Dealing with Dealers: Sovereign CDS Comovements*

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ABSTRACT

We show that sovereign CDS that have common dealers tend to be more correlated, especially when the dealers display similar quoting activity in those contracts over time. This commonality in dealers' activity is a powerful driver of CDS comovements, over and above fundamental similarities between countries, including default, liquidity, and macro factors. We posit that the mechanism causing the excess correlation is the buying pressure faced by CDS dealers due to the existence of frictions. An instrumental variable analysis confirms that our findings are indeed rooted in a causal relationship.

JEL Classification: G12, G14.

Keywords: Sovereign CDS, comovements, commonalities, dealers.

I. Introduction

Asset returns may comove beyond what can be expected from their fundamentals due to the existence of frictions or anomalies. In this paper, we empirically investigate why sovereign Credit Default Swap (CDS) spreads comove 'too' much, or more than what one might expect based on economic similarities between countries. Using a unique dataset of intraday CDS quotes disaggregated at the dealer level, we show that CDS dealers play an important role in the pricing and correlation of CDS spreads. Pairs of sovereign CDSs that share common dealers, specifically when those dealers display similar activity in both contracts over time, tend to be more correlated, all else equal. We measure this common dealership, which we label *Commonality in Quotes,* as the correlation between the number of daily quotes reported to a pair of countries by a given dealer.

Our main finding is that the *Commonality in Quotes* is a powerful driver of CDS correlation, controlling for country similarities in default, liquidity, and macro variables. The effect is statistically and economically significant. A one standard deviation increase in the *Commonality in Quotes* would lead to an increase equivalent to 21.1% of the average CDS excess correlation across the sample period. In fact, the economic impact of the *Commonality in Quotes* is stronger than that attributable to the remaining country-pair specific explanatory variables, including credit risk fundamentals such as the correlation between the bonds' yield percentage changes. The fact that the *Commonality in Quotes* variable is significant even when controlling for the bond correlations suggests that CDS are subject to some market frictions that are specific to this market and not to the bond market. Nevertheless, in agreement with Longstaff, Pan, Pedersen, and Singleton (2012), we find that there exists a common aggregate factor that exerts a first order effect on CDS comovements.

We posit that the mechanism causing the CDS excess correlation is the buying pressure faced by CDS dealers. This contribution of demand pressure to derivatives pricing has been documented by Garleanu, Pedersen, and Poteshman (2009) and Bongaerts, de Jong, and Driessen (2011), among others. Specifically, we conjecture that the common demand on a given pair of sovereign CDS is explained by the dealers'

urgency to buy protection in order to mitigate the credit risk of their portfolios and/or to lower regulatory capital requirements, especially in banks (Yorulmazer, 2013; and Klingler and Lando, 2014). This willingness to trade exerts a pressure, increasing CDS premia in a way that is not necessarily related to the fundamentals of those CDS. As a consequence, when the dealer is big enough and experiences this buying pressure in the CDS of two different countries, it will induce an extra or non-fundamental correlation between the CDS of those countries. It turns out that the CDS market is especially prone to having relative large players because it is dominated by the so called G14 dealers, who are the largest derivatives dealers worldwide and hold roughly 90% of the CDS notional amount (Mengle, 2010). In fact, we find that our *Commonality in Quotes* variable explains CDS spread correlation especially when large dealers face buying pressure.

The relationship between *Commonality in Quotes* and CDS return correlation can also move in the opposite direction, so endogeneity could be a concern. For example, dealers could choose to provide more quotes to those pairs of countries whose CDS prices are more correlated. We deal with this issue in two different ways. We first implement an instrumental variable approach using as instrument the average changes in the tier 1 capital ratio of a large group of international banks that are potential participants in the CDS market. The motivation for the use of this instrumental variable relies on the use of CDSs by banks as credit risk mitigants to reduce the capital requirements for existing exposures. Thus, the demand on a given pair of sovereign CDS would be associated with the changes in the banks' tier 1 capital ratio and so, with the participants in the CDS market; but not with the ex-ante CDS comovement. Secondly, we clean our measure of *Commonality in Quotes* by regressing it on three lags of the CDS correlation, and use the residuals as our variable of interest. The results obtained from both analyses confirm that our finding is indeed rooted in a causal relationship between *Commonality in Quotes* and CDS return comovement.

Our findings link to two different strands of the literature. It first builds on a series of papers documenting an increasing trend in the comovements between the CDS spreads of the European Monetary Union (EMU) countries during the recent

crisis (i.e., Caporin, Pelizzon, Ravazzolo, and Rigobon (2013), or Kalbaska and Gatkowski (2012), among others). As CDS market dealers play an essential role in providing liquidity to the market by disseminating bids and offers to potential clients seeking to trade credit protection[1], a handful of papers also analyze the effect of the liquidity provision on CDS prices (Longstaff, Mithal and Neis, 2005, or Tang and Yan, 2007, among others). However, on the one hand, little is still known about the effect of dealers' liquidity provisions on CDS price comovements. On the other, none of the mentioned papers test how the dealers' activity helps improve the explanatory power of such correlations, nor do they use information at the dealer level.

Secondly, this paper is also related to the broader area of market frictions in financial markets. It is specifically linked to those papers documenting that market frictions make prices deviate from fundamentals or comove beyond fundamentals (see Barberis, Shleifer, and Wurgler (2005), and others). Our analysis focuses on the effect of friction-based trading on CDS price comovements. Some recent papers have studied the price impact of intraday CDS transactions in the presence of trading frictions. Shachar (2013) examines the role of liquidity provision by dealers in the CDS market and finds that order imbalances of end-users have a significant impact on price, which depends on the sign of the dealers' inventory. Gündüz, Nasev, and Trapp (2013) show that CDS traders adjust their prices to the order flows they observe, with the adjustment of the premium growing stronger as inventory risk increases. Siriwardane (2014) measures CDS sellers' capacity to supply CDS and documents that dealers' risk-bearing capacities affect CDS prices.

We contribute to the above mentioned literature by documenting a cross-securities price pressure derived from friction based demand in the context of sovereign CDS. This cross-securities price pressure is already hinted in Ho and Stoll (1983), who 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

[1] The importance of dealers' activity in the CDS market is remarkable. Robert Pickel, CEO of ISDA, in his testimony before Congress on March 10, 2009, stated that 86% of the Depository Trust & Clearing Corporation (DTCC) trades were dealer-to-dealer trades.

reduce her total inventory risk.[2] There is, however, little evidence of this cross-asset price pressure in the sovereign CDS market. According to data provided by DTCC, sovereign CDS were among the top traded single-name contracts, including corporates, in terms of the net notional amount. Moreover, sovereign and corporate CDS contracts are known to be different (see Vogel, Bannier, and Heidorn, 2013; and European Central Bank (ECB), 2009).

Summarizing, the use of a unique dataset with dealer-level intraday quotes enables us to provide new evidence on the role of non-fundamental factors in explaining sovereign CDS comovements. Taken together, our results are consistent with the CDS premia containing a non-default-related component that CDS traders charge to protect themselves and take advantage of market frictions. This willingness towards a joint buy of sovereign CDS strongly contributes to causing comovement across their credit spreads. The economic magnitude of this friction-based trading is not negligible and should be accounted for before measuring contagion or comovement among sovereign CDS prices to be used for regulatory or risk diversification purposes.

The remainder of the paper is organized as follows. Section II describes our methodology and data sources. Section III presents our results, and Section IV concludes the paper.

II. Data and Methodology

A. Data and Sample

Intraday CDS quotes disaggregated at the 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) spanning from January 2008 to October 2011. The same information is employed for an additional sample of 39

[2] Other papers such as Antón and Polk (2014) also show that there is a cross-stock price pressure in the stock market arising from common ownership of mutual funds.

non-EMU countries from January 2010 to October 2011 to confirm the robustness of the results obtained for the EMU countries.

We primarily focus on the EMU countries for three reasons. First, the level of contagion among these countries during the crisis has been very strong and has persisted for a long period of time. Second, the activity in the EMU sovereign CDS contracts has increased significantly.[3] Third, all of the CDS have similar characteristics in terms of currency, restructuring clauses, and timing. Although most of the action occurs 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.

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 (hereafter dealers).[4] In fact, the daily data reported by CMA come from these intraday quotes. CMA collects the buy-side data for every contract and aggregates it to a daily frequency.

