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The Impacts of Sovereign Credit Ratings on Exchange Rates

— **Evidence from Eurozone Sovereign Debt Crisis**

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ABSTRACT

This paper examines the impacts of Eurozone sovereign credit rating announcements by three leading rating agencies on exchange rates from January 1, 2009 to March 31, 2011. Firstly we report the mean and volatility of USD/EUR in response to Eurozone sovereign rating news. Secondly, thanks to the high integration in Europe, we extend our analysis to the movement of USD/SEK in order to see how non-Eurozone countries, such as Sweden, are affected by Eurozone sovereign rating news. Furthermore, we exclude the sovereign rating news concerning some small Eurozone countries during this period to observe any different results. We conclude that sovereign rating announcements greatly affect the volatility rather than the mean of USD/EUR. It is noteworthy that markets only react to the news of review concerning large economies and tend to ignore those about small economies. Markets will be adjusted when the real rating actions concerning small economies happen. In addition, Eurozone sovereign rating news only slightly influences the mean of USD/SEK, which implies non-Eurozone countries, such as Sweden, are somewhat indirectly affected by Eurozone sovereign debt crisis.

Keywords: Sovereign credit rating, Exchange rate, Eurozone sovereign debt crisis

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1. Introduction

The ongoing Eurozone financial crisis brings rating agencies into spotlight again. Since January 2009, Standard&Poor's (thereafter S&P) downgraded Greece, Spain, and Portugal, and the Eurozone sovereign debt crisis came to draw the world's attention. In December 2009, S&P downgraded Greece to BBB+ and adjusted the outlooks for Portugal and Spain from "Stable" to "negative". Meanwhile, Moody's Investors Service (thereafter Moody's) and Fitch rating (thereafter Fitch) downgraded Greece as well. The announcements by these leading rating agencies aroused the turmoil in European financial markets, which is considered as the outbreak of Greek sovereign debt crisis. In April 2010, Greece, Portugal and Spain were further downgraded by S&P, Moody's and Fitch. Greece was even cut to BB+ by S&P, the junk status. This triggered panic throughout Eurozone countries and even the whole world, which provoked high fluctuations in stock markets, bond markets and foreign currency markets. There was widespread anxiety among participants in financial markets that the crisis would ripple to other Eurozone countries.

Based on the mass of media reports, the rating agencies are perceived as highly influential in the financial system. Their announcements can affect all-level players in the financial markets, from listed companies to sovereign states. What's more, in face of sovereign rating changes assigned by the authoritative rating agencies, the officials of the country in question will comment on the rating changes in response. Especially in the current Eurozone sovereign debt crisis, the officials of European Commission have criticized the rating agencies many times. They blamed rating agencies for the irresponsible and inappropriate downgrades, which they thought exacerbated the Eurozone financial crisis. For example, in June 2010, right after Moody's downgraded the sovereign debt rating for Greece to Ba1, the junk status, Olli Rehn, the European Union Commissioner for Economic Affairs, said the rating change was both "surprising" and "unfortunate" and "again raises issues related to the role of credit rating agencies in the financial system". Nikos Chountis, one member of European Parliament, also harshly criticized rating agencies, "With the outbreak of the crisis, the EU recognized the negative role played by rating agencies, so one would expect to restrict the role of CRAs in

some way.”¹

Whereas, on contrary to the prevalent perception of rating agencies’ super influence, the impacts of sovereign credit rating announcements issued by the leading rating agencies are highly controversial from the perspective of scholars. There are the bulk of academic researches devoted to the relationship between rating agencies and the financial system. There is no agreement on how the sovereign rating changes can affect the financial markets, e.g. the downgrades will increase the borrowing cost for one country, cut down the national or even global stock market indices or make the currency depreciate. Some scholars argue that rating agencies lag rather than lead the financial markets so as to behave pro-cyclically which facilitates the vicious economic cycle. Some scholars conclude that sovereign rating announcements contain some information unavailable from other resources, which lead to fluctuations in financial markets in response. Others find very weak or even no significant impact of sovereign rating news on the financial system.

