dealers whose bid price and ask price are below the 33rd percentile for each of the two countries in the pair. This measure is denoted as CQ^{IRS}.

The measures of commonalities for dealers facing inventory risk (CQ^{IR}, CQ^{IRB}, and CQ^{IRS}) could share a given amount of their variation with the one obtained for dealers who do not face inventory risk. For this reason, we define an alternative measure of commonality for each of the three specifications referred to the case in which the dealers face inventory risk. We filter those specifications from the *Commonality in Quotes not from Inventory Risk* by regressing each one of the three types of the former variables on

the latter one and then taking the residuals of the regression as our clean measure of commonalities coming from the inventory risk channel. The resultant residual for the commonalities in quotes for dealers facing inventory risk independently on whether they are long or short credit risk, for those being long credit risk, and for those being short credit risk; are denoted as SCQ^{IR}, SCQ^{IRB}, and SCQ^{IRS}, respectively.

C. Modeling Cross-Sectional Variation in Sovereign CDS Comovement

The following equation represents the panel estimate of monthly cross-sectional regressions forecasting the monthly correlation of daily sovereign CDS returns for countries *i* and *j* in month *t* (ρ_{ift}) for the sample of 11 EMU countries (55 different country-pairs) and for the period of January 2008 to October 2011:

$$\rho_{ijt} = a + b * CQ_{ijt-1} + \sum_{k=1}^{n} b_k * CONTROL_{ijk} + \varepsilon_{ij,t} \quad (4)$$

where $CQ_{IFT\text{-}1}$ refers to a our measure of commonality in the quotes that dealers give to both countries in the pair at month $t - 1$ obtained from Equation (1) as defined in Section III.B. $CONTROL_{ijk}$ contains the set of *k* controls that include the dependent variable lagged one month, a group of macro controls, and a group of pair-level controls. All these controls are explained in the next subsection. The standard errors are double-clustered at the country-pair and month level. In two different specifications we use the two different versions of *CQ:* the baseline and the disaggregated in inventory risk faced by dealers.

D. Controls

D.1. *Global variables*

The use of global factors is motivated by Longstaff, Pan, Pedersen, and Singleton's (2012) study of the nature of sovereign credit risk on the basis of CDS spreads. Their results show that the majority of sovereign credit risk can be linked to global factors (a single principal component accounts for 64% of the variation in sovereign credit spreads). We focus on three global variables:

Financing costs of financial institutions: Measured from the first difference of the log of the 3-month Euribor-OIS spread (*ΔLog Euribor-OIS*). The increase in the cost of capital for financially constrained intermediaries is the common factor which influences both liquidity risk and correlation risk and due to this common factor the correlation between returns increases. This relation between liquidity and correlation risk is jointly addressed in Acharya and Schaefer (2006).

Counterparty risk: As in Arora, Gandhi, and Longstaff (2012), we use the dealers' CDS spreads to construct the counterparty risk variable. We follow Arce, Mayordomo, and Peña's (2013) methodology and proxy counterparty risk in the CDS market through the first principal component obtained from the CDS spreads of the main 14 banks that act as dealers in that market.[10] The higher the counterparty risk, the lower the confidence among institutional investors in the CDS market and so, the more difficult to find a counterparty to buy or sell protection, the lower the market activity, and the higher should be the correlation risk. To be consistent with the dependent variable we consider the first difference of the log of the counterparty risk (*ΔLog Counterparty Risk*).

ECB bond purchases: Total amount of purchases conducted by the ECB in the open market in the context of the Securities Market Program (SMP) that was launched in May 2010. We consider this intervention as a global variable of interest because the ECB did not disclose the set of targeted securities/countries. [11] Preliminary studies suggest that SMP purchases had a positive but short-lived effect on market functioning by reducing liquidity premia and lowering level and volatility of yields (Manganelli (2012)). These purchases lead to a common decrease in the strain of the sovereign debt countries and hence to an increase, at least temporary, in the comovements associated to those purchases.

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[10] The 14 main dealers are: Bank of America, Barclays, BNP Paribas, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, JP Morgan, Morgan Stanley, Royal Bank of Scotland, Societé Generale, UBS, and Wachovia/Wells Fargo. These dealers are the most active global derivatives dealers and are known as the G14 (see, for instance, ISDA Research Notes (2010) on the Concentration of OTC Derivatives among Major Dealers).

[11] The Governing Council of the ECB decided the 21st of February 2013 to publish the Eurosystem's holdings of securities acquired under the Securities Markets Program with the reporting the following country by country breakdown: Italy (103 billion euros), Spain (44 billion euros), Greece (34 billion euros), Portugal (23 billion euros) and Ireland (14 billion euros).

D.2. *Pair/Country Specific Variables*

This set of variables accounts for differences/similarities between two countries which potentially affect to the comovements in the CDS spreads. We control by four groups of county specific variables: credit risk of financial institutions, risk premium, CDS liquidity, and macroeconomic variables. For every pair of countries we introduce these variables as the monthly correlation computed using daily observations. However, given the lower frequency of the macroeconomic variables, we use the absolute value of their difference to proxy for the similarities in terms of macro fundamentals.

Credit risk of financial institutions: Acharya, Drechsler, and Schnabl (2011) document a significant comovement between bank CDS and sovereign CDS after the announcement of financial sector bailouts in the Eurozone. Thus, the stronger the relationship between the financial sectors of two given countries, the easiest is that the shocks to financial institutions in a given country affect the sovereign sector of the other country. To control for this comovements we consider the correlation between the log return of the CDS spreads of the banking sector of the corresponding countries (*Corr. Country Banks CDS Log Ret.*).

Country specific risk premium: To control for the similarities of the countries in terms of their risk premium, we use the correlation between the returns of the country stock indexes (*Corr. Country Stock Indexes Ret.*). The country risk premiums have been found to have a positive effect in credit risk by the previous literature (Dieckmann and Plank, 2012) and so, the higher the correlation between the stock markets returns, the higher the correlation between the sovereign CDS log returns.

CDS liquidity: To proxy for the effect of liquidity in the comovements we use the correlation between the sovereign CDS liquidity (*Corr. CDS Relative Bid-Ask*), proxied by the relative bid-ask spread (i.e., bid-ask spread relative to the mid-spread). Previous literature has documented the existence of a liquidity premium in sovereign CDS prices and so, the higher the correlation between the liquidity premium of two countries, the larger would be the correlation in the prices.

