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Crash risk of the euro in the sovereign debt crisis of 2009–2010

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ABSTRACT

The economic-political instability of a country, which is tied to its credit risk, often leads to sharp depreciation and heightened volatility in its currency. This paper shows that not only the creditworthiness of the euro-area countries with weaker fiscal positions but also that of the member countries with more sound fiscal positions are important determinants of the deep out-of-the-money euro put option prices, which embedded information on the euro crash risk during the sovereign debt crisis of 2009–2010. We also find evidence of information flow from the sovereign credit default swap market to the currency option market during the crisis.

1. Introduction

Crash risk of currencies has long been the subject of interest in international finance. Related studies, including those of Eichengreen et al. (1996), Frankel and Rose (1996), Kaminsky et al. (1998), and Kumar et al. (2003), use macro-economic indicators to estimate the probability of currency crashes. These studies focus on developing economies in which currency crashes are linked to their abilities to defend the currencies reflected by country-specific macro-economic variables, such as output growth, foreign exchange reserves, budget deficit, real effective exchange rate deviation, and foreign direct investment.[1] Empirical findings suggest that the strength of a currency is positively related to its economic-political stability. Increased country risk due to economic-political instability would lead investors to sell securities denominated in the country's currency and to repatriate funds, hence putting downward pressure on the currency.

The economic-political instability of a country, which is tied closely to its credit risk, often leads to depreciation and heightened volatility in its currency. Changes in the credit risk of a sovereign borrower anticipated by financial markets should be reflected in its sovereign credit default swap (CDS) spread, which is a direct measure of creditworthiness of the underlying issuer (e.g., the use of the measure in Pan and Singleton, 2008).[2] A sovereign CDS is an over-the-counter (OTC) credit protection contract in which a protection seller pays compensation to a protection buyer to make a contingent payment in the case of a pre-defined credit event. For credit protection buyers who pay a fixed fee called CDS spread, the CDS market offers the opportunity to reduce credit risk. For protection sellers, it offers the opportunity to take credit exposure and earn income without having to fund the position. Similar to CDS spreads, anticipated changes in the realised volatility of currency returns are reflected in the prices of currency options. Carr and Wu (2007) investigate the relationship between currency option-implied volatilities and sovereign creditworthiness for Mexico and Brazil from 2002 to 2005. They find that the level and skew of the option-implied volatility display significant co-movement with the sovereign CDS spreads of the two countries. This suggests that the currency option market has consistently set prices considering the probability of a currency crash triggered by a corresponding sovereign default of the two countries.

While previous studies on currency crashes focused on developing countries, the onset of the European sovereign debt crisis in

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[1] Currency crashes also occur in developed economies. In the early 1990s, the meltdown of the European Monetary System (EMS) led to 8% and 14% devaluations of the British pound and Italian lira when the two currencies were forced to leave the EMS. Another recent example is the dollar-yen crash in early October 1998 when the yen fell sharply by 10% in one trading day.

[2] The sovereign CDS market expanded rapidly in 2009 and 2010. The gross notion of protection is around US$2 trillion as of 2010. See the IMF's Global Financial Stability Report (Meeting New Challenges to Stability and Building a Safer System, April 2010).

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late 2009 called into question the grand experiment of pooling 16 countries into a monetary union. After the new Greek government took office in October 2009, the size of the deficit was revealed to be at 12.7% of the GDP in 2009, with public debts projected to rise to 135% of the GDP by 2011. Greece's problems have laid bare the dangers of divergent fiscal policies in the euro area. Such dangers may induce economic-political events (e.g., substantial restructuring or even default of sovereign debt) and may also cause contagion to the other four members with weaker fiscal positions, namely, Portugal, Italy, Ireland, and Spain.[3] As most euro zone countries have both been creditors and debtors, any default in a country essentially causes a chain reaction among its neighbourhood. The resulting credit risk contagion is detrimental to their banks' loan portfolios and affects the stability of the European banking system.[4] When the debt crisis worsened in the first quarter of 2010, the CDS spreads of these five debt-laden European economies notably rose. Greece's CDS spread increased the most, once surpassing 900 basis points (bps) for the 5-year CDS and closed at 760 bps on April 28, 2010. As concerns spread, the euro also fell sharply by about 19% as of April 2010 since November 2009 (see Fig. 2 below).

This paper studies how the creditworthiness of euro-area countries affects market expectations on the stability of the euro. From the dollar-euro currency option prices and the sovereign CDS spreads of the euro-area countries from January 2006 to April 2010, we find an intriguing pattern of "correlation skew": the correlation between the option-implied volatility and sovereign CDS spreads increases monotonically as the strike prices of the options move from in-the-moneyness to out-of-the-moneyness.[5] This implies that the out-of-the-money put options on the euro, which protect investor against the currency depreciation, are very sensitive to sovereign credit risk in the euro area. In view of this finding, first we study the information transmission between the sovereign CDS and currency option markets to examine whether currency option prices anticipate information of sovereign credit risk from CDS spreads. Secondly, we investigate whether sovereign credit risk is an important determinant of deep out-of-the-money put options, after controlling for global risk appetite, funding liquidity constraint, and macro-financial condition.