In light of the disputes around the role played by rating agencies, we try to examine the impacts of rating agencies on the Eurozone financial crisis in this paper. Our study will focus on the variation of the exchange rate in response to the sovereign rating news of Eurozone countries, i.e. the fluctuation of USD/EUR, from January 1, 2009 to March 31, 2011. Furthermore, the high degree of integration in Europe is not restricted within the Eurozone. The non-Eurozone European countries are highly connected as well. This incomparable integration leads to one question: Is there any indirect influence on non-Eurozone European countries? Therefore, we will expand our analysis to USD/SEK to see whether Sweden is indirectly affected by the sovereign rating news of Eurozone countries. To our knowledge, this kind of indirect influence of rating agencies has rarely been examined in previous studies. One reason that why we choose US dollar as the standard and Swedish Kronor as the comparison is that both countries did not receive any sovereign rating changes during this period. This stability enables us to concentrate on the influence brought by Eurozone countries’ sovereign rating announcements.

¹ <http://www.theparliament.com/latest-news/article/newsarticle/eu-parliament-hits-out-at-immoral-credit-ratings-agencies/>

Our main findings are that sovereign rating announcements greatly affect the volatility rather than the mean of USD/EUR. This is in line with the findings of some other authors. It is noteworthy that markets only react to the news of review concerning large economies and tend to ignore those about small economies. News of review has the dominant effect. That is, the markets react to “possible actions” rather than “real actions” concerning large economies, which we believe attributes to the market expectations. Markets will be adjusted when the real rating actions concerning small economies happen. In addition, Eurozone sovereign rating news only slightly influences the mean of USD/SEK and its effect on the volatility of USD/SEK is not that consistent. This implies that non-Eurozone countries, such as Sweden, are somewhat indirectly affected by Eurozone sovereign debt crisis.

The remainder of our thesis is organized as follows. Section 2 discusses previous researches on the controversial impacts of sovereign credit ratings on the financial system. Section 3 firstly deliberates various methods applied by other authors and then describes our methodology. Section 4 presents the data and some basic data analyses. Section 5 reports the regression results and interpretation. Section 6 provides our conclusion.

2. The Controversial Impacts of Sovereign Credit Ratings

In this section we mainly discuss previous researches on the impacts of sovereign credit ratings on the financial markets. Firstly, we point out three most important channels via which sovereign rating events may cast influence on financial markets. Secondly, we present controversial empirical evidences of sovereign ratings’ impact. Different authors have reached various conclusions concerning this issue. Then we will also discuss the literature related to the spillover effect of sovereign rating announcements, which is beneficial to our analysis of the indirect impacts of Eurozone sovereign debt crisis on non-Eurozone countries such as Sweden. Last but not the least, we briefly summarize some other researches on the exchange rates and news effect.

2.1 How May Sovereign Credit Ratings Affect the Markets?

Similar to other credit ratings, such as ratings for company bonds or municipal bonds, sovereign credit rating is the estimation of the possibility that a sovereign state will default on its obligations, which not only considers the country's ability to repay, but also the willingness to repay (Eaton, Gersovitz and Stiglitz, 1986; Lee, 1993). The sovereign rating changes may affect the financial markets through various channels, amongst which we consider the most influential three channels as follows.

First of all, many financial intermediaries, such as institutional investors, pension funds or banks, are restricted by certain investment mandates to be away from non-investment-grade or junk-status financial products. Basel Accord II² also sets some minimum credit rating requirements for commercial banks' investment to control risks (Reisen and Maltzan, 1998; Reisen, 2003; Ferri, Liu, & Majnoni, 2001). In face of credit rating changes, they may have to adjust their portfolios. For instance, after S&P downgraded Greece to junk status in April 2010, the Greek government bonds were ineligible for collaterals for rescue loans from European Central Bank (ECB) according to previous rules. This would cut the most important financing source for the country, which might worsen the situation. ECB had to emergently suspend its minimum credit rating threshold for Greece in response.³

Additionally, sovereign ratings affect not only the government bond yields that are vital for the national financing, but also private borrowers or listed companies of the same nationality. These assessments are considered as the credit ceiling for one country (Reisen and Maltzan, 1999; Kaminsky and Schmukler, 2002). In general no private borrowers or listed companies will be assigned a rating higher than their country's sovereign rating. Borensztein, Cowan and Valenzuela (2007) find that although "sovereign rating" has been nominally gradually abolished, in fact sovereign ratings still affect private ratings largely. Especially in developing countries, sovereign risks are highly weighed in private borrow and firm ratings (Ferri and

² Basel Accord III rules text was published on December 16, 2010. It is planned that major G-20 financial centers implement Basel III Capital Framework by the end of 2011.