Macro variables: We consider two macro fundamentals in our analysis: the government debt and the government net deficit/surplus relative to GDP. These variables enable us to proxy for the stock of debt in the countries and the accumulated deficit and have been found to have significant effects on the sovereign credit spreads in Bernoth, von Hagen, and Schuknecht (2012) and Mayordomo, Peña, and Schwartz (2012) among others. We

use the absolute differences in relative debt ($Abs|Debt\ to\ GDP_i - Debt\ to\ GDP_j|$) and deficit ($Abs|Deficit\ to\ GDP_i - Deficit\ to\ GDP_j|$) to measure the similarities across countries in terms of these two variables.

IV. RESULTS

A. Forecasting Comovements

Colum (1) of Table III reports our baseline results. We observe a positive and significant effect of the Commonality in Quotes variable: increases in the common quotes significantly increase the correlation between the sovereign CDS log returns. As the correlation between the number of daily quotes reported to countries *i* and *j* increases by 1%, the correlation between their CDS log returns increase by 0.47%, ceteris paribus. The dependent variable lagged one month is used to control for any possible autocorrelation or persistence in that variable. The results suggest a moderate persistence that discards any type of unit root in the dependent variable. None of the global variables exhibit a significant effect on the correlation between CDS log returns. Regarding the pair/country specific variables, we observe that consistently with the existence of a significant liquidity premium in CDS spreads, the stronger the relation between the liquidity of the CDS contracts of a given pair of countries, the stronger the comovements in their prices. The similarities in the degree of the countries' deficit play a significant role in comovements. Thus, if two given countries exhibit a high ratio of deficit relative to GDP the market tends to push their CDS in the same direction. Finally, the similarities in the levels of credit risk of financial institutions of a given pair of countries are translated into a higher level of comovements in the credit risk of the sovereign sectors of those countries.

The specification reported in column (2) corresponds to the one in column (1) extended with fixed effects at country/pair level. Results are consistent with the ones in column (1) but two pair specific variables lose their significance in explaining comovements due to the inclusion of fixed effects. The R-squares of the two specifications are very similar. We perform an F-test of the unconstrained model with fixed effects versus the constrained model without fixed effects. The p-value associated to the F-statistic statistic (0.45) does not reject the null hypothesis that the pair-specific fixed effects are all jointly significant. This suggests that there is not unobserved heterogeneity given the control variables employed in our analysis and so, we define the specification in column (1) as the baseline.

We next analyze the economic significance of the variables according to the baseline results obtained in column (1). The economic impact of the statistically significant variables is reported in column (3). It is obtained from the product of the estimated coefficient and the difference between the 75% and 25% percentiles of each independent variable. The coefficient with the largest economic significance is the one for the commonality in quotes. A change equal to the difference between the 75% and 25% percentiles in the distribution of the previous variable would lead to an increase in the average correlation between the CDS of a given pair of countries equal to 0.083 units. This increase is equivalent to 12.6% of the average CDS correlation across the sample period (0.66). The economic effect of the remaining significant variables in absolute terms, by order of relevance, is 0.066 units for the lagged dependent variable, 0.045 units for the correlation in the CDS relative bid-ask of each pair of countries, and -0.011 units for the absolute difference of deficit to GDP.

As a more reliable method to rank the independent variables in order of importance, we use a Shapley-based decomposition of the R-square of the linear regression. This method uses marginal contributions of a given variable from all sequences and offers strongly robust estimates of the relative importance of each variable even when the variables have a high level of correlation or skewness. The Shapley decomposition is performed on four groups of variables: commonality in quotes, lagged dependent variable, global variables, and pair/country specific variables. The commonality in quotes is responsible for 41.64% of our goodness of fit measure of the model, the lagged dependent variable accounts for 37.19% of the model's fit while the global and the pair/country specific control variables account for only 7.43% and 13.73% of the model's fit, respectively. Our simple measure of commonality in the quotes that dealers give for CDS of EMU countries is a powerful predictor of cross-sectional variation in the correlation of the percentage changes in CDS premia. While the correlation of CDS returns exhibit a reasonable degree of persistence, the fundamental related variables exhibit a second order effect on that correlation.

TABLE III: COMMONALITY IN QUOTES PREDICTS CDS RETURN CORRELATION

This table reports the estimates of monthly panel regressions forecasting the correlation of daily Sovereign CDS log returns in month t for the sample of 11 EMU countries listed in Table I, Panel A. The regressions are at the country-pair level (55 different country-pairs), and for the period of January 2008 to October 2011 (46 months). The independent variables include the Commonality in Quotes (CQ), which refers to the quotes given by dealers to both countries in the pair, and a set of controls, all of them in t-1. Commonality in Quotes are obtained as $CQ_{ijt} = \sum_{d=1}^{D_t} \omega_{dt} corr\left(NQ_{idt}, NQ_{jdt}\right)$, where NQ_{idt} and NQ_{jdt} are the number of daily quotes given to country *i* and country *j* respectively by dealer *d* in a given month *t* and D_t is the total number of dealers reporting quotes to both countries *i* and *j* in month *t*. The CQ is a weighted average of the monthly correlation between the number of daily quotes reported by dealer *d* to countries *i* and *j* in which the weight assigned to dealer *d* in month *t* (ω_{dt}) is defined as the number of common quotes given by a dealer to countries *i* and *j* relative to the total number of number of common quotes to those countries. The set of controls include the dependent variable lagged one month, a group of global, and a group of pair-level controls. The pair specific and global controls are self-explanatory in the way they are labeled in the table, and in the body of the text. Column (1) contains the results for the baseline specification while column (2) reports the results for the same specification with country/pair fixed effects. Standard errors in brackets are double-clustered at the country-pair and month level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The economic impact of the statistically significant variables in the baseline results obtained in column (1) is reported in column (3). It is obtained from the product of the estimated coefficient and the difference between the 75% and 25% percentiles of each independent variable. Finally, column (4) contains a Shapley-based decomposition of the R-square of the linear regression that is performed on four groups of variables: commonality in quotes, lagged dependent variable, global variables, and pair/country specific variables.