This paper is related to recent literature on interconnectivity among the corporate CDS, stock and stock option markets. Acharya and Johnson (2007) find that there is incremental information flow from the corporate CDS market to the stock market. They find that the corporate CDS market leads the stock market to anticipating adverse credit information of the reference firm and this finding is linked to informed-trading in credit derivatives. Cremers et al. (2008) show that the implied volatility skews of individual stock options explain a large part of time-series and cross-sectional variations in corporate yield spreads. Cao et al. (2010) document that implied volatility of deep out-of-the-money put options, which depicts the negative tail of the risk-neutral probability of stock returns, is closely related to corporate CDS spreads – because the options provide investors with similar protections against downside risk. They conclude that stock options play an important role in the price discovery process for firms' credit risk.

A number of recent studies on currency crashes use information on currency option prices. Brunnermeier et al. (2009) document that carry traders are subject to crash risk. Therefore, exchange rate movements between high-interest-rate and low-interest-rate currencies are negatively-skewed. The price of currency crash risk is reflected by the price of the risk reversal, which measures the implied volatility difference between an out-of-the-money call and an out-of-the-money put at the same (absolute) delta. Farhi et al. (2009) propose a disaster-based structural model in which investors incorporate a currency crash risk premium into the value of the exchange rate, and calibrate the crash probability to option prices. Jurek (2009) derives a measure of crash risk from currency options and finds that exposure to a currency crash can be used to explain a significant portion of carry trade returns. However, these studies do not incorporate sovereign credit risk into their analyses and modelling frameworks of exchange rate movements.

This paper is structured as follows. Section 2 discusses the data and descriptive statistics. Section 3 examines the information transmission between the sovereign CDS market for euro-area countries and the dollar-euro currency option market. Section 4 studies the contemporaneous interaction between the sovereign CDS and currency option markets based on an econometric analysis. Section 5 contains the conclusion.

2. Data description

We obtain daily OTC European-style dollar-euro option prices at six fixed maturities of 1, 2, 3, 6, 9, and 12 months across five different strike prices from January 2, 2006 to April 30, 2010.[6] The option prices with different strike prices are quoted using the Black–Scholes implied volatilities in terms of at-the-money straddle, 10- and 25-delta risk reversals, and 10- and 25-delta butterfly spreads. As option dealers only use the Black–Scholes formulas to convert quoted volatilities to option prices, the assumptions of constant parameters in the Black–Scholes model are not inconsistent with the use of different implied volatilities at different strikes in our analysis (see Carr and Wu, 2007). A risk reversal is a directional option strategy that takes the view of the skewness of the exchange rate distribution by simultaneously buying an out-of-the-money call and selling an out-of-the-money put. A butterfly spread is a non-directional trading strategy consisted of holding an out-of-the-money call and an out-of-the-money put in which investors are benefited from a large swing in the exchange rate.[7] The Black–Scholes delta provides a normalised measure of option moneyness where the delta of a European option increases monotonically from 0 to 100, with the moneyness moving from out-of-the-money to in-the-money. We convert the total 30 market quotes of option prices on each trading day into implied volatilities of dollar-euro put options at five different strikes from 10-delta to 90-delta. The Appendix A presents the details of the conversion.

We collect the 5-year sovereign CDS spreads of 11 countries in the euro area, namely, Austria, Belgium, Finland, France, Germany,

[3] Although the Greek economy accounts for only about 3% of the euro-area GDP, Italy and Spain are the third and fourth largest economies in the euro area, respectively.

[4] While Greece accounts for only 1.4% of foreign claims in European banks, economies such as Portugal, Ireland, Italy, and Spain, which have had similar fiscal problems as a whole, accounted for 15.4% in September 2009. The figures are from the Bank for International Settlements (BIS). European banks refer to domestically owned banks of Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and the UK.

[5] A dollar-euro put (call) option here is a European option of selling (buying) euro at the contractual option strike price in an exchange of US dollars at the option maturity.

[6] The option data are from JPMorgan Chase. According to the BIS, the notional amounts outstanding of currency options on the US dollar and euro were US$7540 billion and US$3289 billion respectively at the end of 2009. The daily average turnover of currency options was about US$207 billion in April 2010, and the dollar-euro pair contributed about 28% of the global foreign exchange market turnover. See BIS, *Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity in April 2010*, and *BIS Quarterly Review*, September 2010.

[7] A risk reversal measures the difference between the implied volatilities of an out-of-the-money call and an out-of-the-money put. A positive (negative) risk reversal implies that the risk-neutral exchange rate distribution is positively (negatively) skewed. A butterfly spread measures the difference between the averaged implied volatility of two out-of-the-money options (a call and put) and the implied volatility of an at-the-money option. A positive butterfly spread implies that the exchange rate distribution displays a fatter tail than a lognormal distribution.