³<http://en.mercopress.com/2010/05/04/european-central-bank-beefs-greek-rescue-plan-takes-junk-bonds-as-collatera>

Liu, 2003). As such, sovereign ratings have notably influence on participants of the same nationality in financial markets.

Another way that sovereign ratings may cast influence on the financial system is that these announcements may induce or reinforce herd behavior among market participants, if these ratings are believed to have revealed some publicly unavailable information. If sovereign credit ratings are forward-looking and succeed in predicting default risks, downgrades should systematically precede currency crises (Reinhart, 2002). Hence, served as signals of default risks, sovereign rating changes may lead to herd behavior, particularly in the presence of asymmetric information (Millon and Thakor, 1985; Eichengreen and Mody, 1998; Calvo and Mendoza, 2000). As such, the rating agencies work as information multipliers, which will foster vicious business cycles (Ferri, Liu and Stiglitz, 1999). Even if the market participants believe that credit rating changes are primarily based on publicly available information, these announcements may still be regarded as important signals of creditworthiness and reinforce investors' expectations (Reisen and Maltzan, 1999).

2.2 Controversial Empirical Evidences

Numerous researches have been dedicated to the empirical evidence of the impacts of sovereign rating announcements by three leading rating agencies, namely Fitch, Moody's and S&P. Particularly, there is a heated discussion on the role of rating agencies in Asian financial crisis. Nevertheless, there is no agreement on this issue so far. Some authors believe that there is no clear evidence that sovereign rating announcements affect financial markets significantly. Some authors conclude that financial markets do fluctuate with sovereign rating news and the pro-cyclical behavior of rating agencies tends to facilitate boom-bust cycles and deteriorate the situation especially during crises.

Cantor and Packer (1996a and 1996b) make the first systematic analysis of the determinants and influence of sovereign credit ratings assigned by S&P and Moody's. Based on their simulation, the sovereign rating mainly reflects six economic indicators, namely, per capita income, GDP growth, inflation, external debt, level of economic development and default

history. The authors state that ratings successfully capture the information in macroeconomic indicators and even the information unavailable from other public sources, which indicates that rating agencies lead rather than fall behind the financial markets. Although sovereign debt yields as the representative of the financial market are obviously correlated with ratings, the authors find no significant evidence that yields will be influenced by ratings, with the exception of non-investment-grade rating announcement which affect the market pricing immediately.

In line with the statements of Cantor and Packer (1996a and 1996b), some other authors find very weak or even no impacts of sovereign rating news that only bring some minor disturbance to financial markets (Reisen, 2003; El-Shagi, 2010). Krüssl (2003) studies US bond yields and international liquidity in response to abrupt sovereign rating downgrades. He suggests that there is no necessary linkage between these two. As to why a strong market response is not detected in some empirical researches, one possible reason is that if sovereign ratings are mainly based on publicly available information, rating changes may be anticipated by the market to a great extent (Larraín, Reisen and Maltzan, 1997). This will dampen the market's response to rating announcements.

In contrast to the above "minor or no impacts" statements, many scholars have discovered empirical evidences in support of "great impacts" of sovereign rating news. Kaminsky and Schmukler (2002), Chiang, Jeon and Li (2007) find that changes in sovereign rating and outlook notably disturb bond and stock markets. Rigobon (1998), among others, points out that good news is not very informative to the market and attract little reaction, while bad news such as downgrades causes strong market response. Larraín, Reisen and Maltzan (1997), Reisen and Maltzan (1999) note that there is highly significant rating announcement effect in emerging markets, in particular with the news of "on review with negative outlook", although this effect is diminished by market expectation.

Moreover, rating agencies are accused of their pro-cyclical behaviors which stimulate boom and bust (Monfort and Mulder, 2000; Löffler, 2004). Rating agencies are considered to lag rather than lead the market, namely upgrades come after markets climbing and downgrades

take place after markets downturns. Since investors may withdraw more capital from countries downgraded by leading rating agencies, this will worsen the situation, for example, dramatic currency depreciation, sudden stock indices drop and mounting bond yield spreads. These poor economic indicators bring further downgrades. Finally, a crisis is precipitated. Ferri, Liu and Stiglitz (1999) demonstrate the pro-cyclical nature of rating agencies and consider it as a source of aggravation of the East Asian financial crisis. On the contrary, Mora (2006) questions this view and argues that rating actions during East Asian financial crisis were sticky rather than pro-cyclical. It is questionable to blame rating agencies for amplifying boom-bust cycles.