VARIABLES		Dep. Variable $_t$: Correlation of daily CDS Log Ret. (1)	(2)	(3)	(4)
CQ $_{t-1}$		0.465***	0.457***	0.083	41.64%
		[0.109]	[0.113]		
Correlation CDS Log Ret. $_{t-1}$		0.258**	0.234**	0.066	37.19%
		[0.109]	[0.111]		
Global Variables	Δ Log Euribor-OIS $_{t-1}$	-0.028	-0.034		7.43%
		[0.062]	[0.068]		
	Δ Log Counterparty Risk $_{t-1}$	-0.086	-0.086		
		[0.088]	[0.095]		
	ECB Bond Purchases $_{t-1}$	0.002	0.002		
		[0.001]	[0.002]		
Pair/Country Specific Variables	Corr. Country Banks CDS Log Ret. $_{t-1}$	0.016*	-0.000	0.007	13.73%
		[0.009]	[0.019]		
	Corr. Country Stock Indexes Ret. $_{t-1}$	0.006	-0.006		
		[0.041]	[0.069]		
	Corr. CDS Relative Bid-Ask $_{t-1}$	0.081***	0.077**	0.045	
		[0.031]	[0.034]		
	Abs|Deficit to GDPi - Deficit to GDPj| $_{t-1}$	-0.002**	-0.001	-0.011	
		[0.001]	[0.001]		
	Abs|Debt to GDPi - Debt to GDPj| $_{t-1}$	-0.000	-0.000		
		[0.000]	[0.000]		
Constant		0.113	0.155		
		[0.077]	[0.095]		
Pair/Country FixedEffects		No	Yes		
Observations		2,380	2,380		
R-squared		0.333	0.348		

The revision in November 2009 of the misleading statistics of fiscal deficits by the Greek authorities was the immediate trigger of the current European sovereign debt crisis. We analyze the potential effect of the most influential event in the sample by excluding Greece from our analysis (column (1) in Table IV) and splitting the sample in two sub-periods using as the break point such event: pre-crisis (column (2)) and crisis (column (3)).

Independently on the exclusion of Greece and the sample period employed in our analysis we find that the commonality in quotes has a positive and significant effect on the comovement of sovereign CDS spreads. The coefficients for the control variables are very similar to the ones obtained in the baseline analysis with the exception of the ECB sovereign bond purchases that is significant at 10% level once Greece is excluded from the sample. This result supports the effectiveness of the program to diminish the levels of credit risk documented by Manganelli (2012).

The effect of pair specific CDS liquidity correlation does not exhibit a significant effect in the crisis period. The changes in the role of liquidity related variables, at pair specific and global levels, and counterparty risk after the beginning of the crisis; suggests that liquidity factors are less relevant to explain comovements than counterparty risk. This evidence suggests the dominance of the confidence among institutional investors in the CDS market among the control variables to explain comovements during the crisis period.[12]

[12] The variables related to the ECB bond purchases cannot be employed in the first part of the sample (column (3)) as they take value zero before May 2010.

TABLE IV: COMMONALITY IN QUOTES PREDICTS CDS RETURN CORRELATION (CONT'D)

Table IV shows the estimates of the regressions similar to column (1) in Table III, but when Greece is excluded from the sample (column (1)), and two different subperiods are analyzed, corresponding to the first and second part of the sample: January 2008 to November 2009 in column (2), and December 2009 to October 2011 in column (3). Everything else remains as in Table III.

	Dep. Variable $_t$: Correlation of daily CDS Log Ret.		
VARIABLES	(1)	(2)	(3)
CQ $_{t-1}$	0.628***	0.860***	0.383***
	[0.094]	[0.126]	[0.140]
Correlation CDS Log Ret. $_{t-1}$	0.221**	0.143	0.124*
	[0.106]	[0.121]	[0.069]
Δ Log Euribor-OIS $_{t-1}$	-0.021	0.112*	-0.123
	[0.059]	[0.059]	[0.087]
Δ Log Counterparty Risk $_{t-1}$	-0.054	-0.083	0.418***
	[0.077]	[0.068]	[0.127]
ECB Bond Purchases $_{t-1}$	0.002*		-0.001
	[0.001]		[0.002]
Corr. Country Banks CDS Log Ret. $_{t-1}$	0.012	-0.038	0.036
	[0.016]	[0.023]	[0.024]
Corr. Country Stock Indexes Ret. $_{t-1}$	0.002	-0.015	0.033
	[0.055]	[0.068]	[0.069]
Corr. CDS Relative Bid-Ask $_{t-1}$	0.071**	0.142**	0.030
	[0.033]	[0.063]	[0.034]
Abs|Deficit to GDPi - Deficit to GDPj| $_{t-1}$	-0.002***	-0.006***	-0.002**
	[0.001]	[0.001]	[0.001]
Abs|Debt to GDPi - Debt to GDPj| $_{t-1}$	-0.000	-0.000	-0.000
	[0.000]	[0.000]	[0.000]
Constant	0.020	-0.080	0.284**
	[0.080]	[0.083]	[0.115]
Observations	1,944	864	1,080
R-squared	0.369	0.425	0.225

B. Comovements and Dealers Inventory Risk

In this section, we perform a test to analyze the effect of the commonalities obtained from dealers with inventory. As detailed in Section III.B, we consider common low ask and bid prices or high ask and bid prices for a given pair of countries to define dealers tackling inventory risk that will attempt to restore the inventory to the desired level by adjusting bid and ask prices. The commonalities obtained from dealers facing inventory risk in global sense are denoted as CQ^{IR} and the results obtained for this measure are reported in column (1) of Table V. We observe that the coefficient of commonalities is highly significant while the coefficients of the remaining control variables remain unchanged.[13]

Additionally, we consider separately the commonalities obtained from dealers quoting high ask and bid prices for a given pair of countries (i.e. dealers facing inventory risk who are net short credit risk) and those quoting low ask and bid prices (i.e. dealers facing inventory risk who are net long credit risk). The commonalities obtained from high (low) ask and bid quotes are denoted as CQ^{IRB} (CQ^{IRS}) and the results obtained for joint use of the two previous type of commonalities are reported in column (2) of Table V. We observe that the effect of commonalities obtained from dealers facing inventory risk who are net short credit risk is significantly different from zero while the one for dealers facing inventory risk who are net long credit risk is not. The stronger effect of inventory risk forcing dealers to buy more European CDS is in agreement with dealers entering into offsetting hedge transactions to adjust their positions and limit exposure to market movements and being less willing to sell protection and further increasing their exposure to counterparty risk and to the default of a given EMU country. This result is consistent with Shachar's (2013) analysis of how dealers' inventory levels affect the CDS price and the finding that the contemporaneous price impact of buying is much larger than the immediate price impact of selling. It suggests that the dealers with inventory risk willing to hedge their positions in a given pair of EMU countries contribute to increase the CDS prices of those countries and as a consequence their correlation. These results confirm the effect of inventory risk behind the common quotes reported by dealers and its later impact on the CDS comovements.

