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CDS Spreads in European Periphery—Some Technical Issues to Consider

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CDS Spreads in European Periphery - Some Technical Issues to Consider

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Authorized for distribution by Stijn Claessens

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Abstract

This paper looks at some technical issues when using CDS data, and if these are incorporated, the analysis or regression results are likely to benefit. The paper endorses the use of stochastic recovery in CDS models when estimating probability of default (PD) and suggests that stochastic recovery may be a better harbinger of distress signals than fixed recovery. Similarly, PDs derived from CDS data are risk-neutral and may need to be adjusted when extrapolating to real world balance sheet and empirical data (e.g. estimating banks losses, etc). Another technical issue pertains to regressions trying to explain CDS spreads of sovereigns in peripheral Europe—the model specification should be cognizant of the under-collateralization aspects in the overall OTC derivatives market. One of the biggest drivers of CDS spreads in the region has been the CVA teams of the large banks that hedge their exposure stemming from derivative receivables due to non-posting of collateral by many sovereigns (and related entities).

JEL Classification Numbers: F34; G21; G33; G14; G28

Keywords: CDS spreads; peripheral Europe; stochastic recovery rate; probability of default; collateral use in OTC derivatives; cheapest-to-deliver bonds; price of risk

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[1] This paper has benefitted from comments by Stijn Claessens, Pijus Virketis, Saul Doctor, Ben Miller, Ben Heller, James Aitken, Leonard Evans, Darrel Duffie and some others in the markets who wish to remain anonymous.

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I. INTRODUCTION

The credit default swap (CDS) market is unique among all over-the-counter (OTC) derivative products. Although other OTC derivative products also provide some level of hedging, the 'jump risk'— that stems from large price movements in the underlying reference entity— associated with a CDS can be large relative to other OTC derivatives. Thus, the level of losses/gains from the use of CDS contracts can be sizable and can often move markets of the underlying instrument (i.e. the tail wags the dog). Lately, CDS contracts have come under scrutiny by regulators and politicians in the context of the recent sovereign debt crisis. However, they remain mathematically sound instruments that contribute toward 'completing' the markets. This paper will look at some technical issues when using CDS data, and if these are incorporated, the analysis and/or regression results are likely to benefit.

The next section focuses on how default probabilities can be extracted from CDS spreads. Key determinants of CDS spreads are the risk-neutral recovery rate and the probability of default, where the recovery rate and the probability of default are jointly stochastic (by definition). Standard practice in estimating probability of default from CDS spreads assumes a constant recovery value. Using a model with the 'cheapest to deliver' bond (CTD) to proxy stochastic recovery values treats the probability of default as a function of both the CDS spread as well as the recovery value; the other models do not do so and thus pick up the probability of default from the CDS spreads only. We illustrate the importance of doing so for countries in the European periphery.

Section III of this paper highlights the difference between risk-neutral probabilities that are derived from CDS spreads, and the real-world probabilities that stem from empirical data such as Moody's expected default frequencies (EDF). Often times, models use risk-neutral probabilities derived from CDS spreads on real world data (e.g., balance sheet of banks etc) without taking the 'adjustment factor' into consideration. Ignoring this adjustment may lead to higher loss estimates during distress periods. We again take examples from banks in the European periphery to illustrate this.

Section IV highlights under-collateralization aspects in the over-the-counter (OTC) derivatives market that stems from some privileged clients (including sovereigns and related entities) not posting their share of collateral to the large banks when due. As a result, the large 10-15 banks active in the OTC derivatives market need to hedge their exposure to such clients, when the banks are "in-the-money" on their derivative positions. Typically banks buy CDS to hedge such exposure. We illustrate CDS related hedging issues in European periphery due to under-collateralization in the OTC derivatives market. Unlike Section II and III where we have explicit suggestions to improve analysis on CDS data, Section IV provides anecdotal information from market sources that econometricians need to be cognizant of.

We conclude in Section V and suggest that the above issues should be incorporated when making policy inferences using CDS spreads data from the European periphery.

II. Stochastic versus Fixed Recovery Value

Most CDS models assume a constant recovery rate (typically 40%) on reference obligations (e.g., Greece or Société Générale). This means most analysts simply use *changes in CDS spreads* to derive the *implied probability of default.*[2] However, probability of default (PD) and recovery values are (jointly) stochastic and the CDS spread is thus a joint function of *p* and *r*, i.e., $CDS = f(\tilde{p}, \tilde{r})$. Using stochastic recovery values matters especially during periods of distress, when bond prices are well below par. One can proxy the recovery rate by the price of the bond that is 'cheapest to deliver' (CTD) for the reference obligation (Singh, 2003). At the auction, the CDS settlement is always against the principal claim (or the par value).[3] The PD is then the ratio of the CDS spreads to the loss implied in the price of the CTD:

$$PD = \frac{\text{CDS Spread}}{\text{Loss Given Default}}$$

where the 'Loss Given Default' is 1 minus the recovery value. If stochastic, the price of the CTD is used as recovery value. In the constant case, a recovery value of typically 40% is used.

Prior to 2005 when there was a 'credit event' (i.e., when the CDS was triggered), a buyer of a CDS contract would have to physically deliver a bond to get the payment from the CDS seller. The buyer would take the cheapest bond eligible for delivery to maximize her payoff (par minus the bond). This happened in credit events following Argentina, Uruguay etc. *However, post 2005, physical delivery is no longer required.*[4,5] The holder/buyer of the CDS contract will use the 'recovery value,' as determined by the auction process after the credit event has taken place.[6] For basis investors (i.e., those who hedge their bond exposure via CDS), delivery by CTD allows them to maximize their payoff (i.e. par minus CTD).[7] Of

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[2] CDS rate is the mean default arrival rate (hazard rate) times mean expected fractional loss in market value if default were to occur, as discussed in (Duffie and Singleton, 2003; Duffie 1999).