Reinhart (2002) states that sovereign ratings systematically interact (with a lag) with international capital markets, as shown in sovereign bonds' yield spreads. She blames that rating agencies have concentrated on fundamental indicators which are not the most reliable for their low predictive power concerning currency crisis. Ferri, Liu and Stiglitz (1999) agree with this view. Fitch (1998) and Moody's (1991 and 1995) acknowledge that some important factors are missed in the sovereign rating assessment, such as short-term foreign currency liquidity condition (Truglia, 1998).

2.3 Spillover Effect of Sovereign Rating Announcements

Another branch of studies sheds light on the spillover effect of sovereign rating announcements, that is, whether the sovereign rating news concerning one country will spark off contagious fluctuation in other countries. Kaminsky and Schmukler (2002) find important cross-country spillover effects of sovereign rating changes, with financial markets in emerging countries jointly rising or crumbling after rating announcements. Chiang, Jeon and Li (2007) use daily data of nine Asian stock returns during 1990 to 2003 and point out that leading rating agencies contribute to the dynamic correlations in Asian financial markets. Consistent with their findings, Goldstein, Kaminsky and Reinhart (2000), Gande and Parsley (2005), Ferreira and Gama (2007) suggest that sovereign rating changes play a significant role in financial contagions.

One study most relevant to our paper is carried out by Arezki, Candelon and Sy (2011). They pay attention to the spillover effects of sovereign rating announcements on the ongoing Eurozone debt crisis. They categorize sovereign rating news into various groups, such as “rating changes”, “outlook revision” and “review” (watchlist). They also classify rating news based on the geographical origins into Baltic states, Central Asia and Eastern Europe. Their conclusion is that the spillover effects of sovereign rating downgrades are statistically and economically evident. Both the type of rating news and the source of the country contribute to this spillover effect. Additionally, they note that rating downgrades near speculative grade cast influence throughout Eurozone countries.

Enlightened by the studies on ratings’ spillover effect, we extend our analysis to the movement of USD/SEK in response to Eurozone countries’ rating events. Although Sweden is not a Eurozone member, it has close economic bond with Eurozone countries because of the high degree of integration in Europe. While Sweden showed very good economic performance during our study period, we observe that sometimes its currency tended to fluctuate when there was important news about Eurozone sovereign debt crisis. Therefore we wonder whether there is any indirect influence on Non-Eurozone European countries, represented by Sweden, brought by Eurozone sovereign rating announcements. The corresponding currency fluctuation is on behalf of the overall economic condition in Sweden. Eurozone sovereign rating events represent the overall degree of Eurozone sovereign debt crisis.

2.4 Exchange Rates and the News Effect

The majority of researches on the impacts of sovereign rating changes employ bond yields or stock market indices as target variables. Comparatively fewer studies involve exchange rates in the analysis. Reinhart (2002) argues that it is totally legitimate to ground credit ratings on recent exchange rate changes. Since credit ratings assess the default risk of outstanding loans, currency depreciation leads to heavier burden for the country to repay, which causes higher default risks. Some scholars present empirical evidence that there is self-reinforcing relationship between exchange rates and sovereign ratings (Reisen and Maltzan, 1999;

Kräussl, 2003). El-Shagi (2010) uses the exchange rate in addition to stock market indices as main crisis indicators and applies case study to five Asian countries struck most heavily by Asian financial crisis. He concludes that currency depreciations mostly precede sovereign rating downgrades and there is no empirical evidence that sovereign rating changes contribute considerably to acceleration of Asian financial crisis. However rating agencies may generate short-term fluctuations in exchange rates.

Although the literature on the relationship between sovereign rating news and the exchange rate is sparse, there are abundant studies on the effect of other news on the exchange rate, mostly macroeconomic announcements, official statements concerning economy, and media reports. We can get some inspiration from these researches as well. Jansen and Haan (2005) summarize some influential papers studying the effects of news on exchange rates. They present various variables, estimation methods and the data frequency used in selected papers. They use the EGARCH model proposed by Nelson (1991) to investigate the impacts of European Central Bank officials' statements on the euro-dollar exchange rate. Their study suggests that ECB statements have very small effect on the conditional mean of the euro-dollar exchange rate. However, the volatility of the exchange rate is easily affected by the news. Markets respond asymmetrically to positive or negative news. Inspired by Jansen and Haan (2005), we use EGARCH model in this thesis to capture the mean and volatility of USD/EUR and USD/SEK in reaction to sovereign rating announcements concerning Eurozone countries.