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[13] The commonalities from inventory risk are obtained after defining dealers with inventory risk. A given dealer *d* is considered as facing inventory risk for countries *i* and *j* when her average bid and ask prices are below the 33rd percentile in both countries or above the 66th percentile in both countries. The use of the 25th and 75th percentiles delivers similar results but leads to a lower number of observations to implement the analysis.

Note that the number of observations in the first columns is lower than the ones in the baseline specification (i.e. column (1) of Table III) and so, it is not feasible to compare the explanatory power of the new commonality measures. We repeat the baseline analysis for the same observations we have information on the commonalities from inventory risk and find that the R-squared for the baseline is lower than the one reported in Table V. In addition, by breaking down the total R-squared by groups of variables using a Shapley-based decomposition we find that the commonality in quotes obtained from the dealers with inventory accounts for 42.75% of the model's fit. This percentage is higher than the one attributable to the baseline measure of commonality in quotes of Table III (41.64%).

Given that dealers could follow a common pattern in terms of providing quotes for specific pairs of countries, we repeat the analysis using the three measures of commonality in quotes for dealers facing inventory risk filtered from the commonalities of those dealers who do not face inventory risk. Column (3) contains the results obtained when we use the overall filtered inventory risk variable (SCQ^{IR}) while column (4) contains the results from the joint use of the two filtered variables depending on whether dealers are supposed to be net long credit risk (SCQ^{IRb}) or net short credit risk (SCQ^{IRs}). The results are fully consistent with the ones reported in columns (1) and (2) but the magnitude of the filtered coefficients is lower.

TABLE V: COMMONALITY IN QUOTES FROM INVENTORY RISK

Table V reports panel estimates of monthly cross-sectional regressions forecasting the correlation of daily Sovereign CDS log returns in month *t* for the sample of 11 EMU countries listed in Table I, Panel A. The regressions are at the country-pair level (55 different country-pairs), and for the period of January 2008 to October 2011 (46 months). The independent variables in this table are similar to those in Table III. The novelty here is that the variable *Commonality in Quotes* is defined in a different way. Instead of *Commonality in Quotes* for all dealers, we now look exclusively at the common quotes for dealers that experience inventory risk in both countries of the pair. To construct the *Commonality from Inventory Risk* we only use the quotes by a given dealer tackling inventory risk who, as a consequence, reports common low ask and bid prices or high ask and bid prices for a given pair of countries to restore the inventory to the desired level. The commonalities obtained from dealers tackling inventory risk in global sense are denoted as CQ^{IR} and the results obtained for this measure are reported in column (1). Additionally, we consider separately the commonalities obtained from dealers quoting high ask and bid prices for a given pair of countries (i.e. dealers facing inventory risk who are net short credit risk) and those quoting low ask and bid prices (i.e. dealers facing inventory risk who are net long credit risk). The commonalities obtained from high (low) ask and bid quotes are denoted as CQ^{IRB} (CQ^{IRS}) and the results obtained for joint use of the two previous type of commonalities are reported in column (2). Finally, we repeat the analysis using the three measures of commonality in quotes for dealers tackling inventory risk filtered from the commonalities of those dealers who do not tackle inventory risk. Column (3) contains the results obtained when we use the overall filtered inventory risk variable (SCQ^{IR}) while column (4) contains the results from the joint use of the two filtered variables depending on whether dealers are supposed to be net long credit risk (SCQ^{IRB}) or net short credit risk (SCQ^{IRS}). All other controls (global, and country-pair) are as in Table III. In the interest of brevity and because results are consistent with the ones of Table III we only report the coefficients for the new specifications of commonality in quotes. Standard errors in brackets are double-clustered at the country-pair and month level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dep. Variable $_i$: Correlation of daily CDS Log Ret.			
VARIABLES	(1)	(2)	(3)	(4)
CQ^{IR}_{t-1}	0.385***			
	[0.067]			
CQ^{IRS}_{t-1}		0.111		
		[0.075]		
CQ^{IRB}_{t-1}		0.231***		
		[0.079]		
SCQ^{IR}_{t-1}			0.291***	
			[0.068]	
SCQ^{IRS}_{t-1}				0.064
				[0.066]
SCQ^{IRB}_{t-1}				0.182**
				[0.089]
Correlation CDS Log Ret. $_{t-1}$	0.217**	0.178**	0.296***	0.221**
	[0.099]	[0.090]	[0.108]	[0.094]
Constant	0.201***	0.251***	0.456***	0.495***
	[0.059]	[0.077]	[0.078]	[0.073]
Control Variables	Yes	Yes	Yes	Yes
Observations	2,263	1,997	2,260	1,997
R-squared	0.268	0.210	0.213	0.165

C. Dealing with Endogeneity

In our analysis we have regressed monthly CDS comovements on the dealers' quotes commonalities lagged one month. Nevertheless, endogeneity may be a concern here because it is plausible that CDS comovements' innovations may also affect the dealers' common quotes at the same time, through some behavior observed in such correlations that may persist for a given number of months. To conclude that the commonality in quotes is indeed causing CDS comovements to increase; we re-estimate the regressions reported in Equation (5) using two different methods: an instrumental variable approach and an analysis implemented using the commonalities in quotes filtered from the contemporaneous and two lags of CDS return correlations.

We firstly consider the use of instrumental variables. We need an instrumental variable that affects exclusively all the participants in the CDS market and not to the whole econ-

omy. The channel through which we explain this effect of commonality in correlations is a shock to the inventory risk faced by dealers. The reason for employing a shock affecting to CDS market dealers is obvious given their role in the CDS market (i.e. by the end of 2011 dealers accounted for 64% of gross market values in the CDS market). According to Acharya, Schaefer, and Zhang (2008) inventory holding costs rise more dramatically during months in which fixed income instruments are downgraded to junk category. For this reason, we proxy this shock to inventory risk with the number of firms whose credit rating was downgraded to the junk category in the European Union. This instrument represents a shock specific to corporate bond market rather than to the whole economy and so, to the sovereign CDS spreads.