[3] If for legal reasons, the value of bonds is reduced to half, the investor has to deliver twice as much to affect physical settlement.

[4] The first auction was on a CDS index, with the underlying being Collins & Aikman, an auto parts manufacturer. The first single name auction was on Delphi in 2005. The basic premise of the auction was to allow CDS to settle without there being a short squeeze (or the demand for bonds to be physically delivered). In 2009 ISDA moved to mandatory auction settlement.

[5] This can, and has, led to more speculative activity since the buyer of the CDS contract does not have to buy an actual bond and then deliver the bond to get paid at the auction. The increase in speculation may be a reason why the EU has kept its focus on naked CDS ban since last summer. Auctions requiring physical delivery only would have also curbed speculative activity.

[6] In other words, prior to 2005, recovery value was rationally proxied by the CTD bond. Since 2005, due to changes by ISDA, recovery value is unknown until ISDA undertakes the auction generally 30 days after the credit event is announced. So the CDS market is still "alive" after a credit event is announced and 'naked" CDS contracts can still speculate on the final recovery value that is determined at the auction.

[7] Du and Zhu (2011) show that ISDA's CDS auctions may be biased.

course, for those not delivering at the ISDA auction (i.e., they opt for cash settlement), payoff equals par minus "recovery" determined at the ISDA auction which is exogenous and thus uncertain.

Box 1. What are Cheapest-to-deliver bonds?

The choice of CTD bonds is not simple and often reflects legal and other contractual issues that are not common knowledge. For example, most ISDA's (International Swaps and Derivatives Association, the governing body for CDS contracts) CDS contracts for Western European Sovereign require that for bonds to be eligible for delivery maturities cannot be longer than 30 years (this is under the Old Restructuring or "Old R"). However a small portion of Greek—a Western European Sovereign—CDS contracts have the Modified Modified Restructuring clause, which have different delivery terms than the Old R contracts.

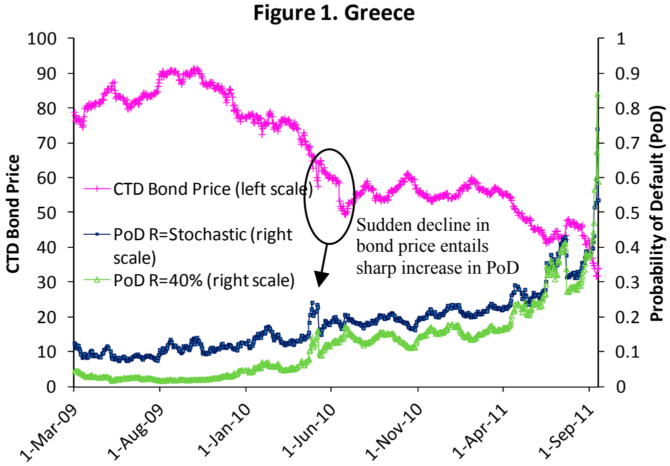
Certain other bonds may also not be delivered in the CDS auction, such as callable bonds, zero-coupon bonds and strips. Floaters and inflation-indexed bonds (also known as inflation-linked bonds or simply linkers) are likely to be deliverable, ignoring the value of "accretion" due to inflation, but accepting initial value if there is deflation. In the context of Argentina's ISDA auction soon after the 2001 default, interest-capitalization bonds (the Argy "18s" and "31s") were initially deemed not eligible for delivery, as the holder would not accrue any interest or principal until 2018 or 2031. These were later (legally) accepted as delivery.

Also, the bonds that can be delivered must be in a delivery currency specified in the contract—typically the G-7 currencies and sometimes, Korean Won and Mexico peso are acceptable. In Uruguay's case, Chilean peso bonds issued by Uruguay in 2002 were not deliverable under ISDA's acceptable currencies.

Considering the above restrictions, the CTD bonds for example are as follows: Greece (2040), Portugal (2037), Spain (2037), and Italy (2026)