The 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 and not for the CDS spreads,[5] we calculate the spread following the ISDA CDS Standard Model to convert up-front payments into

[3] According to data provided by DTCC, France, Italy, Germany, and Spain were among the top 5 reference entities in terms of the net notional amount outstanding by September 2011, including sovereign and corporate references. Belgium, Austria and Portugal were in 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 the sovereign CDS ($81 billion) by January 2010.

[4] 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.

[5] Some dealers only provide up-front prices for Greece after April 2011.

spreads.[6] To guarantee a minimum level of synchronicity across EMU countries, we exclude quotes outside the main working hours (7am to 8pm GMT+1) and quotes given on Saturdays and Sundays.[7] Information related to control variables comes from other sources and will be further 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 the total number of quotes and dealers for the EMU countries, as well as the daily average, at the country level. Each country has on average of approximately half a million quotes (i.e., more than 572 daily quotes on average). There is an average of 28 different dealers giving quotes for each country. Panel B contains the aggregate descriptive statistics for the EMU and non-EMU countries using information from January 2010 to October 2011. In this sample of countries, we use all of the available quotes independently of the reporting time due to the different time zones. This panel confirms that the activity in the 11 EMU countries is higher than that observed in 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, for that sub-period, the average number of daily quotes for each individual EMU country is almost 950, versus 260 for each individual non-EMU country. The total and the average number of dealers reporting prices for the two groups of countries are very similar.

Panel C shows a revealing feature of our analysis: there is a great amount of concentration in dealers' activity. The 10 most active dealers provide 45.9% of the total number of quotes in our sample, and the 30 most active dealers account for 90.8% of the total quotes, a fact that highlights why commonality in quotes from large dealers matters for CDS pricing.

< Insert Table I here >

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

[7] Quotes outside these hours and on 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.

Comovements in the sovereign CDS are computed as the monthly correlation of daily sovereign CDS returns for countries *i* and *j* in month *t* (ρ_{ijt}), for the sample of 11 EMU countries (55 different country-pairs) for the period of January 2008 to October 2011. CDS returns refers to the percentage change in the CDS spread and is obtained as the first difference in the logarithm of the CDS spreads. The daily CDS spreads are obtained from Markit instead of CMA to avoid any dependence on the method used by CMA to compute daily prices from the intraday contributions of dealers. Panel A of Figure 1 shows the median of ρ_{ijt}, jointly with the 5th and 95th percentiles. From the beginning of the sample to the collapse of Lehman Brothers, we observe a wide dispersion across correlations ranging from -0.56 to 0.93. Since September 2008, the median of the correlations has fluctuated steadily between 0.43 and 0.86. The 5th and 95th bands show a small dispersion in March 2009 due to the implementation of the economic stimulus package in the US. On the contrary, we observe a greater dispersion since May 2010 when there is a sizeable decrease in 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.

Our regression analysis relies on the correlations among sovereign filtered CDS returns (instead of CDS returns) or excess CDS correlations. These correlations can be interpreted as a 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 on measuring economic fundamentals and identify contagion through the correlation of an asset pricing model's residuals. These residuals are obtained from a regression in which the dependent variable is the CDS return of a given country and the explanatory variable is a market variable. For the analysis that only involves EMU countries, we employ a sovereign CDS industry-specific index as the market variable, 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*.[8] For the analysis that involves the entire universe of sovereign CDS, we use the equally-weighted average daily CDS returns of all countries in the sample. We denote the monthly correlation of daily sovereign filtered CDS returns for countries *i* and *j* in month *t* as ρ^*_{ijt}. Panel B of Figure 1 shows the median of ρ^*_{ijt}, jointly with the 5th and 95th percentiles. This variable fluctuates between 0.1 and 0.8 and exhibits a higher variation than the series in Panel A of Figure 1. The excess correlation reaches its highest levels in September 2008 and April 2010 coinciding with Lehman Brothers' collapse and the month before the Greek bailout.

<Insert Figure 1 here>

Table II reports the descriptive statistics of the monthly correlation of daily sovereign CDS returns and filtered returns and the monthly commonalities in quotes for countries *i* and *j*. 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 or the CDS correlations. These commonalities, as well as the correlation between CDS returns, exhibit an upward trend from the levels observed in 2008 that remain high from 2009 onwards. Nevertheless, the correlations between filtered CDS returns exhibit a weaker upward trend.

<Insert Table II here>

B. Measuring Commonality in Quotes

i. *Commonality in Quotes*

Two countries will be more connected if they have many dealers in common and if those dealers are similarly active in giving quotes to those countries. We

[8] 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) began trading on 28 September 2009. This index consists of 15 countries, but its beginning date is far away from the beginning of our sample.

average across dealers the correlation of the number of quotes given by each dealer *d* to both countries *i* and *j* in month *t*. We label this variable *Commonality in Quotes (CQ)*, and define it as:

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

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.* If dealer *d* does not report quotes on a country at a certain date, we impute a zero value for that date. The correlation of quotes coming from a very active dealer should weigh more than the correlation coming from a dealer that gives very few quotes. As a consequence, the *Commonality in Quotes* is a weighted average of the monthly correlation between the number of daily quotes reported by all dealers to countries *i* and *j* in which the weight assigned to dealer *d* in month *t* (ω_{dt}) is defined as follows:

$$\omega_{dt} = \frac{\min(TQ_{idt}, TQ_{jdt})}{\sum_{d=1}^{D} \min(TQ_{idt}, TQ_{jdt})} \qquad (2)$$

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 of ω_{dt} across all dealers in each month is equal to one.

This measure, *Commonality in Quotes,* captures how connected two countries are, depending on the activity, size, and number of dealers handling CDS for those two countries. We hypothesize that if there is a large dealer giving many quotes to two countries in a pair, the CDS of those countries will exhibit a high level of comovement.

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 displays 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.

< Insert Figure 2 here>

ii. *Commonality in Quotes and dealer's trading pressure*

We now turn to a more disaggregated version of the *Commonality in Quotes*. Consistent with seminal papers on market microstructure (see for instance Ho and Stoll, 1983), we consider that a dealer who is willing to reduce her position in CDS will decrease both the bid and ask prices. On the contrary, a dealer who is willing to buy CDS and not sell gives a high bid and ask price to ensure the purchase and deter additional buyers. This willingness towards a joint sale or joint buy of the CDS of a given pair of countries could lead to greater comovement. If that dealer is large enough, the CDS spreads quoted for the two countries would change simultaneously due to the dealer's activity, but not because of the two countries' similarities in fundamentals.

To capture the effect of trading based on buying or selling pressure, we break down the variable *Commonality in Quotes* in three variables. *Commonality in Quotes from Buying Pressure* (CQ_{ijt}^{B}) is defined as in equation (1), but using quotes from those dealers facing buying pressure. These dealers are willing to buy CDS but less willing to sell protection and so, they are supposed to give high bid and ask quotes relative to other dealers. We consider that a dealer *d* faces buying pressure on countries *i* and *j* when her average bid price and ask price in month *t* are above the 66th percentile of the distribution of all dealers' bid and ask prices for both countries. In the same vein, *Commonality in Quotes from Selling Pressure* (CQ_{ijt}^{S}) is defined using quotes from those dealers facing selling pressure on countries *i* and *j.* It occurs when her average

bid price and ask price are below the 33rd percentile of those distributions.[9] Finally, we obtain *Commonality not from Buying or Selling Pressure* (CQ^{NBS}) on the basis of those dealers whose bid and ask prices are within the 33rd and 66th percentiles in both countries.

$$CQ_{ijt}^{l} = \sum_{d=1}^{D_t^l} \omega_{dt}^{l} \mathrm{corr}(NQ_{idt}^{l}, NQ_{jdt}^{l}) \ \in [-1,1] \ \ where\ l = B, S, NBS \qquad (3)$$

where l denotes whether dealer d reporting CDS quotes to countries i and j faces buying pressure (B) or selling pressure (S) or none (NBS) in both countries i and j. Thus, we have a commonality variable for each of the three previous possibilities. The notation is similar to the one employed in the baseline commonality variable, but now NQ_{idt}^{l} and NQ_{jdt}^{l} are the number of quotes given to country i and country j, respectively, by dealer d with a level of trading pressure l in a given month t. Regarding the weights (ω_{dt}^{l}), they are obtained as in equation (2) but considering separately the dealers in the category of trading pressure l to countries i and j at time t, respectively. D_t^l denotes the total number of dealers in each of the three categories, denoting the degree of trading pressure l reporting quotes to both countries i and j in month t.