The motivation for the use of this instrumental variable relies then on Acharya, Schaefer, and Zhang (2008) analysis based on GM and Ford downgrade to junk category in May 2005. When bonds are downgraded to the junk category many investors are forced to liquidate those bonds to comply with regulatory and investment restrictions. The authors show that the imbalance in trading of GM and Ford downgraded bonds adversely affected the inventory positions of market makers forcing them to price their heighted inventory risk into prices of all other securities they intermediate. That imbalance is in fact significant in explaining not only GM and Ford or other bonds' price changes but also the CDS price changes since the traders of bonds are also traders in CDS markets. Thus, if intermediaries indeed systematically increased CDS spreads around the GM and Ford downgrade, CDS returns, and more precisely, the component of CDS returns that is unrelated to changes in the fundamentals, is expected to have become more correlated across different entities. This explains the excess comovements of CDS prices across all industries around the downgrade. In fact, Acharya, Schaefer, and Zhang (2008) find that the relationship between liquidity risk and correlation risk is causal. This provides direct evidence that intermediaries' inventory and funding constraints was the channel that linked liquidity risk and correlation risk and the supports the instrument employed in our analysis.

We run an instrumental variable regression robust to heteroskedasticity in which the Commonality in Quotes (CQ) of a given pair of countries are instrumented through the number of firms whose credit rating was downgraded to the junk category in the European Union by Standard & Poor's. In the first stage, we regress CQ on the instrument and find that the instrument is positive and significant at any standard level of significance. It confirms that dealers tend to give common quotes in a given pair of countries as the number of downgraded bonds to the junk category increases. Table VI reports the results of the second stage regression in which we use the fitted commonal-

ity in quotes from the first stage to predict cross-sectional variation of CDS comovements one month ahead. In the interest of brevity, Table VI only contains the coefficient of the instrumented commonality in quotes variables. Column (1) reports the results obtained when the instrumented commonality is measured according to equation (1) while column (2) contains the results obtained when the instrumented variable is the commonality in quotes from inventory risk measured according to Equation (3). As it can be inferred from the significant coefficient for the two measures of dealers' commonalities we conclude that the potential endogeneity of these commonalities does not bias our results. This piece of evidence confirms that our finding comes indeed from a causal relation between commonality in quotes and CDS return comovement.

To check the validity of our instrument, we perform the Kleibergen-Paap Rank LM statistic to check whether the equation is identified that is, whether the excluded instrument (the number of EU firms downgraded to the junk category) is «relevant» (correlated with the endogenous regressor). According to this under-identification test we reject the null hypothesis (equation is under-identified) and so, the instrument is relevant and the model is identified. We also perform a weak identification test to analyze whether the brokers-dealers leverage is correlated with the common quotes but only weakly. For this test and given that the estimation is robust to heteroskedasticity, we use the Kleibergen-Paap Wald Rank F statistic. The statistic obtained in comparison with the corresponding critical values enables us to reject the hypotheses that the equation is weakly identified.

We perform an additional analysis to discard that our results suffer from endogeneity. According to Andrade, Chang, and Seasholes (2008) the cross-security price pressure that may lead to excess comovements across securities is higher among securities with more correlated fundamentals as in the case of stocks could be cash flows. Besides showing the causal effect from the above analysis, we now present an analysis in which in the first stage we regress the commonality in quotes and the commonality in quotes from inventory risk on the contemporaneous and two lags of the CDS spread return correlation and use the residuals of the two variables as our variable of interest. Filtering the commonalities in that way ensures that the current and past effects of correlations across CDS prices should not be an issue in our analysis. The results for the baseline commonality and the one from inventory risk are reported in Columns (3) and (4) of Table VI and strongly support the consistency of the results obtained in previous analyses.

TABLE VI: ENDOGENEITY

Table VI reports panel estimates of monthly cross-sectional regressions forecasting the correlation of daily Sovereign CDS Returns in month *t* for the sample of 11 EMU countries listed in Table I, Panel A. The regressions are at the country-pair level (55 different country-pairs), and for the period of January 2008 to October 2011 (46 months). The independent variables in this table are similar to those in column (1) of Table III and column (1) of Table 5. The novelty in columns (1) and (2) is that the variable *Commonality in Quotes* and *Commonality from Inventory Risk* are instrumented with the number of firms whose credit rating was downgraded to the junk category in the European Union. That is INST. CQ (INST. CQ^{IR}) is the fitted variable of the regression of the *Commonality in Quotes (Commonality in Quotes from Inventory Risk)* on the instrument. Columns (3) and (4) use the filtered *Commonality in Quotes* and *Commonality from Inventory Risk* from the Correlation of the CDS log returns. That is, FILT. CQ (FILT. CQ^{IR}) is the residual of the regression of the *Commonality in Quotes (Commonality in Quotes from Inventory Risk)* on the contemporaneous and two lags of the correlation of CDS log return. All other controls (global, and country-pair) are as in Table III. In the interest of brevity and because results are consistent with the ones of Table III we only report the coefficients for the new specifications of commonality in quotes. Standard errors in brackets are double-clustered at the country-pair and month level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dep. Variable $_t$: Correlation of daily CDS Log Ret.			
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**
INST. CQ_{t-1}	2.483***			
	[0.620]			
INST. CQ^{IR}_{t-1}		4.902**		
		[2.33]		
FILT. CQ_{t-1}			0.297***	
			[0.098]	
FILT. CQ^{IR}_{t-1}				0.252***
				[0.070]
Correlation CDS Log Ret. $_{t-1}$	0.364***	0.364***	0.306***	0.234**
	[0.053]	[0.102}	[0.106]	[0.095]
Constant	-1.448***	-3.343*	0.423***	0.476***
	[0.469]	[1.790]	[0.076]	[0.073]
Control Variables	Yes	Yes	Yes	Yes
Observations	2,380	2,380	2,315	2,212
R-squared	0.28	0.28	0.258	0.208

D. Extensions and Robustness tests

D.1. *The effect of commonalities in quotes for the whole universe of sovereign CDS*

To discard that the results are due to the strong similarities among the 11 EMU countries forming the sample we now extend our analysis to the whole universe of sovereign CDS for which there are quotes on a regular basis. This leads to a final sample that consists of 50 countries (39 non-EMU countries). Column (1) of Table VII contains the results obtained for the baseline specification extended to all countries.[14] We still find a positive and strongly significant effect of commonalities. Columns (2) and (3) contain the results for the commonalities from inventory risk that are equivalent to CQ^{IR}, CQ^{IRb} and CQ^{IRS}, but for the whole sample of countries. Results in column (2) are consistent with the ones obtained for the EMU countries. Nevertheless, we obtain a worth mentioning difference in column (3) with respect to the results for the EMU countries. We now find that for the new extended sample, the commonalities from inventory risk of both dealers being either net long or short credit exhibit a significant effect on the CDS spreads comovements. Thus contrary to the hedging trend observed in EMU countries, the dealers could be willing to sell CDS in non-EMU countries. The two commonalities from inventory risk are filtered from the ones obtained from those dealers who do not face inventory risk to obtain the coefficients in columns (4) and (5) that are fully consistent with those in columns (2) and (3) confirming the effect of inventory risk behind the common quotes reported by dealers and its later impact on the CDS comovements.