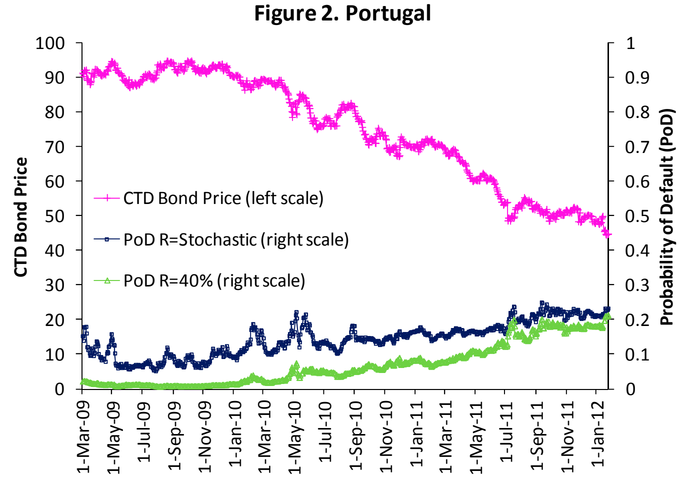
Stochastic versus Fixed Recovery Value

Figure 1. Greece



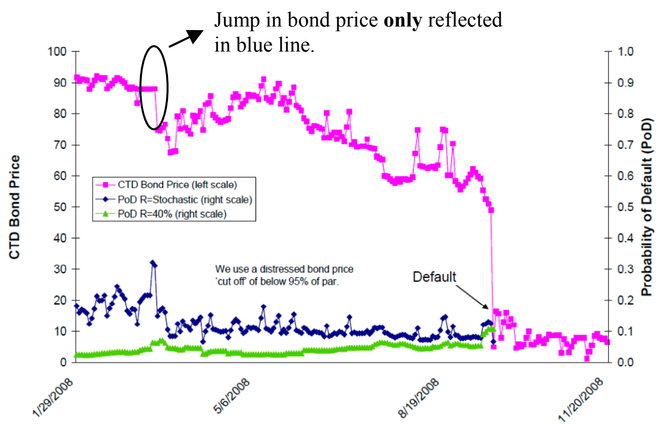
Stochastic versus Fixed Recovery Value

Figure 2. Portugal



Stochastic versus Fixed Recovery Value

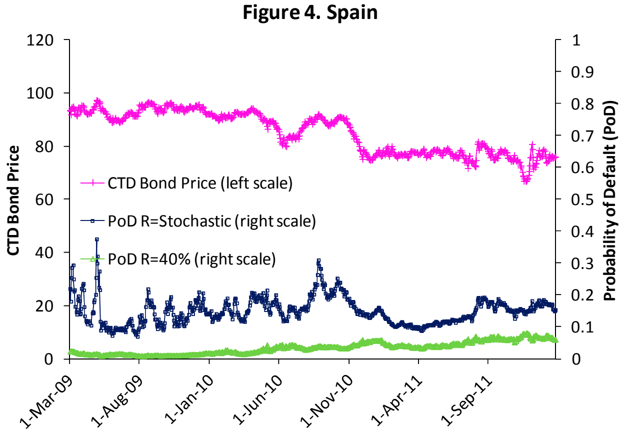
Figure 3. Lehman Brothers



The difference between a fixed and stochastic recovery value matters. For example, if there are abrupt jumps—let's say the EFSF/ESM does not help and a periphery's bond prices "jump" down from say 90 to 60. When jumps happen, our blue line will respond (blue line = PD from stochastic recovery) but the green line will not respond. We show this in Lehman when there was a jump. Greece and Portugal are 'slow moving trains' so there are no abrupt jumps. For illustrative purposes, Figures 4 and 5 show the PDs for Spain and Italy. Although the two PD's derived from stochastic and constant recovery values in Figure 1 to Figure 5 might be perceived as being very close to each other, on closer examination Figure 6 to Figure 9 shows that the difference is actually large.

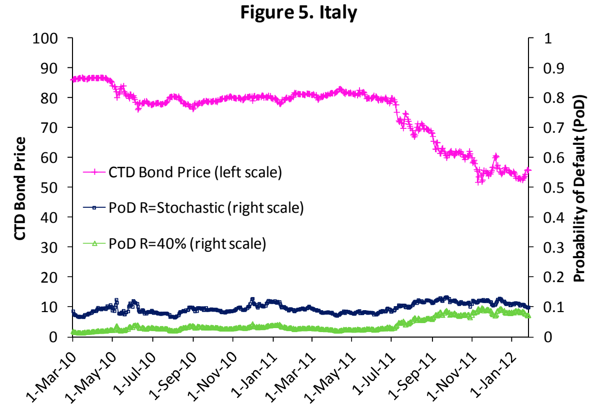
Stochastic versus Fixed Recovery Value

Figure 4. Spain



Stochastic versus Fixed Recovery Value

Figure 5. Italy



Recovery value from CDS vs recovery value from bonds

The need to deviate from the constant recovery values matters even more for financial institutions and sovereigns. Unlike corporations, financial institutions have few tangible assets. Recovery values are therefore generally low for financial institutions, as shown for Lehman (8.6 cents) and Icelandic banks (1 to 2 cents). This makes it even more important to assume a stochastic recovery value and model the probability of default accurately when financial institutions are in distress. Another reason is that the recovery value for CDS is **not** necessarily the same as the recovery value from debt-exchange/debt restructurings. For example the Icelandic banks' restructured debt trades—after the debt exchange—in the mid 20s cents on the dollar. This is because the CDS recovery is determined at the ISDA auction 30 days after the credit event is announced, while typically the debt exchange "recovery" is much later and a function of the tenor (and other variables) of the new debt received via the debt exchange.[8] In summary, models that use CDS data should take into account the stochastic nature of recovery value, especially when bonds are priced well below par during distress.