C. Modeling Sovereign CDS Comovement

The following equation represents the panel estimate regression explaining the monthly correlation of daily sovereign CDS excess returns for countries i and j in month t $\left(\rho_{ijt}^{*}\right)$ for the sample of 11 EMU countries (55 different country-pairs) for the period from January 2008 to October 2011:

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

[9] We use these percentiles to guarantee a minimum number of observations to compute the correlations. We require that the dealers provide quotes for at least two days to consider their quotes in the computation of the commonality measure.

where CQ_{ijt} refers to our measure of *Commonality in Quotes* that dealers give to both countries in the pair at month t obtained from equation (1) as defined in Section II.B. $CONTROL_{kijt}$ contains the set of k controls that include a group of pair-level controls. All of these controls are explained in the following subsection and are defined as contemporaneous to the dependent variable. The parameter δ_t denotes the use of month fixed-effects to control for the effect of common factors. The standard errors are double-clustered at the country-pair and month levels. In two different specifications, we use the two versions of *CQ:* the baseline one and the disaggregated one in trading pressure faced by dealers.

D. Controls

This set of variables accounts for differences and similarities between two countries that may potentially affect the comovements in the CDS spreads. We control for five groups of country-pair specific variables: sovereign credit risk, credit risk of financial institutions, risk premium, CDS liquidity, and macroeconomic variables. For every pair of countries, we measure the monthly correlation of each of the above variables, computed using daily observations. Given the lower frequency of the macroeconomic variables, however, we use the absolute value of their difference to proxy for the similarities in terms of macro fundamentals.

Sovereign credit risk: Both bonds and CDS spreads are two measures of the same underlying credit risk. Nevertheless, Badaoui, Cathcart and El-Jahel's (2013) find that sovereign bond spreads are less subject to liquidity frictions than CDS spreads. For this reason, the use of the correlation between the bond yield percentage changes of the corresponding countries (*Corr. Country Sov. Bond Log Ret.*) enables us to control for fundamental based sovereign credit risk comovements.[10] We expect a positive and significant effect of this control variable. But more importantly, if the commonality in quotes variable is statistically significant even when controlling by the bond

[10] We use bond yields instead of bond spreads to include Germany in our analysis as the bond spread is normally the difference between the bond yield of a given country and the one of Germany. Additionally, using bond yields we ensure that the correlations are not driven by any rate of reference such as the swap rate.

correlations; we can conclude that CDS are subject to some market frictions that are specific to this market and are no common to the bond market.

Credit risk of financial institutions: Acharya, Drechsler, and Schnabl (2014) document a significant comovement between bank CDS and sovereign CDS after the announcement of financial sector bailouts in the Eurozone. As a consequence, the stronger the relationship between the financial sectors of two given countries, the more easily the shocks to financial institutions in the first country affect the sovereign sector of the second country. To control for this comovement, we consider the correlation between the log return of the CDS spreads of the banking sectors of the corresponding countries (*Corr. Country Banks CDS Log Ret.*).

Country-specific risk premium: The country risk premiums have been found to have a positive effect on credit risk in existing literature (Dieckmann and Plank, 2012). Thus, the higher the correlation between the stock market returns, the higher we expect the correlation between the sovereign CDS log returns. To control for the similarities of countries in terms of their risk premium, we use the correlation between the log returns of the countries' stock indices (*Corr. Country Stock Indexes Log Ret.*).

CDS liquidity: Previous literature has documented the existence of a liquidity premium in sovereign CDS prices; thus, the higher the correlation between the liquidity premium of two countries, the larger the correlation in CDS prices would be. 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).

Macro variables: We consider two macro fundamentals in our analysis: government debt and the government net deficit/surplus relative to GDP. Using these variables, we proxy for the stock of debt in countries and the accumulated deficit. They have been found to have significant effects on the sovereign CDS spreads in Aizenman, Hutchison, and Jinjarak (2013) and Beirne and Fratzscher (2013), among others. We use the absolute differences in relative debt (*Abs|Debt to GDP$_i$ - Debt to*

GDP_j|) and deficits (*Abs*|*Deficit to* GDP_i - *Deficit to* GDP_j|) to measure the similarities across countries in terms of these two variables.

Longstaff, Pan, Pedersen, and Singleton's (2012) study of the nature of sovereign credit risk based on CDS spreads and 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). In view of this, it is highly plausible that all correlations are driven by a common set of factors besides the pair specific similarities or differences. For this reason, we include month fixed effects in the regression model. The use of time effects enables us to rule out any common aggregate factor that moves all correlations up or down together.

III. Results

A. Determinants of Comovements

A.1 Baseline Analysis

Table III reports our baseline results. We employ two alternative specifications for which we report the results without (column (1)) and with (column (2)) the *Commonality in Quotes* variable to emphasize its power in explaining comovements. Both columns (1) and (2) contain all the control variables plus time effects. Regarding the new variable included in column (2), 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 excess returns. Concretely, an increase of 1% in *Commonality in Quotes* increases the correlation between their CDS excess returns by 0.45%, ceteris paribus. Apart from being statistically significant, the explanatory power of this variable seems to be sizeable because the R-squared increases by a 6.5% from 35.6% to 37.9% after its inclusion in the regression.

Regarding the control variables, we observe a positive relationship between the bond and CDS correlations. This is due to the fact that bond yields and CDS spreads represent two measures of the same credit risk. The fact that the *Commonality in Quotes* variable is significant even when controlling for the bond

correlations suggests that CDS are subject to some market frictions that are specific to this market and not to the bond market. The similarities in the levels of credit risk of the financial institutions of a given pair of countries are translated into a higher level of comovements in the credit risk of those countries' sovereign sectors. Finally, we observe that, consistent with the existence of a significant liquidity premium in CDS spreads, the stronger the relationship between the liquidity of the CDS contracts for a given pair of countries, the stronger the comovements in their prices. The similarities in the degree of the countries' deficits play a weakly significant role in comovements: if two given countries exhibit a high ratio of deficit relative to GDP, the market tends to push their CDS in the same direction.

We next analyze the economic significance of the variables according to the baseline results obtained in column (2). It is obtained from the product of the estimated coefficient and the standard deviation of each independent variable. The results are reported in column (3). The coefficient with the largest economic significance is the one of *Commonality in Quotes*. A change equal to one standard deviation of the previous variable would lead to an increase in the average excess correlation between the CDS of a given pair of countries equal to 0.076 units. This increase is equivalent to 21.1% of the average CDS excess correlation across the sample period (0.361). The economic effect of the remaining significant variables in absolute terms, by order of relevance, is 0.056 units for the correlation between the sovereign yields of a given pair of countries, 0.020 units for the correlation between the credit risk of the financial institutions of the two countries forming the pair, 0.013 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 of ranking the independent variables in order of importance, we use a Shapley-based decomposition of the R-squared of the linear regression. This method uses the 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. Column (4) contains the proportion of the R-squared explained by each variable apart from

the month fixed effects that are grouped in one category. The *Commonality in Quotes* is responsible for 7.32% of the goodness of fit measure of the model, while the correlation between bond yields and the correlation between CDS liquidity account for 5.24% and 3.07% of the model's fit, respectively. None of the remaining country-pair specific control variables account for more than 3% of the model's fit, respectively. In agreement with previous literature documenting the linkage of sovereign CDS spread to global factors (see Longstaff, Pan, Pedersen, and Singleton, 2012, among others) we find that time fixed effects are responsible for 77.65% of the goodness of fit measure of the model. This result reinforces the idea that there exists a common aggregate factor that moves together all EMU countries correlations.

In view of these results, we conclude that our simple measure of commonality in the quotes that dealers provide for CDS of EMU countries is a powerful driver of the variation in CDS return correlations. Although the excess correlation of CDS returns exhibits a strong dependence on a common factor captured by month fixed-effects, the fundamental related variables exhibit a second-order effect on that correlation.

< Insert Table III here >

The revision of the misleading statistics of fiscal deficits by the Greek authorities in November 2009 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 baseline analysis, in Table IV, column (1), and splitting the sample into two sub-periods using this event as the break point: pre-crisis (column (2)), and crisis (column (3)).