[14] Due to the lack of information on the banking sector CDS spreads of many Non-EMU countries we substitute the credit risk of the financial institution control variable by the absolute difference of the bank non-performing loans to total gross loans ($Abs|NPLTLi - NPLTLj|$).

TABLE VII: COMMONALITIES IN QUOTES FOR THE UNIVERSE OF SOVEREIGN CDS

Table VIII reports panel estimates of monthly cross-sectional regressions forecasting the correlation of daily Sovereign CDS Returns in month for the sample of 50 countries over the world. The regressions are at the country-pair level (820 different country-pairs), and for the period of January 2010 to October 2011 (22 months). The *Commonality in Quotes* (CQ) is defined as in Table III and the variables related to the inventory risk (CQ^{IR}, CQ^{IRB}, CQ^{IRS}, SCQ^{IR}, SCQ^{IRB}, SCQ^{IRS}) are defined as in Table V. The novelty here is the countries under study. As reported in Table I, Panel B, the sample is composed of 11 EMU and 39 Non-EMU countries. All other controls (global, and country-pair) are as in Table III apart from the correlation of country banks CDS Log returns that, due to the lack of information, is substituted by the absolute difference of the bank nonperforming loans to total gross loans (Abs|NPLTLi - NPLTLj|). Standard errors in brackets are double-clustered at the country-pair and month level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	Dep. Variable $_t$: Correlation of daily CDS Log Ret. (1)	(2)	(3)	(4)	(5)
CQ_{t-1}	0.254***				
	[0.071]				
CQ^{IR}_{t-1}		0.207***			
		[0.051]			
CQ^{IRS}_{t-1}			0.098***		
			[0.033]		
CQ^{IRB}_{t-1}			0.109**		
			[0.049]		
SCQ^{IR}_{t-1}				0.168***	
				[0.046]	
SCQ^{IRS}_{t-1}					0.093***
					[0.029]
SCQ^{IRB}_{t-1}					0.109**
					[0.052]
Correlation CDS Log Ret. $_{t-1}$	0.220***	0.236***	0.212***	0.271***	0.243***
	[0.058]	[0.060]	[0.056]	[0.059]	[0.053]
Δ Log Libor-OIS $_{t-1}$	-0.136**	-0.125*	-0.116*	-0.112	-0.104
	[0.069]	[0.067]	[0.067]	[0.070]	[0.067]
Δ Log Counterparty Risk $_{t-1}$	0.392*	0.417*	0.378*	0.423*	0.380*
	[0.234]	[0.227]	[0.215]	[0.234]	[0.214]
ECB Bond Purchases $_{t-1}$	0.001	0.000	0.001	-0.000	0.000
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Abs|NPLTLi - NPLTLj| $_{t-1}$	0.001	0.001	0.002**	0.001	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Corr. Country Stock Indexes Ret. $_{t-1}$	0.074**	0.091***	0.099***	0.116***	0.124***
	[0.031]	[0.030]	[0.034]	[0.031]	[0.034]
Corr. CDS Relative Bid-Ask $_{t-1}$	0.062***	0.063***	0.066***	0.075***	0.077***
	[0.022]	[0.022]	[0.021]	[0.022]	[0.019]
Abs|Deficit to GDPi - Deficit to GDPj| $_{t-1}$	-0.005***	-0.005***	-0.005***	-0.004***	-0.005***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Abs|Debt to GDPi - Debt to GDPj| $_{t-1}$	-0.000*	-0.000**	-0.000**	-0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Constant	0.262***	0.262***	0.290***	0.337***	0.365***
	[0.040]	[0.042]	[0.042]	[0.046]	[0.046]
Observations	16,594	15,490	12,080	15,485	12,080
R-squared	0.307	0.301	0.300	0.274	0.282

D.2. *Other measures of sovereign CDS return correlation*

In this section we first analyze the effect of the commonalities in quotes on the correlations among sovereign CDS filtered returns. These correlations can be interpreted as contagion according to Bekaert, Harvey, and Ng (2005) who define contagion as «excess correlation, that is, correlation over and above what one would expect from economic fundamentals.» Like Bekaert, Harvey, and Ng (2005), we take an asset pricing perspective to measuring economic fundamentals and identify contagion by the correlation of an asset pricing model's residuals. These residuals are obtained from a regression in which the dependent variable is the CDS log return of a given country and the explanatory variable is a market variable. For the analysis that only involves EMU countries we employ as the market variable a sovereign CDS industry-specific index, which is constructed from European countries by Thomson Financial based on the Thomson Reuters Composite CDS data, to estimate the filtered CDS returns for a given country *i*.[15] For the analysis that involves the whole universe of sovereign CDS we use the equally weighted average daily CDS returns of all countries in the sample.

Columns (1) – (3) contain the results for the EMU for the three specifications of commonalities being the first one referred to the baseline specification and the two next columns for the specifications considering inventory risk as a whole and inventory risk distinguishing on whether the dealers aim to increase or decrease their inventory. Columns (4) – (6) contain the corresponding results for the whole universe of sovereign CDS. We observe that results are consistent with the use of CDS returns to calculate the correlations across CDS contracts for the two groups of countries.

[15] This equally-weighted index is available via Thomson Datastream (DS Mnemonic: DSESV5E) and reflects an average mid-spread calculation of the index's constituents. The only traded index on European sovereign CDS (SovX Western Europe) started trading on 28 September 2009. This index consists of 15 countries but its initial date is far away from the beginning of our sample.