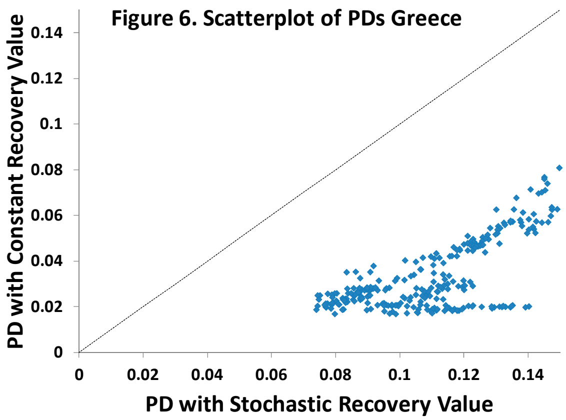


Figure 6. Scatterplot of PDs Greece

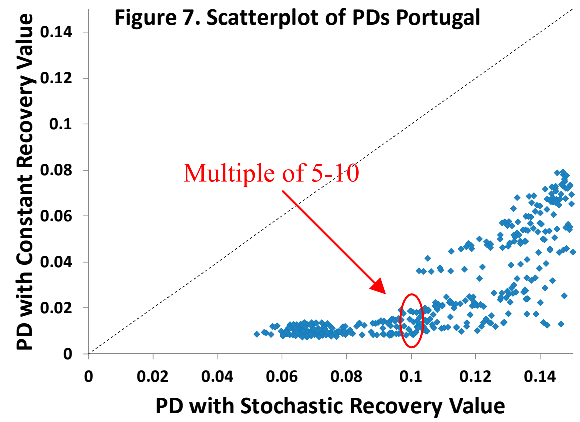


Figure 7. Scatterplot of PDs Portugal

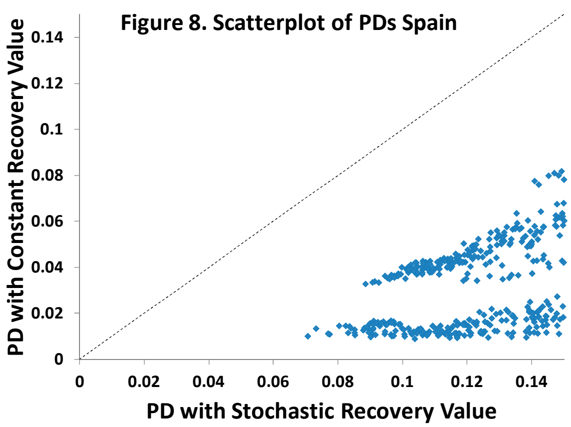


Figure 8. Scatterplot of PDs Spain

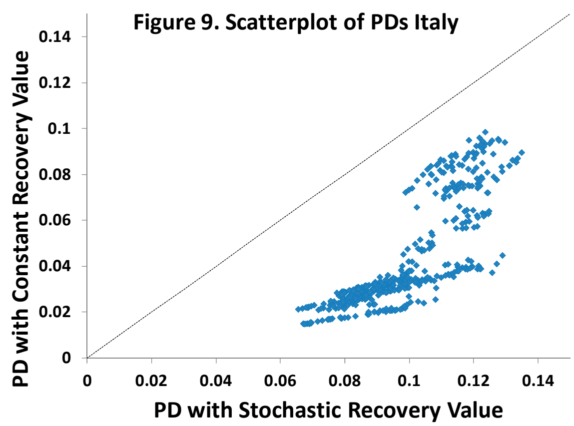


Figure 9. Scatterplot of PDs Italy

III. Real-world versus Risk-neutral probabilities

During the recent financial crisis, the two types of PDs (based on CDS spreads and Moody's expected default frequency, respectively) have differed markedly for large banks, and the resulting loss estimates have also varied significantly. In order to properly identify policies with respect to large banks in distress, a closer review of the key differences arising from the various methods to extract PDs is necessary. Indeed, the difficulties in harmonizing the results of the methodologies discussed need to be spelled out, as they potentially bear an effect on authorities' reactions and subsequent policy advice.

[8] Ex-post default, debt negotiations typically take longer to conclude and thus debt-exchanges have been generally after the ISDA auction for the associated CDS market. Greece has been an exception/aberration to this given the focus on a "voluntary" debt exchange via the PSI (private sector involvement) for well over a year and the uncertainty of the associated CDS market.

These differences start with the underlying market signals used to calculate the PDs. CDS spreads providing signals from debt and/or credit markets—given an assumed level of recovery—have been used to arrive at a PD measure. By design, it is risk neutral because it does not take into account investors' varying degrees of risk aversion. Risk neutrality allows to bypass the need to calibrate a real world measure of investors' utility by assuming that all investors are risk neutral. PDs derived via the risk neutrality assumption are widely accepted when pricing credit instruments or assessing the impact of default risk on a portfolio of assets with similarly priced components.

The Moody's KMV methodology, which accounts for investors' risk aversion by extracting signals from equity markets to arrive at a "real world" measure of risk have also been used to extract PDs. In contrast to risk neutral PDs, which use only market prices as inputs, risk measures based on the real world approach also use balance sheet inputs. It is generally accepted that real world measures provide for a better approximation of investors' risk aversion and are as such better suited to carrying out scenario analysis to calculate potential future losses caused by defaults (see Hull, 2009.) Nevertheless, the nature of the inputs used for real world measures also provide for the potential of missing important market signals (especially during distress).

When using CDS data, there is a risk adjustment factor that is needed to convert risk-neutral probabilities derived via CDS spreads to real-world probabilities. The resulting implication is that during periods of market stress, losses computed from risk neutral PDs may need to be adjusted downward to arrive at the real world probabilities.

The recent literature on this topic converges on the methodology of Amato (2005) that proxies the conversion factor by taking the credit signal or CDS spreads in the numerator, and an equity signal in the denominator (e.g., expected default frequency or EDF from Moody's KMV database).[9] In other words, the risk-neutral probabilities derived via various methodologies using CDS spreads need to be adjusted by a nontrivial factor to determine real-world probabilities derived via EDF. Such adjustment factors for large global banks (or sovereigns) during distress may be sizeable and varies between institutions.

An example of an equity market signal would be taking the Moody's KMV expected default frequency (EDF) as a real world measure. To make the denominator comparable to the numerator (i.e., CDS spreads, which are a function of probability and recovery value), we multiply EDF with the corresponding recovery value metric. This risk adjustment factor is approximately the ratio of the CDS signal to the equity signal.

[9] The BIS Quarterly Review, March 2009, shows that the risk adjustment factor for major global banks during Lehman crisis (2007/2008) had fluctuated from an average of about 4 to 12.

So the risk adjustment factor is given by the following equation:

$$\text{risk adjustment factor} = \frac{CDS}{EDF \cdot (1 - R)}$$

Where R is the recovery value based on empirical loss estimates in the real world and is about 40%; or in other words, LGD or (1-R) is 60%. Intuitively, a risk-neutral investor will want to be "paid more" than a risk-averse investor (which represents the real world). A risk adjustment factor that is higher than one approximates the higher compensation needed in a risk-neutral world relative to the actual (risk-averse) world.