Independently of 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 after the exclusion of Greece are very similar to those obtained in the baseline analysis. Nevertheless, we find some worth mentioning differences between the pre-crisis (column (2)) and crisis (column (3)) periods. Before the crisis, fundamental variables such as deficit to GDP were the main drivers of CDS

comovements. The absence of significance of the correlation between bond yields is explained by the flat trend of sovereign bond yields for the pre-crisis period. Nevertheless, bond yields exhibit a significant effect on the dependent variable during the crisis period. Macro variables lose their explanatory power with the crisis as CDS comovements are more exposed to other risk factors.

< Insert Table IV here >

A.2 Alternative Correlations, Commonalities, Frequencies, and Countries

First of all and to ensure that the results are not affected by the use of Markit to compute the excess CDS correlation, we now compute the dependent variable using CMA CDS daily prices. Column (1) of Table V reports the results for the baseline specification obtained from Markit while column (2) contains the results for the alternative measure of excess correlation obtained using CMA daily prices. Both datasets lead to identical results.

One may argue that the variable *Commonality in Quotes* simply reflects liquidity. Although the correlation between our variable of interest and the variable measuring the similarities of the two countries in terms of their CDS bid-ask spreads (0.24) does not support that conjecture, we next provide additional evidence to support the robustness of our results. To this end, 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 to substitute the commonality. The results reported in column (3) of Table V are almost the same as those in column (1).

To ensure that the results are not due to the strong similarities among the 11 EMU countries forming the sample, we next extend our analysis to the entire universe of sovereign CDS for which there are regular quotes. This leads to a final sample that consists of 50 countries (39 non-EMU countries) for the sample period 2010-2011. Column (4) of Table V contains the results obtained for the baseline specification

extended to all countries.[11] We still find a positive and strongly significant effect of commonalities.

Finally, we 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) for the sample of EMU countries. To implement the daily analysis, we must define the correlation between sovereign CDS on a daily basis. To this end, we take advantage of the intraday quotes to calculate hourly CDS 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.[12] We compute the daily correlation leaving the missing values without replacement. The *Commonality in Quotes* is obtained as in equation (1) but by computing daily correlations from the number of quotes per hour using those reported from 7.00 to 19.00 (GMT+1) and assigning zero when there are no 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 those used in Table III and have a quarterly frequency. The remaining explanatory variables are updated on a daily basis using weekly rolling windows. The results, in column (5), are qualitatively similar to the ones obtained for the monthly frequency (column (1)).

< Insert Table V here >

B. Comovements and Dealers' Trading Pressure

In this section, we perform a test to analyze the effect of the commonalities obtained from dealers facing trading pressure. As detailed in Section II.B, we consider common high (low) ask and bid prices for a given pair of countries to define dealers facing buying (selling) pressure. The commonalities obtained from dealers facing buying (selling) pressure for a given pair of countries are denoted as CQ^{B}_{ijt} (CQ^{S}_{ijt})

[11] 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 bank nonperforming loans to total gross loans defined on an annual basis (*Abs|NPLTLi - NPLTLj|*).
[12] The lower frequency of quotes for the years 2008 and 2009 impedes increasing the number of intraday observations employed to obtain the correlations, given that we must use the same time span for all the years in the sample.

while the ones obtained from dealers who do not face trading pressure are denoted as CQ_{ijt}^{NBS}. The results obtained for the joint use of the three types of commonalities are reported in column (1) of Table VI. We observe that the effect of commonalities obtained from dealers facing buying pressure is significantly different from zero, while that for dealers facing selling pressure and those who do not face either buying or selling pressure is not.[13] The coefficients of the remaining control variables remain unchanged. It suggests that dealers willing increase their positions in a given pair of EMU countries contribute to increasing the CDS prices of those countries and, consequently, their correlation. This supports Shachar's (2013) finding that the contemporaneous price impact of buying is much larger than the immediate price impact of selling. Moreover, the role of dealers buying pressure on CDS prices and comovements is supported by the increase in the real demand of dealers in the sovereign CDS market that exhibit an increasing trend since mid-2009 (see Klingler and Lando, 2014). These results are also in agreement with those obtained by Garleanu, Pedersen, and Poteshman (2009) and Bongaerts, de Jong, and Driessen (2011), among others; on the contribution of demand pressure to derivatives pricing.

Our finding is consistent with dealers being less willing to sell protection and further increasing their exposure to counterparty risk and to the default of a given EMU country. The effect of demand pressure on CDS comovements could be explained by the use of sovereign CDSs as a credit risk mitigants to reduce portfolio credit risk and/or to lower regulatory capital requirements. Sovereign CDSs are appropriate instruments to hedge direct exposures to sovereign debt or hedge other assets whose value is correlated with the creditworthiness of the sovereign as banking or utility sectors (see April 2013 World Economic Outlook, IMF). Additionally, when a bank acquires a CDS against a risky investment, the bank can hold less capital against such investment. The use of CDS to lower regulatory capital requirements and to free up capital on banks' balance sheet has been addressed by Yorulmazer (2013) and

[13] A given dealer *d* is considered as facing buying (selling) pressure for countries *i* and *j* when her average bid and ask prices are above (below) the 66th (33rd) 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.

Klingler and Lando (2014).[14,15] Nevertheless, the use of CDS by banks to improve the appearance of their capital ratios could lead to an incentive to invest in highly risky projects (Yorulmazer, 2013) and to increase risky lending (Shan, Tang, and Yan, 2014) and as a consequence to increase systemic risk.

There are additional frictions and features of the sovereign CDS market that could help to explain the role of common quotes from dealers facing buying pressure. Thus, these common quotes could be due to dealers' strategies such as bond-CDS basis trading to profit from pricing differences between the CDS and the underlying bond (Mayordomo, Peña, and Romo, 2014). In addition, the buying pressure could also obey to the dealers' willingness to express their opinion or information on the country creditworthiness using naked CDS positions (Duffie, 2010). Finally, according to market microstructure literature, common demand of a pair of sovereign CDS may be the result of managing inventory risk on single securities traded by a dealer facing that risk (Shachar, 2013; and Gündüz, Nasev, and Trapp, 2013).[16]

Most of the quotes are reported by a small number of dealers (see Section II. A) and so, the commonalities in quotes associated to these dealers could have a stronger effect on the excess correlations. In fact, Mengle (2010) documents that the 14 largest dealers worldwide hold roughly 90% of the CDS notional amount. To deal with this issue we define a more disaggregated version of the commonalities in quotes variables for dealers facing buying pressure. To capture the effect of dealers' market power, we break down the variable *Commonality in Quotes from Buying Pressure* (CQ^{B}_{ijt}) in two variables according to the dealer's size. We employ three alternative thresholds to define large dealers facing buying pressure. Thus, we consider as large

[14] As illustrated by Yorulmazer (2013), AIG claimed in its public financial statements that 72% of the notional amounts of CDSs sold by AIG Financial Products as of December 2007 were used by European and other banks for capital relief.

[15] The new regulatory requirements due to Basel III that aim to reduce counterparty credit risk in derivatives transactions have also contributed to increase dealers' demand pressure (see Klingler and Lando, 2014).

[16] Inventory control and risk-sharing has attracted significant attention in the stock market as a motive behind interdealer trading (see Garman (1976), Stoll (1978), Amihud and Mendelson (1980), Ho and Stoll (1983), O'Hara and Oldfield (1986), among others). According to this literature, dealers accommodate buying and selling by outside investors and adjust their quoted prices to restore their inventories to some desired level, thereby causing price movements.

dealers facing buying pressure in a given month t those whose total number of quotes to a given pair of countries is above (i) the median ($CQ_{ijt}^{B>pctl50}$), (ii) the top tercile ($CQ_{ijt}^{B>pctl66}$), and (iii) the top quintile ($CQ_{ijt}^{B>pctl80}$) of the distribution of the total number of quotes per pair and dealer. Columns (2) – (4) of Table VI contain the results obtained from the joint use of the four types of commonalities for the three previous thresholds, respectively. We observe that the effect of the *Commonality in Quotes* is dominated by the activity of larger dealers among those facing buying pressure. This finding is in agreement with Gündüz, Naser, and Trapp (2013) whose findings are consistent with the "notion that the lack of competition in CDS markets gives rise to dealer market power with significant price impact".