TABLE VII: OTHER MEASURES OF SOVEREIGN CDS RETURN CORRELATION

Table VIII reports the impact of the *Commonality in Quotes and Commonality from Inventory Risk* as in Table III and Table V, respectively. The novelty here is the use of the correlation of daily Sovereign CDS Filtered Returns in month *t* as a dependent variable in the panel estimation of the monthly cross-sectional regression forecasting. Columns (1) – (3) report the analysis for the 11 EMU countries listed in Table I, Panel A. The regressions are at the country-pair level (55 different country-pairs), and for the period of January 2008 to October 2011 (46 months). The dependent variable is obtained from the residual of the regression of the CDS log return of a given country on a sovereign CDS industry-specific index, which is constructed from European countries by Thomson Financial. All other controls (global, and country-pair) are as in Table III. Columns (4) – (6) report the analysis for a sample of 11 EMU and 39 Non-EMU countries. The regressions are at the country-pair level (820 different country-pairs), and for the period of January 2010 to October 2011 (22 months). The dependent variable is obtained from the residual of the regression of the CDS log return of a given country on an equally weighted average daily CDS return of all countries in the sample. All other controls (global, and country-pair) are as in Table VII. In the interest of brevity and because results are consistent with the ones of Table III and Table VII, respectively, we only report the coefficients for the new specifications of commonality in quotes. Standard errors in brackets are double-clustered at the country-pair and month level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent Variable $_t$:	Correlation of FilteredSov. CDS log Ret.					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
CQ_{t-1}	0.247***			0.275***		
	[0.078]			[0.041]		
CQ^{IR}_{t-1}		0.192***			0.200***	
		[0.050]			[0.029]	
CQ^{IRS}_{t-1}			-0.018			0.100***
			[0.080]			[0.023]
CQ^{IRB}_{t-1}			0.171**			0.156***
			[0.086]			[0.025]
Corr. of FilteredSov. CDS log Ret. $_{t-1}$	0.217***	0.207***	0.218***	0.409***	0.448***	0.452***
	[0.067]	[0.066]	[0.063]	[0.030]	[0.027]	[0.028]
Constant	0.017	0.081	0.107	-0.154***	-0.143***	-0.178***
	[0.098]	[0.081]	[0.109]	[0.028]	[0.023]	[0.029]
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,380	2,263	1,997	16,594	15,490	12,080
R-squared	0.149	0.136	0.148	0.333	0.337	0.384

D.3. *Other measures of commonality in quotes*

Alternatively to the baseline commonality measure we consider four other variations of such measure whose results are reported in Panel A of Table IX. In the interest of brevity we only report the coefficients for the variable of interest (commonality in quotes and its variations) and the lagged dependent variable for the sample that consists of EMU countries. The first variation is the one in which the commonality in quotes is defined as an equally weighted average of the monthly correlations of the daily number quotes reported by a given dealer *d* to countries *i* and *j*:

$$CQ_{ijt}^{EW} = \sum_{d=1}^{D_t} \frac{1}{D_t} corr\left(NQ_{idt}, NQ_{jdt}\right) \in [-1,1] \tag{5}$$

where D_t is the total number of dealers reporting quotes to both countries *i* and *j* in month *t*. Contrary to measure obtained from Equation (1), this specification gives the same weights to the dealers independently on the number of quotes reported by each of them. The results are reported in column (2) of Panel A and are similar to those obtained for the baseline specification (column (1)). Thus, considering all dealers equally independently on their quoting activity does not affect our results.

As a second specification we consider the commonality obtained from Equation (1) but only consider those days in which there is quoting activity (CQ_{ijt}^{QA}). So, instead of assigning zeros to those days in which there are not quotes we exclude them when computing the correlation between the number of quotes given to country *i* and *j*. The results contained in column (3) are fully consistent with those reported in column (1).

We next measure commonality in quotes from the amount of common quotes given by different dealers to each pair of countries each month. We label this variable *Commonality in Quotes Ratio (CQR)*, and define it as:

$$CQR_{rjt} = \frac{\sum_{d=1}^{D_t} \min\left(TNQ_{idt} TNQ_{idt}\right)}{TQ_{it} + TQ_{jt}} \in [-0,0.5] \tag{6}$$

where TNQ_{idt} and TNQ_{jdt} are the total number of quotes given to country *i* and country *j* respectively by dealer *d* in a given month *t* while TQ_{it} and TQ_{jt} are the total number of quotes given by all dealers to countries *i* and *j* at month *t*, respectively. This variable

captures the connectivity of countries *i* and *j* due to commonality in quotes given by CDS dealers. If a dealer gives 1 quote to France, and 10 quotes to Spain, we say that France and Spain only share «1 common quote» from that dealer, the minimum of the two. We then aggregate that value for all dealers giving quotes to both countries, and normalize it dividing it by the sum of total quotes given to France and Spain. The results obtained for this specification are reported in column (4) and confirm the robustness of our results.

One may argue that the variable commonality in quotes is just reflecting liquidity. Although the correlation between our variable of interest and the one measuring the similarities of the two countries in terms of their CDS bid-ask spreads (0.24) does not support that conjecture, we next give additional evidence to support the robustness of our results. For such aim, we filter the commonality in quotes of each pair of countries from the correlation between their CDS bid-ask spreads on the basis of an auxiliary regression and use the residual in substitution of the commonality (SCQ_{ij}^{BA}). The results reported in column (5) are identical to those in column (1). Thus, independently on the method employed to measure the commonalities in quotes, they present a consistent significant effect on the commovements of CDS returns at 1% significance level.

TABLE IX: OTHER MEASURES OF COMMONALITY IN QUOTES AND FREQUENCY

Table IX reports the impact of the *Commonality in Quotes* for a sample of 11 EMU countries. The novelties with respect to Table III are: (i) the use of alternative measures of Commonalities in Quotes (Panel A); (ii) the use of daily frequency (Panel B). Panel A reports the panel estimates of monthly cross-sectional regressions at country/pair level (55 pairs) forecasting the correlation of daily Sovereign CDS log Returns in month for the period January 08 to October 11 (46 months). Column (1) reports the baseline *Commonality in Quotes* (CQ). In column (2) commonality in quotes is defined as an equally weighted average of the monthly correlations of the daily number quotes (CQ^{EW}). In column (3) commonality in quotes is estimated excluding those dates for which dealer *d* does not report quotes to country *i* or *j* (CQ^{QA}). The alternative definition of the commonalities in quotes used in column (4) is defined as $COR = \sum_{D=1}^{D} \min\left(TNQ_{idt}, TNQ_{idt}\right) / \left(TQ_{it} + TQ_{jt}\right)$, where TNQ_{idt} and TNQ_{jdt} are the total number of quotes given to country *i* and country *j* respectively by dealer *d* in a given month *t* while TQ_{it} and TQ_{jt} are the total number of quotes given by all dealers to countries *i* and *j* at time *t*. Column (5) reports the results of the baseline commonality in quotes filtered by the correlation between the CDS bid-ask spreads (SCQ^{BA}). All other controls are as in Table III. Panel B reports panel estimates of daily cross-sectional regressions at country/pair level (55 pairs) forecasting the correlation of intraday Sovereign CDS Log Returns for the period January 08 to October 11 (887 trading days). All other controls are similar to those in Table III but defined on a daily basis (except *ECB Bond Purchases*, *Abs|Deficit to GDP$_i$ - Deficit to GDP$_j$|* and *Abs|Debt to GDP$_i$ - Debt to GDP$_j$|)*. Columns (2) – (5) report the results under different treatments of the dependent variable. In column (2) we impute the previous quote if there is a missing CDS quote for a dealer in a given hour. Column (3) is obtained as column (2) but excluding the observations for which the hourly CDS return is 0. Column (4) leaves the missing values without replacement for the previous value. Column (5) leaves the missing values, and excludes the observations for which the hourly CDS return is 0. Column (1) reports the baseline analysis for comparability reasons. Standard errors in brackets are double-clustered at the country-pair and day level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