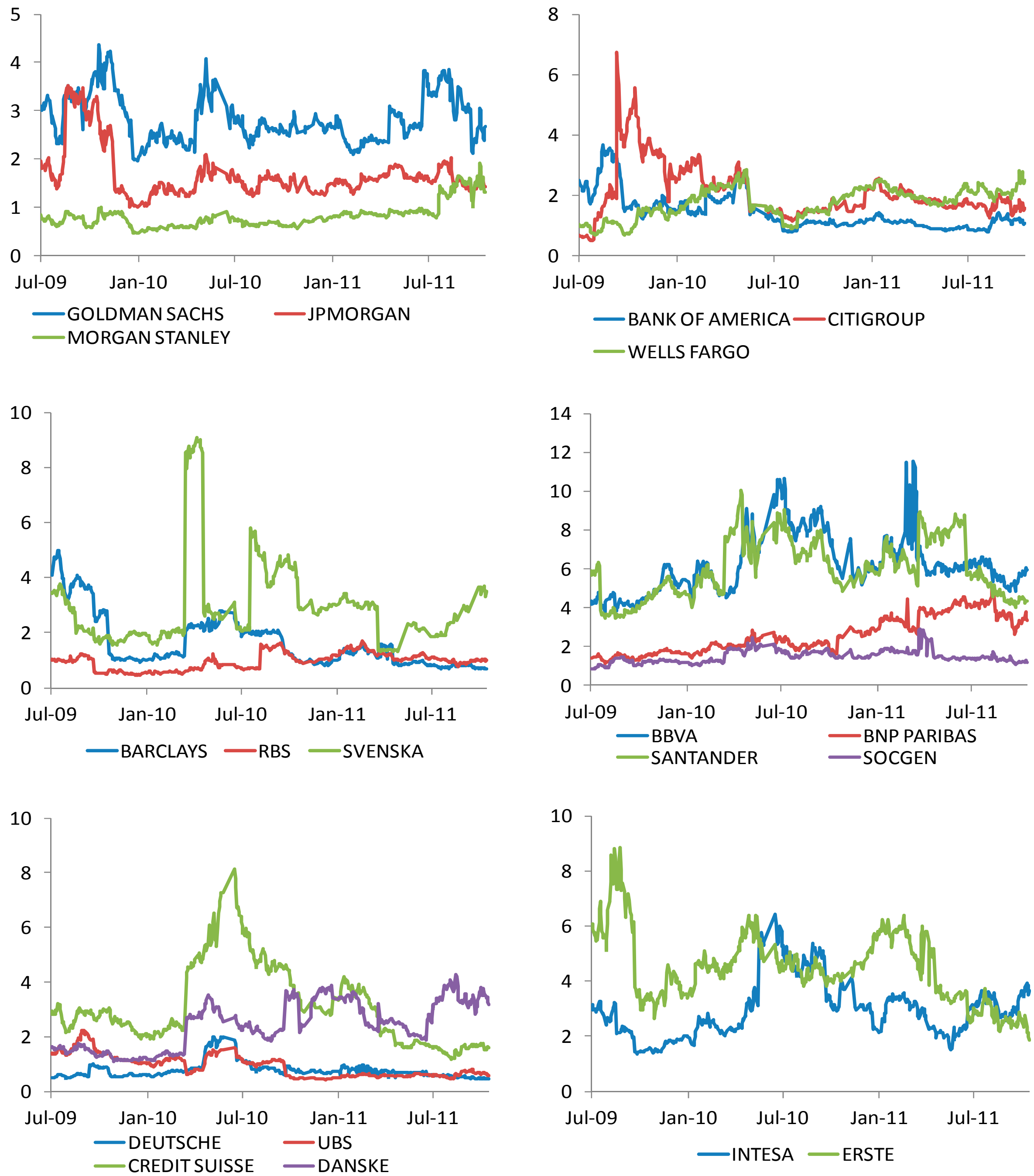
We plot the risk adjustment factor for major banks in the U.S. and Europe. We find that since the summer of 2009 until recently (i.e., October, 2011) the risk adjustment factor for U.S. banks is around 2 and for European banks is around 2.5 as per Figure 10; the risk adjustment is non-trivial. In practice CDS spreads are still applied to balance sheet data and both types of PDs are used interchangeably (which should not be the case).[10] Thus when using CDS data to find banking sector loss estimates, it will be useful to consider this ratio before interpreting loss estimates on actual balance sheet data.[11]

Otherwise, such losses may well be higher than those projected using real world probabilities. Such outsized (and incorrect) loss estimates of one institution may then have ripple effects on estimating losses in other institutions, leading to systemic instability.

[10] See GFSR, September 2011, Chapter 1 Box 1.3

[11] The speech by Herve Hannoun (2011) also highlights the two types of probabilities via Table 1 and Table 7; the two tables are not comparable. http://www.bis.org/speeches/sp111026.htm

Figure 10. Risk Adjustment Factors: CDS / (EDF*(1-R))



IV. CDS SPREADS AND UNDER-COLLATERALIZATION IN THE OTC DERIVATIVES MARKET

Present market practices for those using OTC derivative contracts result in residual derivatives liabilities and derivative assets. By 'residual' we mean after all possible netting has been done within the OTC derivatives book and after the (limited) collateral posted on the contracts has been subtracted (see Annex I). Thus, residual risk captures the shortfall of collateral stemming from clients of large banks not posting their share of collateral to their clients or vice versa. Earlier research finds that the 10-15 largest players in the OTC derivatives market may have about $1.5 to 2.0 trillion in under-collateralization for derivative receivables and a similar amount of derivative payables (BIS, 2011; Singh, 2010). Such residual liabilities and assets exist because client's of large banks, sovereigns (and related entities), AAA insurers/pension funds, large corporates, multilateral institutions (e.g., EBRD), Fannie Freddie, and the "Berkshire Hathaway" types of firms do not post their full share of collateral. They are viewed by large banks as privileged and (presumably) safe clients.

From a risk management angle, large banks' credit valuation adjustment (CVA) teams need to hedge their 'in the money' positions, or derivative receivables, when there is a likelihood that these positions may not be paid in full.[12] For example, hedging derivative receivables due from a sovereign pushes up the CDS spreads on the sovereign, as seen in peripheral Europe in the past year or so. This in turn may impact the sovereign's debt issuance costs (since CDS spreads impact the spreads of the underlying bonds).