< Insert Table VI here >

C. Accounting for Endogeneity

In our analysis, we have regressed monthly CDS excess comovements on dealers' quote commonalities. Nevertheless, endogeneity may be a concern here because it is plausible that innovations in CDS excess comovements may simultaneously affect the dealers' common quotes through some behavior observed in such correlations. To conclude that the *Commonality in Quotes* is indeed causing CDS excess comovements to increase, we re-estimate the regressions reported in equation (4) using two different methods: an instrumental variable approach and an analysis implemented using the commonalities in quotes filtered from the three lags of CDS return correlations.

We first consider the use of instrumental variables. We require an instrumental variable that exclusively affects the participants in the CDS market, not the entire economy. The channel through which we explain the effect of *Commonality in Quotes* is an exogenous shock derived from the dealers demand for capital relief purposes. In the context of the Basel II Accord, banks should satisfy a minimum capital requirements defined as the ratio between core equity or Tier 1 capital and risk weighted assets (RWA). In the RWA calculation, claims on sovereign debt are risk weighted depending on the rating of the issuer country: 0% (AAA to AA-), 20% (A+ to

A-), 50% (BBB+ to BBB-), 100% (BB+ to B- or unrated), 150% (below B-).[17] The motivation for the use of this instrumental variable relies on Yorulmazer (2013) and Klingler and Lando (2014) evidence about the use of CDSs by banks as credit risk mitigants to reduce the capital requirements for existing exposures (see also ECB, 2009). Thus, for each pair of countries we use as an instrument the average quarterly percentage change in the Tier 1 capital ratio of a subset of internationally active banking institutions whose headquarters are not located in any of the two countries/economic areas forming the pair.[18] Given that information on the Tier 1 capital ratio is released on quarterly basis, we define the dependent and independent variables on a quarterly basis. These data are obtained from COMPUSTAT and the individual banks quarterly and annual reports when information is not available in COMPUSTAT. We use a sample of 54 large banking institutions from 18 countries to define the instrument. These international banks are the same used by López-Espinosa, Moreno, Rubia, and Valderrama (2012) in their analysis of systemic risk. Thus, our instrumental variable proxies a demand shock on the sovereign CDSs to hedge the credit exposures of the largest and global active banks where improvements of the average Tier 1 capital ratio are related to an efficient use of sovereign CDSs.

The instrumental variable regression is based on equation (4) in which the *Commonality in Quotes from Buying Pressure* (CQ^{B}_{ijt}) is instrumented through the abovementioned instrument. The regression is performed on several subsets of pairs of countries from the whole universe of sovereign CDS described in Section II.A and summarized in Panel B of Table I. Due to the use of both EMU and non-EMU countries, the analysis relies on quarterly observations for the period 2010-2011.

Column (1) of Table VII reports the results for the instrumental variable analysis conducted on those pairs of countries with rating category equal or lower than A+ at any quarter over the sample period. These are pairs of countries whose

[17] http://www.bis.org/publ/qtrpdf/r_qt1312v.htm

[18] Basel II Accord recognizes the national discretion of lower the risk weight applied to their banks' exposures denominated in domestic currency and in fact, it is often in practice zero. For this reason, in the case of EMU countries, we do not consider banks belonging to any of the EMU countries.

long-term bonds have a positive risk weight that could favor the demand of sovereign CDS to reduce the capital requirements. The sample consists of 24 countries. In a first stage, not reported in the table, we regress CQ_{ijt}^{B}on the instrument and find that the instrument is positive and significant at any standard level of significance. It suggests that improvements in the average Tier 1 capital ratio are related to an active control of the RWA through the demand of sovereign CDS for those countries whose bonds have positive risk weights. Column (1) of Table VII reports the results of the second stage regression in which we use the fitted *Commonality in Quotes* from the first stage to explain the variation of CDS excess comovements. As can be inferred from the positive and significant coefficient for the instrumented variable (INST. CQ_{ijt}^{B}), we conclude that the potential endogeneity of these commonalities does not bias our results. This piece of evidence confirms that our finding does indeed come from a causal relationship between *Commonality in Quotes* and CDS excess return comovement.

To verify 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 percentage change in Tier 1 capital ratio for the corresponding subset of banks) is "relevant" (correlated with the endogenous regressor). According to this under-identification test, we reject the null hypothesis (equation is under-identified); thus, the instrument is relevant and the model is identified.[19] As the previous instrumental regression is exactly identified, we consider the squared of the percentage change in Tier 1 capital ratio as an additional instrument to analyze the validity of the instruments from the over-identification test based on Hansen J statistic. Results are reported in column (2) of Table VII. We confirm that the instruments are valid given that they are uncorrelated with the error term.

The results reported in columns (3) and (4) are obtained from similar analyses to those in columns (1) and (2); but using only those pairs of countries with rating

[19] We also perform a weak identification test to analyze whether the instrument is weakly correlated with the common quotes. In view of the Kleibergen-Paap Wald Rank F statistic, we reject the hypotheses that the equation is weakly identified.

equal or higher than AA- such that their debt has zero risk weight. This sample consists of 21 countries. We find that the instrumented variable (INST. CQ_{ijt}^{B}) is not statistically significant at any standard significance level. This result confirms the validity of the capital relief channel as a driver of the demand of sovereign CDS and the comovements among them.

We perform an additional analysis to ensure that our results do not 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, for example, cash flows in the case of stocks. In addition, to showing the causal effect from the above analysis, we now present an analysis that consists of two stages. In the first stage, we regress the *Commonality in Quotes from Buying Pressure* (CQ_{ijt}^{B}) on three lags of the CDS return correlation and use the residuals as our variable of interest. Filtering the commonalities in this way ensures that the past effects of CDS correlations will not be an issue in our analysis. The results are reported in column (5) of Table VII; and strongly support the consistency of the results obtained in previous analyses.

< Insert Table VII here >

IV. Conclusion

This paper analyzes the effect of the CDS market dealers' activity on the comovement of sovereign CDS spreads. The lack of information on intraday quotes at the dealer level leaves a gap in the literature documenting the role of dealers' activity in CDS contacts. The use of a dataset that consists of the intraday quotes contributed by each specific dealer enables us to fill this gap and provide new evidence about the role of non-fundamental factors in explaining such comovements in periods in which market frictions emerge in the CDS market.

We show that a simple measure of the connectedness of two sovereign CDS through their common dealers' quoting activity is a powerful driver of the variation in CDS excess return correlations. In fact, the economic impact of the commonality

variable is much stronger than the impact attributable to other country-pair fundamentals such as credit, default, and liquidity risks and macro factors.

The strong effect of this *Commonality in Quotes* is explained by the strategy adopted by dealers to trade. If dealers face buying pressure in two countries at the same time, the joint purchases of CDS for those countries would lead to simultaneous changes in the prices of the two CDS. An instrumental variable analysis confirms that our findings indeed reflect a causal relationship between *Commonality in Quotes* and CDS excess 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 causing comovement across credit spreads. Thus, the economic magnitude of this friction based trading should be accounted for before extrapolating measures of contagion or comovement from CDS prices. This would improve the usefulness of CDS to monitor credit risk and contagion across countries.

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

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Table I: Summary Statistics

Table I contains the summary statistics of the final sample of CDS quotes and the dealers' activity. Panel A reports the total number of quotes and the total number of dealers reporting quotes as well as their daily averages for 11 EMU countries from January 2008 to October 2011 at the country level. 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 January 2010 to October 2011. Panel C summarizes the total number of quotes per dealer and the dealer's market share for the 11 EMU countries from January 2008 to October 2011.