PANEL A					
	Dep. Variable $_t$: Correlation of daily CDS log-returns				
VARIABLES	(1)	(2)	(3)	(4)	(5)
CQ_{t-1}	0.465***				
	[0.109]				
CQ^{EW}_{t-1}		0.540***			
		[0.120]			
CQ^{QA}_{t-1}			0.195***		
			[0.067]		
CQR_{t-1}				0.996***	
				[0.155]	
SCQ^{BA}_{t-1}					0.426***
					[0.108]
Correlation CDS Log Ret. $_{t-1}$	0.258**	0.254**	0.363***	0.235**	0.279***
	[0.109]	[0.105]	[0.114]	[0.109]	[0.108]
Constant	0.113	0.074	0.412***	0.081	0.437***
	[0.077]	[0.083]	[0.078]	[0.081]	[0.072]
Control Variables	Yes	Yes	Yes	Yes	Yes
Observations	2,380	2,380	2,379	2,380	2,380
R-squared	0.333	0.339	0.275	0.323	0.320
PANEL B					
	Monthly	Daily			
Dep. Variable $_t$: Correlation of CDS Log Ret.		Fill	Fill, NZ	No Fill	No Fill, NZ
VARIABLES	(1)	(2)	(3)	(4)	(5)
CQ_{t-1}	0.465***	0.416***	0.458***	0.460***	0.478***
	[0.109]	[0.048]	[0.053]	[0.059]	[0.060]
Correlation CDS Log Ret. $_{t-1}$	0.258**	0.216***	0.175***	0.170***	0.162***
	[0.109]	[0.015]	[0.014]	[0.014]	[0.014]
Constant	0.113	-0.059	-0.066	-0.071	-0.082
	[0.077]	[0.048]	[0.051]	[0.058]	[0.059]
Control Variables	Yes	Yes	Yes	Yes	Yes
Observations	2,380	46,085	44,402	42,144	41,582
R-squared	0.333	0.093	0.070	0.062	0.059

D.4. *Other frequencies for defining sovereign CDS return correlation*

To show that the effect of the commonality does not depend on the data frequency employed we repeat our analysis using daily data (887 trading days). To implement the daily analysis we need to define the correlation between sovereign CDS on a daily basis. For such aim, we take advantage of the intraday quotes to calculate hourly CDS log returns. We aggregate the quotes per hour using those reported from 7.00 to 19.00 (GMT+1) such that we use 13 observations to compute the daily correlation.[16] We consider four different specifications to define the daily correlation between the hourly CDS returns whose results are contained in Panel B of Table IX. First, we estimate the daily correlation using CDS log returns such that when there is a missing value for a given dealer in a given hour we impute the previous quote available for this dealer (column (2)). The second specification (column (3)) is similar to the previous one but we exclude the observations for which the hourly CDS log return is 0 to discard any arbitrary imputation beyond our scope. To avoid any bias due to the effect of the imputed observations we compute the daily correlation leaving the missing values without replacement (column (4)). In the last specification (column (5)) we leave the missing values without replacement and additionally exclude observations for which the hourly return is 0 for the same reason explained in specification contained in column (3). The *Commonality in Quotes* are obtained as in Equation (1) but computing daily correlations from the number of quotes per hour using those reported from 7.00 to 19.00 (GMT+1) and assigning zero in case there are not quotes within a given hour. Regarding the remaining independent variables, the absolute differences for a given pair of countries in the ratios of debt and deficit to GDP are the ones used in Table III and have a quarterly frequency. The variables referred to the ECB Bond Purchases are updated weekly due to the information availability. The remaining explanatory variables are updated on a daily basis. Results are qualitatively similar to the ones obtained for the monthly frequency (column 1).

V. CONCLUSION

CDS data vendors employ their methodologies to offer daily quotes that are obtained after combining the quotes received by different dealers. We test whether the common

[16] The lower frequency of quotes for the years 2008 and 2009 impedes to increase the number of intraday observations employed to obtain the observations given that we need to use the same time span for all the years in the sample.

quotes for a given pair of countries, reported by the same dealer, affect the correlation between CDS spreads and find that they do.

We find that the effect of the commonality in quotes is significant at any standard significance level and has very strong forecasting power on the future comovements between sovereign CDS spread. In fact, the economic impact of the commonality variable is much stronger than the one attributable to the remaining explanatory variables considered in our analysis, including the traditional fundamental variables.

The strong effect of this commonality in quotes is explained by the strategy adopted by the dealers to deal with inventory risk. If dealers face inventory risk in two countries at the same time, the joint sales or purchases of CDS for those countries to restore the inventory to the desired level; could lead a simultaneous changes in the prices of the two CDS. An instrumental variable analysis confirms that our findings reflect indeed a causal relation between commonality in quotes and CDS comovement.

These results are consistent with the CDS premia containing a non-default related component that CDS traders charge to protect themselves against market frictions and that strongly contributes to cause comovements across credit spreads. Thus, the economic magnitude of this friction should be accounted for before extrapolating measures of contagion or comovements from CDS prices.

Policy measures such as a higher transparency or central clearing would eliminate or weaken the role of market frictions as inventory risk and would improve the usefulness of CDS to monitor credit risk contagion across countries. A proper transparency improves inventory risk sharing among symmetrically informed dealers, resulting in lower inventory holding costs (Naik, Neuberger, and Viswanathan, 1999). Central clearing could lead to a reduction of counterparty risk and to a proper netting of positions that would diminish the effect of inventory risk on the sovereign CDS comovements.

Finally, the new evidence on the determinants of the comovement among sovereign CDS spreads has important implications for risk diversification of the euro zone debt portfolios given that investors should understand that an important part of the comovements in their portfolios is not due to fundamentals but to commonalities in the dealers' quotes.

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