Typically, the "street" or the large 10-15 dealers active in the OTC derivative market are often on the same side of a trade (i.e., a few of them may hold similar positions when dealing with a sovereign). For example, several market sources indicate that the street is "in-the-money" on interest rate swap positions that have been written since early 2000s. Most dealers took the floating rate leg of an IRS (interest rate swap, an OTC derivative), and the sovereign typically took the fixed leg. As rates have remained low since the 2008 crisis (and are likely to remain low), many of the IRS positions are now sizable derivative "receivables" on the books of the banks since sovereigns typically do not post collateral to the large banks and settle at maturity (and IRS can typically be 30 years in tenor).

Thus the demand for hedging such growing receivables leads to a rise in CDS spreads of the underlying sovereign that is "out of the money". Market sources indicate that between 25%-40% of a large dealers' receivables that need to be hedged may stem from sovereign (or related entities) exposures; an equal fraction is from corporate clients[13]. *Thus, addressing the under-collateralization issues is important to understanding the CDS spreads in peripheral Europe*.

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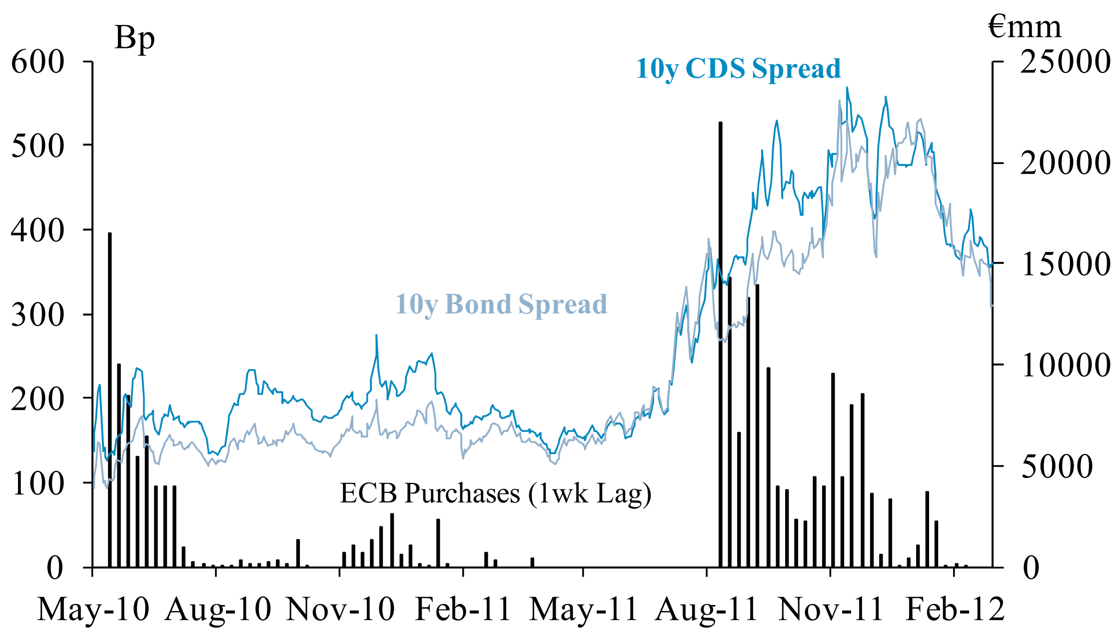
[12] CVA teams largely use CDS to hedge their OTC derivatives books. However, Basel III's recommendations for capital relief will recognize a hedge only via CDS (i.e., other forms of hedges will not be recognized by Basel III).

[13] The sovereigns' related entities include quasi sovereign, debt management office, municipalities etc.

Here are two examples that are again difficult to pick up in regressions that try to explain CDS spreads in the periphery. The no-arbitrage relationship between CDS and the bond market is important but recently there have been actions that have unbundled the *basis* (i.e. the difference between CDS spreads and bond spreads). Although CDS spreads are in theory priced off the underlying bond, often times the "tail wags the dog". Technical issues can affect the basis (such as squeeze, short cover, one-sided trades, etc). Thus changes in basis can affect CDS spreads due to the no arbitrage condition.

1. The secondary market purchases (SMP) program buys bonds (not CDS). Figure 11 shows that whenever the ECB was active, the basis widened since SMP reduces bond spreads *only and does not impact CDS.*