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

EMU	No. Quotes		No. Dealers	
Countries	Aggregate	Daily Average	Aggregate	Daily Average
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.	No. Quotes		No. Dealers	
	Countries	Aggregate	Daily Average	Aggregate	Daily Average
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%

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 (ρ_{ijt}),the monthly correlation of daily sovereign filtered CDS returns (ρ^*_{ijt}) for all pairs of the EMU countries, and the monthly *Commonality in Quotes* (CQ_{ijt}) for such countries. Panel A reports the information for the 11 EMU countries listed in Table I, while Panel B excludes Greece. Panels C and D break down the mean and standard deviation 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	444	5	70	6986
CDS Log Ret.	Daily	0.00	0.05	-0.49	0.00	0.49
ρ_{ijt}	Monthly	0.65	0.26	-0.58	0.72	0.98
ρ^*_{ijt}	Monthly	0.36	0.29	-0.73	0.38	0.97
CQ_{ijt}	Monthly	0.75	0.17	-0.15	0.79	0.98

Panel B: ALL COUNTRIES but GREECE

Variable	Freq	Mean	SD	Min	Median	Max
CDS	Daily	122	171	5	65	1304
CDS Log Ret.	Daily	0.00	0.05	-0.49	0.00	0.49
ρ_{ijt}	Monthly	0.66	0.26	-0.58	0.73	0.98
ρ^*_{ijt}	Monthly	0.37	0.29	-0.73	0.39	0.97
CQ_{ijt}	Monthly	0.76	0.16	0.10	0.80	0.98

Panel C: SUBPERIODS

		2008		2009		2010		2011	
Variable	Freq	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CDS	Daily	38	40	90	64	184	209	456	862
CDS Log Ret.	Daily	0.01	0.05	0.00	0.05	0.00	0.05	0.00	0.04
ρ_{ijt}	Monthly	0.41	0.34	0.76	0.12	0.71	0.17	0.70	0.18
ρ^*_{ijt}	Monthly	0.33	0.29	0.35	0.27	0.40	0.28	0.36	0.29
CQ_{ijt}	Monthly	0.59	0.17	0.82	0.08	0.81	0.11	0.77	0.19

Panel D: SUBPERIODS (ALL COUNTRIES but GREECE)

		2008		2009		2010		2011	
Variable	Freq	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CDS	Daily	34	35	82	59	133	119	264	286
CDS Log Ret.	Daily	0.01	0.05	0.00	0.05	0.00	0.05	0.00	0.04
ρ_{ijt}	Monthly	0.41	0.35	0.76	0.12	0.73	0.15	0.73	0.15
ρ^*_{ijt}	Monthly	0.33	0.29	0.35	0.27	0.42	0.29	0.40	0.28
CQ_{ijt}	Monthly	0.58	0.17	0.82	0.07	0.81	0.10	0.82	0.11

Table III: Commonality in Quotes Predicts CDS Return Correlation

This table reports the estimates of panel regressions of the monthly correlation of daily sovereign filtered CDS returns (ρ^*_{ijt}) 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) for the period of January 2008 to October 2011 (46 months). The independent variables include the *Commonality in Quotes* (CQ_{ijt}), which refers to the number of quotes given by dealers to both countries in the pair, and a set of controls, all of them in *t*. *Commonality in Quotes* are obtained as $CQ_{ijt} = \sum_{d=1}^{D_t} \omega_{dt} \text{corr}(NQ_{idt}, NQ_{jdt})$, 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_{ijt} 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 control variables include country-pair specific variables and month fixed effects. The set of country-pair variables are self-explanatory in the way they are labeled in the table and in the body of the text. Column (1)-(2) report the results for equation (4) without and with the *Commonality in Quotes* (CQ_{ijt}) variable, respectively. 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 variables in the baseline results obtained in column (2) is reported in column (3). It is obtained from the product of the estimated coefficient and one standard deviation of the independent variable. Finally, column (4) contains a Shapley-based decomposition of the R-squared and reports the contribution of every independent variable to the R-squared of the baseline analysis (column (2)).

		Dep. Variable: Correlation of filtered daily CDS Log Ret. (ρ^*_{ijt})			
VARIABLES		(1)	(2)	(3)	(4)
	CQ_{ijt}		0.447***	0.076	7.320%
			[0.073]		
Country-Pair Specific Variables	$Corr.Country\ Sov.Bond\ Log\ Ret._{ijt}$	0.157***	0.131***	0.056	5.240%
		[0.032]	[0.032]		
	$Corr.Country\ Banks\ CDS\ Log\ Ret._{ijt}$	0.064*	0.070**	0.020	2.390%
		[0.033]	[0.030]		
	$Corr.Country\ Stock\ Indexes\ Log\ Ret._{ijt}$	0.096	0.085	0.016	2.660%
		[0.063]	[0.058]		
	$Corr.CDS\ Relative\ Bid - Ask_{ijt}$	0.065***	0.036**	0.013	3.070%
		[0.020]	[0.018]		
	$Abs\left\vert Deficit\ to\ GDP_i - Deficit\ to\ GDP_j\right\vert_t$	-0.002*	-0.002	-0.011	1.330%
		[0.001]	[0.001]		
	$Abs\left\vert Debt\ to\ GDP_i - Debt\ to\ GDP_j\right\vert_t$	0.000	0.000	0.010	0.340%
		[0.000]	[0.000]		
Constant		0.088	-0.093		
		[0.077]	[0.074]		
Month Fixed Effects		Yes	Yes		77.650%
Observations		2,530	2,530		
R-squared		0.356	0.379		

Table IV: Commonality in Quotes Predicts CDS Return Correlation (cont'd)

Table IV shows the estimates of the regressions similar to column (2) 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: Correlation of filtered daily CDS Log Ret. (ρ^*_{ijt})		
VARIABLES	(1)	(2)	(3)
CQ_{ijt}	0.482***	0.571***	0.292***
	[0.102]	[0.102]	[0.076]
$Corr.Country\ Sov.Bond\ Log\ Ret._{ijt}$	0.131***	0.095	0.149***
	[0.030]	[0.103]	[0.033]
$Corr.Country\ Banks\ CDS\ Log\ Ret._{ijt}$	0.092**	0.026	0.113***
	[0.037]	[0.039]	[0.039]
$Corr.Country\ Stock\ Indexes\ Log\ Ret._{ijt}$	0.060	-0.042	0.170**
	[0.076]	[0.088]	[0.072]
$Corr.CDS\ Relative\ Bid-Ask_{ijt}$	0.057***	0.063*	0.008
	[0.018]	[0.033]	[0.021]
$Abs\left\vert Deficit\ to\ GDP_i - Deficit\ to\ GDP_j\right\vert_t$	-0.002	-0.007***	0.000
	[0.001]	[0.003]	[0.001]
$Abs\left\vert Debt\ to\ GDP_i - Debt\ to\ GDP_j\right\vert_t$	0.001	0.001	0.001
	[0.001]	[0.001]	[0.001]
Constant	-0.110	0.027	-0.320***
	[0.095]	[0.132]	[0.102]
Month Fixed Effects	Yes	Yes	Yes
Observations	2,070	1,210	1,320
R-squared	0.398	0.330	0.438

Table V: Alternative correlations, commonalities, frequencies and countries

Table V reports the panel estimates of variations in the baseline analysis (equation (4)). Column (1) reports the baseline analysis (column (2) of Table III). In column (2) *Commonality in Quotes* (CQ_{ijt}) is estimated from CMA information instead from Markit. Column (3) reports the results of the baseline *Commonality in Quotes* filtered by the correlation between the CDS bid-ask spreads ($FILT.CQ_{ijt}^{BA}$). Columns (1) – (3) employ as a dependent variable the monthly correlation of daily sovereign filtered CDS returns 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) for the period of January 2008 to October 2011. The set of control variables is common across different columns and refer to a country-pair specific variables and month fixed effects. Column (4) reports panel estimates of monthly regressions of the correlation of daily sovereign filtered CDS returns in month *t* for the sample of 50 countries across the world (11 EMU and 39 non-EMU countries). The regressions are at the country-pair level (820 different country-pairs) for the period of January 2010 to October 2011. The novelty here is the countries under study. All other controls are as in columns (1) – (3), apart from the correlation of country banks' CDS log returns, which, due to the lack of information, is substituted by the absolute difference of bank nonperforming loans to total gross loans defined on an annual basis (*Abs|NPLTL$_i$ – NPLTL$_j$|*). Column (5) reports the panel estimates of daily regressions at the country-pair level (55 pairs) on the correlation of intraday sovereign CDS log returns for the period from January 2008 to October 2011 (887 trading days). All other controls are similar to those in columns (1) – (3) but are defined on a daily basis using weekly rolling windows (except *Abs|Deficit to GDP$_i$ - Deficit to GDP$_j$|* and *Abs|Debt to GDP$_i$ - Debt to GDP$_j$|)*. 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.