Figure 11. Total SMP Purchases and Change in Basis for a peripheral sovereign



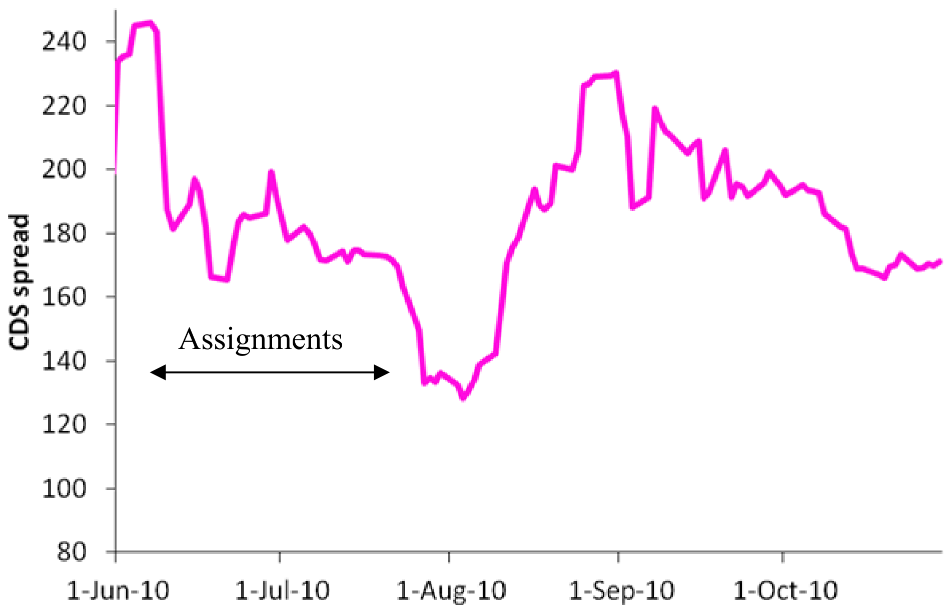
Source: JP Morgan

2. In recent years, market sources indicate that Treasury of peripheral sovereign(s) have occasionally been active in the OTC derivatives market to reduce its CDS spreads (by *assignment* of OTC derivatives contracts from large global banks to the sovereign's local banks).[14] The Treasury requests large banks active in OTC derivatives market not to hedge their exposure to the sovereign since it led to an increase in the CDS spreads of the sovereign (Figure 12 and Annex II). So by an *assignment*, the original derivatives contract is reassigned from the large global bank to the periphery's local bank (or another domestic entity) at the

[14] It is difficult to turn down request from one of your biggest derivative clients.

request of the Treasury, but the out-of-the-money positions of the Treasury are not due till maturity of the contract. *Novation* would entail a 'tear up' of the original contract, and the Treasury would have to 'settle' the out-of the-money positions and pay the accrued balance up to the date of the novation at the time of novation.[15]

Figure 12. 5 year CDS spread for a European Peripheral



Source: Bloomberg

Thus, understanding the overall OTC derivative portfolio at banks is paramount to explaining the CDS spreads in the region. As long as all clients of large banks do not post their fair share of collateral (i.e. initial margin and variation margin), banks will continue to hedge their exposure on OTC derivatives where they are "in the money". In the context of peripheral Europe, it is unlikely in a collateral constraint environment that this will change. In fact, the regulatory proposals that will move OTC derivatives to centralized counterparties (CCPs) *exempt* sovereigns from posting collateral (Oliver Wyman, 2011; Singh 2011). Thus, in order

[15] CDS volatility on peripheral Europe has been on the rise since Greece came to the fore front in 2009. This has had material impact on the books of large banks active in the OTC derivatives market. For example, Morgan Stanley 2011 financial statements states, "On December 22, 2011, the Company executed certain derivative restructuring amendments which settled on January 3, 2012. Upon settlement of the amendments, the exposure before hedges and net exposure for Italy decreased to $2.887bn [from $6.268bn] and $1.522bn [from $4.901bn], respectively, and the exposure before hedges and net exposure for Peripherals decreased to $5.044bn [from $8.425bn] and $3.056bn [from $6.435bn], respectively." Note that before the trade, Morgan Stanley's net counterparty exposure to the Italian sovereign (i.e., repurchase transactions, securities lending and OTC derivatives) taking into consideration legally enforceable master netting agreements and collateral, was as much as $4.2bn, in addition to $689m in exposure to Italian non-sovereigns (via *www.totalderivatives.com*).

to explain CDS spreads in the sovereign context, regressions will remain misspecified unless they include the collateral (or under-collateral) elements that drive the CDS spreads.[16] Unlike Section II and III where we have explicit suggestions to improve analysis on CDS data, this section provides anecdotal information from market sources that econometricians need to be cognizant of omitted variables in their regressions. However we do not (yet) have a metric for such omitted variable due to the confidential nature of this data.

V. Conclusion

This paper looks at some technical issues when using CDS data, and if these are incorporated, the analysis or regression results are likely to benefit. The paper endorses the use of stochastic recovery in CDS models when estimating probability of default (PD) and suggests that stochastic recovery may be a better harbinger of distress signals than fixed recovery. Similarly, PDs derived from CDS data are risk-neutral and may need to be adjusted when extrapolating to real world balance sheet and empirical data (e.g. estimating banks losses etc). Analysis or regressions trying to explain CDS spreads for sovereigns in peripheral Europe need to be cognizant of the under-collateralization aspects in the overall OTC derivatives market. One of the biggest drivers of CDS spreads in the region has been the CVA teams of the large banks that hedge their exposure stemming from derivative receivables due to non-posting of collateral by many sovereigns (and related entities).

[16] Incorrectly leaving out one or more important independent variables leads to omitted-variable bias.