	Correlation of filtered daily CDS Log Ret. (ρ^*_{ijt})				Corr. of Intraday CDS Log Ret. (ρ_{ijt})
VARIABLES	(1)	(2)	(3)	(4)	(5)
CQ_{ijt}	0.447***	0.509***		0.660***	0.668***
	[0.073]	[0.106]		[0.045]	[0.071]
$FILT.CQ_{ijt}^{BA}$			0.329***		
			[0.071]		
$Corr.Country\ Sov.Bond\ Log\ Ret._{ijt}$	0.131***	0.134***	0.152***	0.075***	-0.011
	[0.032]	[0.026]	[0.032]	[0.018]	[0.014]
$Corr.Country\ Banks\ CDS\ Log\ Ret._{ijt}$	0.070**	0.077**	0.064**		0.026**
	[0.030]	[0.032]	[0.032]		[0.012]
$Abs\lvert NPLTL_i - NPLTL_j\rvert_t$				0.000	
				[0.001]	
$Corr.Country\ Stock\ Indexes\ Log\ Ret._{ijt}$	0.085	0.027	0.091	0.078*	1.545***
	[0.058]	[0.051]	[0.059]	[0.040]	[0.276]
$Corr.CDS\ Relative\ Bid-Ask_{ijt}$	0.036**	0.020	0.082***	0.118***	0.020***
	[0.018]	[0.020]	[0.020]	[0.024]	[0.007]
$Abs\lvert Deficit\ to\ GDP_i - Deficit\ to\ GDP_j\rvert_t$	-0.002	-0.001	-0.002	-0.002*	-0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
$Abs\lvert Debt\ to\ GDP_i - Debt\ to\ GDP_j\rvert_t$	0.000	0.000	0.000	-0.000	-0.000
	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]
Constant	-0.093	-0.149*	0.158*	-0.399***	-0.758***
	[0.074]	[0.080]	[0.084]	[0.031]	[0.250]
Month Fixed Effects	Yes	Yes	Yes	Yes	No
Daily Fixed Effects	No	No	No	No	Yes
Observations	2,530	2,480	2,480	14,208	44,140
R-squared	0.379	0.472	0.367	0.273	0.276

Table VI: Dealer's trading pressure

Table VI reports the estimates of panel regressions on the monthly correlation of daily sovereign filtered CDS returns (ρ^*_{ijt}) 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) for the period of January 2008 to October 2011 (46 months). The independent variable in this table is the one employed in Table III. The novelty here is that the variable *Commonality in Quotes* is broken down according to the trading pressure faced by each dealer in each pair of countries. According to equation (3), we consider the commonalities obtained from dealers quoting ask and bid prices above the 66th percentile in the two countries (i.e., dealers facing buying pressure, CQ^B_{ijt}) separately from those obtained from dealers quoting ask and bid prices below the 33rd percentile (i.e., dealers facing selling pressure, CQ^S_{ijt}). Those dealers whose bid and ask prices are within the 33rd and 66th percentiles in both countries are used to compute the *Commonality in Quotes* for dealers facing neither buying nor selling pressure (CQ^{NBS}_{ijt}). Column (1) reports the results obtained from the joint use of the three types of commonalities. In addition, to capture the effect of dealers' market power, we further break down the variable CQ^B_{ijt} in two according to the dealer's size. We employ three alternative thresholds to define large dealers facing buying pressure. Thus, we consider as large dealers facing buying pressure in a given month those whose total number of quotes to a given pair of countries is above (i) the median ($CQ^{B>pctl50}_{ijt}$ in column (2)), (ii) the top tercile ($CQ^{B>pctl66}_{ijt}$ in column (3)), and (iii) the top quintile ($CQ^{B>pctl80}_{ijt}$ in column (4)) of the distribution of the total number of quotes per pair an dealer. Columns (2) – (4) contain the results obtained from the joint use of the four types of commonalities for the three previous thresholds, respectively. In the interest of brevity and because the results are consistent with those of Table III, we only report the coefficients for the new specifications of *Commonality in Quotes* variables. 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.

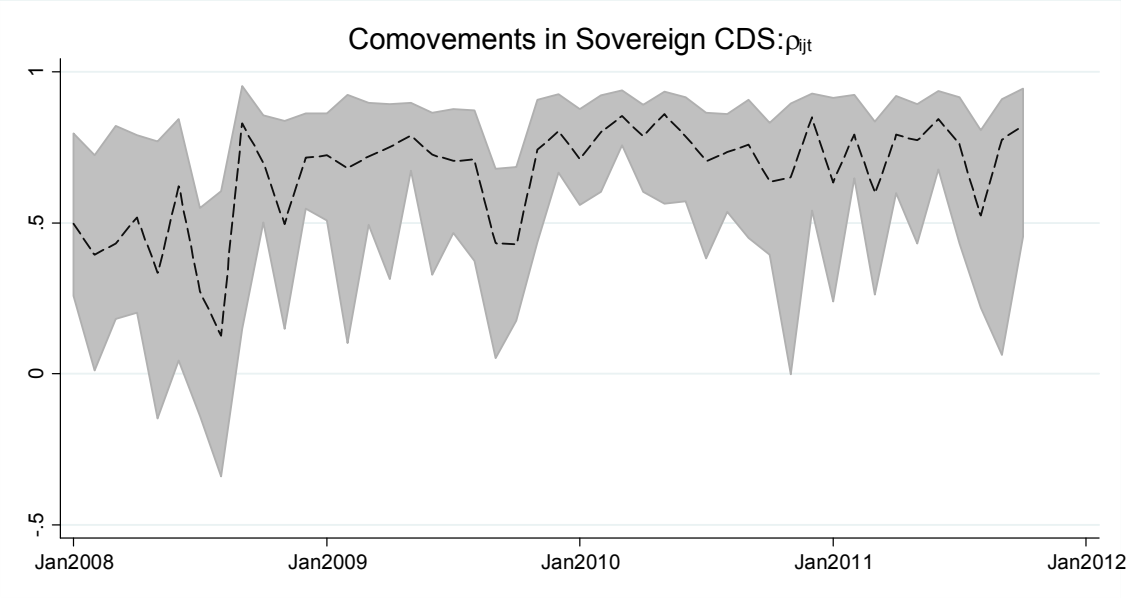
	Dep. Variable: Correlation of filtered daily CDS Log Ret. (ρ^*_{ijt})			
VARIABLES	(1)	(2)	(3)	(4)
CQ^S_{ijt}	0.122	0.119	0.121	0.126
	[0.087]	[0.087]	[0.088]	[0.087]
CQ^{NBS}_{ijt}	0.105	0.114	0.109	0.117
	[0.124]	[0.120]	[0.122]	[0.122]
CQ^B_{ijt}	0.220**			
	[0.091]			
$CQ^{B>pctl50}_{ijt}$		0.195**		
		[0.079]		
$CQ^{B<pctl50}_{ijt}$		0.002		
		[0.031]		
$CQ^{B>pctl66}_{ijt}$			0.192**	
			[0.076]	
$CQ^{B<pctl66}_{ijt}$			0.010	
			[0.037]	
$CQ^{B>pctl80}_{ijt}$				0.134**
				[0.062]
$CQ^{B<pctl80}_{ijt}$				0.056
				[0.050]
Pair-Country Level Control Variables	Yes	Yes	Yes	Yes
Month Fixed Effects	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Observations	2,184	2,184	2,184	2,184
R-squared	0.385	0.385	0.385	0.385

Table VII: Accounting for Endogeneity

Table VII reports the results of a set of analyses to rule out any potential endogeneity problem. Columns (1) – (4) report the results of the instrumental variable analysis. This analysis is based on equation (4) in which we instrument the *Commonality in Quotes from Buying Pressure* (CQ^{B}_{ijt}). For each pair of countries, the instrument is defined as the average quarterly percentage change in the Tier 1 capital ratio ($\%Ch\ Tier1$) of a subset of international banks whose headquarters are not located in any of the two countries/economic areas forming the pair. The analysis is performed on several subsets of pairs of countries from the whole universe of sovereign CDS described in Panel B of Table I. Given that information of the Tier 1 capital ratio is released on quarterly basis and due to the use of both EMU and non-EMU countries, the analysis relies on quarterly observations for the period 2010-2011. Hence, the dependent and control variables are the ones in Table III but on a quarterly basis. Column (1) reports the results for the instrumental variable analysis conducted on those pairs of countries and quarters in which the two countries have a rating category equal or lower than A+ (positive risk weight). Column (3) reports the results for the instrumental variable analysis conducted on those pairs of countries and quarters in which the two countries have rating equal or higher than AA- (zero risk weight). In columns (2) and (4) we check whether the instruments in columns (1) and (3), respectively, are uncorrelated with the error term. For such aim, we propose equations that are not exactly identified by including the squared of the instrument as an additional instrumental variable. Column (5) reports the results obtained from an alternative methodology to deal with endogeneity. This column contains the estimates of panel regressions on the monthly correlation of daily sovereign filtered CDS returns for the sample of 11 EMU countries listed in Table I, Panel A. The novelty here is the use of the *Commonality in Quotes* that is due to dealers facing buying pressure filtered from the past CDS correlations ($FILT.\ CQ^{B}_{ijt}$). The dependent and control variables are the ones reported in Table III. In the interest of brevity and because the results are consistent with those of Table III, we only report the coefficients for the new specifications of *Commonality in Quotes*. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dep. Variable $_t$: Correlation of filtered daily CDS Log Ret. (ρ^{*}_{ijt})				
Window length	Quarterly	Quarterly	Quarterly	Quarterly	Monthly
VARIABLES	(1)	(2)	(3)	(4)	(5)
$INST.\ CQ^{B}_{ijt}$	0.703***	0.704***	0.007	0.028	
	[0.132]	[0.132]	[0.21]	[0.194]	
$FILT.\ CQ^{B}_{ijt}$					0.179***
					[0.060]
Pair-Country Level Control Variables	Yes	Yes	Yes	Yes	Yes
Month Fixed Effects	No	No	No	No	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	No
Constant	Yes	Yes	Yes	Yes	Yes
Observations	1348	1348	1172	1172	2,099
Number of pairs	264	264	204	204	54
R-squared	0.061	0.063	0.515	0.521	0.375
Underidentification test (Kleibergen-Paap rk LM statistic)	60.453	60.453	20.697	23.040	-
Chi-sq(1) P-val	0.000	0.000	0.000	0.000	-
Overidentification test (Hansen J statistic)	Equation exactly	0.026	Equation exactly	0.141	-
Chi-sq(1) P-val	identified	0.871	identified	0.707	-
Instrumented:	CQ^{B}_{ijt}	CQ^{B}_{ijt}	CQ^{B}_{ijt}	CQ^{B}_{ijt}	-
Excluded instruments:	$\%Ch\ Tier1$	$\%Ch\ Tier1$; $\%Ch\ Tier1^2$	$\%Ch\ Tier1$	$\%Ch\ Tier1$; $\%Ch\ Tier1^2$	- -

Panel A



Panel B

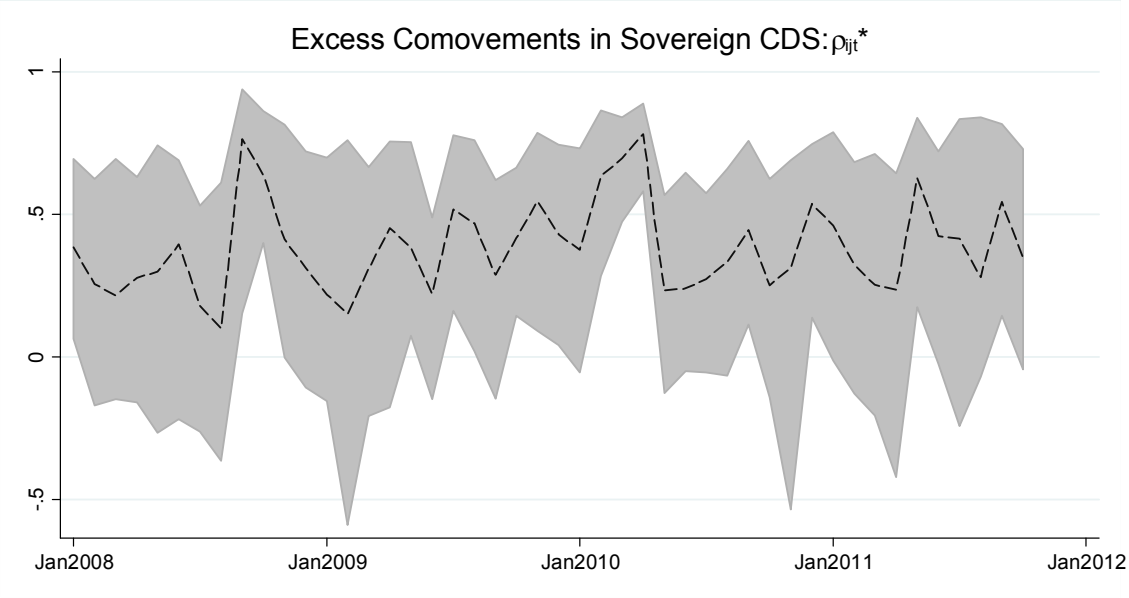


Figure 1: Comovements in Sovereign CDS

This figure depicts two measures of the comovement in sovereign CDS. Panel A reports the monthly correlation of the daily CDS log return (ρ_{ijt}) for the considered 11 EMU countries (i.e., 55 different country-pairs). Panel B reports the monthly correlation of daily sovereign filtered CDS returns (ρ^*_{ijt}) and constitutes our baseline measure of the comovements in sovereign CDS. The charts show the median correlation (dashed line), together with their 5th and 95th percentiles (shaded area) for the period January 2008 to October 2011.

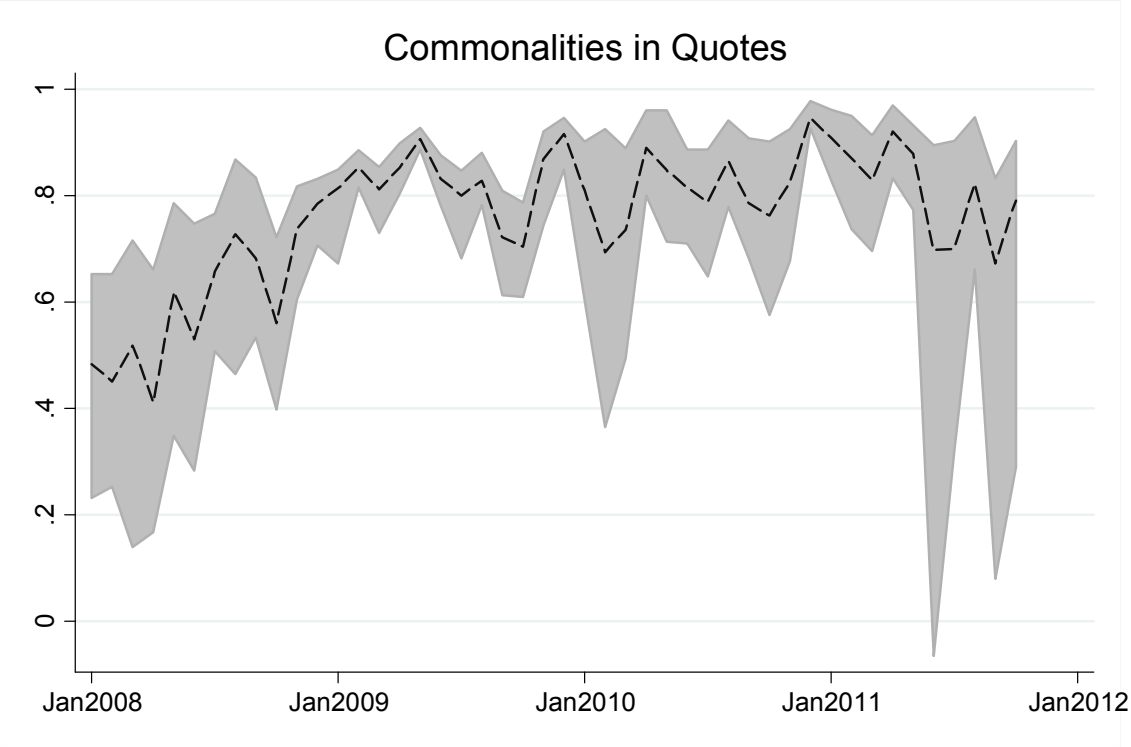


Figure 2: Commonalities in Quotes

This figure depicts the *Commonalities in Quotes* (CQ_{ijt}) obtained as $CQ_{ijt} = \sum_{d=1}^{D_t} \omega_{dt} \text{corr}(NQ_{idt}, NQ_{jdt})$, 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_{ijt} 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 the case that dealer *d* does not report quotes to country *i* on a certain date, we impute a value of zero for that date. The chart shows the median correlation (dashed line), together with their 5th and 95th percentiles (shaded area) for the period January 2008 to October 2011.