ANNEX 1. RESIDUAL DERIVATIVE RECEIVABLES AT A LARGE BANK'S FINANCIAL STATEMENT

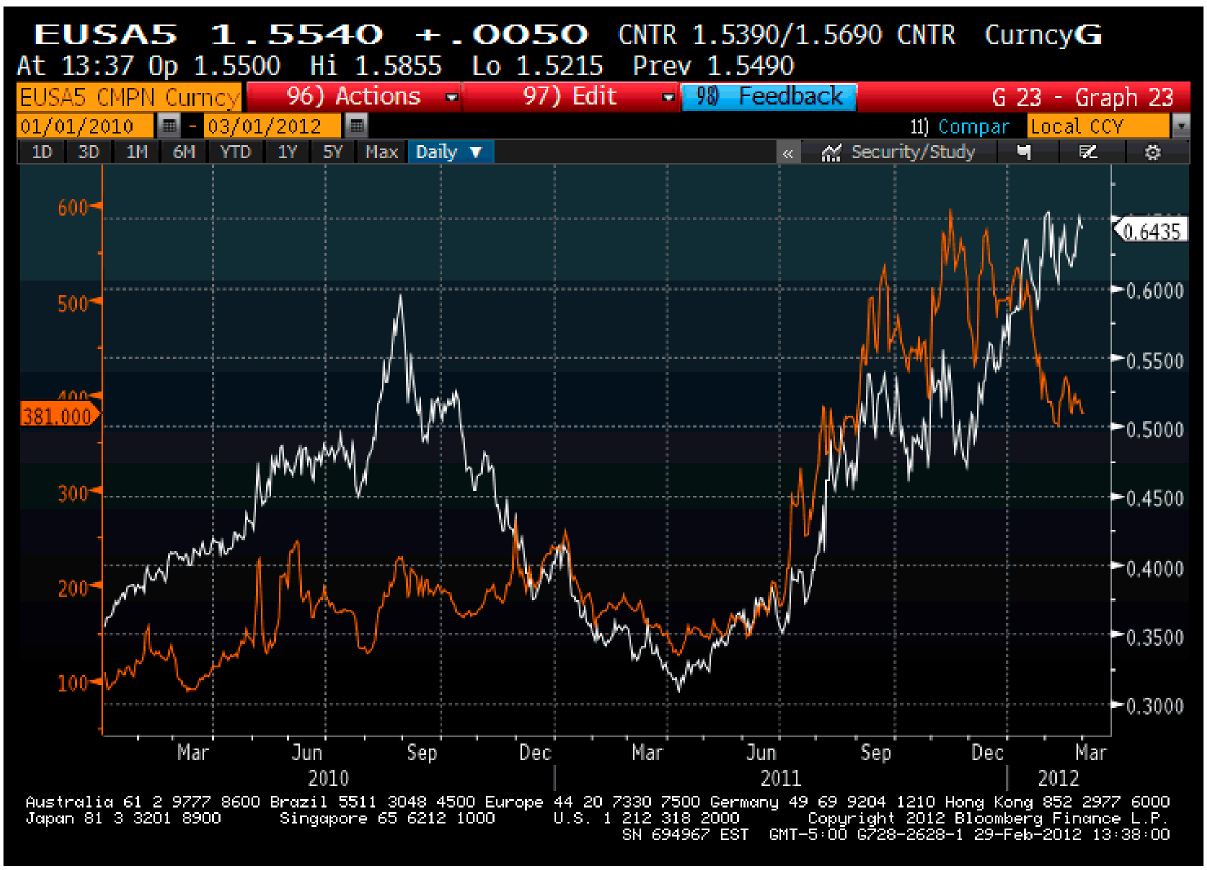
	March 2009	
	Derivative Assets	Derivative Liabilities
	(in millions)	
Derivative contracts for trading activities		
Interest rates	$ 1,171,827	$ 1,120,430
Credit	469,118	427,020
Currencies	92,846	85,612
Commodities	80,275	77,327
Equities	100,291	92,612
Subtotal	$ 1,914,357	$ 1,803,001
Derivative contracts accounted for as hedges under SFAS No. 133		
Interest rates	$ 24,347	$ 1
Currencies	50	31
Subtotal	$ 24,397	$ 32
Gross fair value of derivative contracts	$ 1,938,754	$ 1,803,033
Counterparty netting	(1,685,348)	(1,685,348)
Cash collateral netting	(149,081)	(27,065)
Fair value included in "Trading assets, at fair value"	$ 104,325	
Fair value included in "Trading liabilities, at fair value"		$ 90,620

Residual derivative assets

ANNEX II. 5 YEAR CDS AND EURO INTEREST RATE SWAP CURVES

Most derivatives with large banks active in OTC derivatives market are interest rate swaps (IRS). When rates fall, the swaps go "in-the-money" for the banks, and they have to hedge by buying CDS. For money-center large banks that have exposure to European periphery's corps or banks, they are likely to hedge with CDS. The causality is from IRS to CDS. Also, when periphery is in trouble, there is general risk aversion. This leads to lower EUR swap curve, as bund yields fall (dragging swaps lower) and it looks like European growth could get hit hard and maybe ECB will have to stay lower for longer. Causality is from CDS curve to the Euro swap curve.

Below is the correlation of 5 year US dollar CDS of a peripheral sovereign and the Euro generic interest rate swap curve (inverted). Ignoring such correlation in regressions will lead to misspecified analysis of CDS spreads in European periphery.



References

Amato, Jeffrey, 2005, "Risk Aversion and Risk Premia in the CDS Market," *Bank for International Settlements, Quarterly Review* (December), pp. 55–68.

Bank for International Settlements, 2011, "Semiannual OTC Derivative Statistics at end June 2011," November, Table 1.

Du, Songzi, and Haoxiang Zhu, 2011, "Are CDS Auctions Biased?" working paper, Stanford GSB.

Duffie, Darrell, 1999, "Credit Swap Valuation," *Financial Analyst Journal*, January-February, Vol. 55, No. 1, pp. 73–87.

Duffie, Darrell, and Kenneth Singleton, 2003, "Modeling Term Structures of Defaultable Bonds," *Review of Financial Studies*, No. 12, pp. 687–720.

Global Financial Stability Report, 2011, International Monetary Fund, (September).

Hull, John, 2009, "The Credit Crunch of 2007: What Went Wrong? Why? What Lessons Can Be Learned?" *Journal of Credit Risk* (May).

Moody's, 2007, "EDF™ 8.0 Model Enhancements."

Oliver Wyman, 2011, "The Future of Capital Markets Infrastructure," February.

Singh, Manmohan, 2003, "A New Methodology to Proxy Recovery Value in CDS contracts," IMF Working Paper No. 03/242.

Singh, Manmohan, and Carolyn Spackman, 2009, "The Use (and Abuse) of CDS Spreads during Distress," IMF Working Paper No.09/62.

———, 2010, "Collateral, Netting and Systemic Risk in the OTC Derivatives Market," IMF Working Paper No. 10/99.

———, and Karim Youssef, 2010, "Price of Risk – Recent Evidence from Large Financials," IMF Working Paper No.10/190.

———, 2011, "Making OTC Derivatives Safe—A Fresh Look," IMF Working Paper No.11/66.