As mentioned above, most researches on the impacts of sovereign rating changes employ bond yield or stock market indices as target variables, rather than exchange rates. One reason is that countries in those samples do not use one common currency, which results in the preferred application of stock indices or bond yield spreads in different countries. Yet the current Eurozone debt crisis enables us to investigate the market response to sovereign rating news from another perspective. We consider all Eurozone countries' rating announcements as in one group and use the movement of euro as the representative of the market response in the whole Eurozone, which may distinguish our research among others.

3. Methodology

The main purpose of this section is to present the research methodology used to analyze the effects of sovereign rating announcements of Eurozone countries on the exchange rates of both EUR and SEK. Firstly, some of previous research methods of news effects on exchange rates will be summarized, followed by a general introduction of the targeted econometric method and estimation techniques. At last, the modeling strategy applied in this study will be shown and discussed.

3.1 Research Methods of News Effect on Foreign Exchange Markets

Despite researches on the effects of sovereign rating events on the exchange rate are few, many studies on other news effects have been conducted. These studies apply various empirical methods.

Hakkio and Pearce (1985) analyze the effect of macroeconomic announcements on short-run spot exchange rates using OLS estimation method and conclude that short-run exchange rate movements react to unexpected changes in the money supply, but are not affected by other macroeconomic news. Fatum and Hutchison (2002) investigate the effectiveness of ECB intervention on the exchange rate of euro by applying OLS approach. This research focuses on which news has significant impact on exchange rates, and the results indicate that news of rumors and speculation of intervention in support of euro by the ECB or other central banks has positive effect on the euro exchange rate, while statements by officials not supporting the euro negatively affect the euro rate. Andersen et al. (2003) apply an ARMA model to investigate the news effect of macroeconomic announcements on the exchange rate movements of US dollar, concluding that the exchange rate of US dollar is significantly influenced by macroeconomic announcements. The limitation of these researches is that they only concentrate on news impact on mean value movements without measuring effects on changes in volatilities.

The event study method is also applied in investigation to news effects on foreign exchange

markets. Fatum and Hutchison (2003) use the event study approach to examine whether intervention affects the exchange rate and find evidence of short-run influence on the exchange rate. Subaşı (2008) performs the event study method and examines the effects of sovereign rating and outlook changes on stock returns and exchange rates. The results indicate that rating downgrades affect the exchange rates and increase their volatilities. The difficulty to conduct the event study method is that it must be guaranteed that there is only one event in the event window. Thus when more than one event appears in the same period, it is hard to define the event window and the results might be biased.

The restriction of the event study method leads to the difficulty of application in our study. During the period of debt crisis in Eurozone, there exists possibility that more than one sovereign rating announcement is published on each day, which might result in the hardness of defining the event window. During our sample period, there are three days with more than one rating event occurring. Even if a one-day event window is defined, these overlapping events might be incorrectly regarded as one event and lead to biased results. In addition, for the situation that sovereign news is announced on some consecutive days, despite the feasibility of event window definition, the effects on the market after the day of event occurrence cannot be captured in practice. Therefore, to model the news effects of sovereign rating announcements on the exchange rate, it needs a model that can overcome this restriction.

Jansen and Hann (2005) conduct a study on the reaction of exchange rate to ECB statements. Both the mean level and volatility of the EUR/USD are modeled by using the EGARCH estimation approach. The results suggest that ECB statements have small impacts on the level of the exchange rate but obvious influences on its volatility.

Compared with the event study method, using an EGARCH model does not capture the abnormal performance of the exchange rates when an event is published. The event study method appraises the effect of an event by measuring the abnormal return as follows:

$$\epsilon_{it}^* = R_{it} - E[R_{it}|\Omega_t],$$

where ϵ_{it}^* , R_{it} , and $E[R_{it}|\Omega_t]$ are the abnormal return, actual return, and normal return,

respectively; and $E[R_{it}|\Omega_t]$ can be estimated by using the OLS estimator. Ω_t represents the conditioning variables such as macroeconomic factors which determine the exchange rate. Through appraising the abnormal return, the abnormal performance on the event can be captured, whereas an EGARCH model cannot work on this. As mentioned before, during the sample period, there exist some days with more than one sovereign rating news published, which cause that it cannot be guaranteed only one event in each event window, so the event study method is difficult to be applied in our investigation. However, using an EGARCH model, such a problem manages to be solved, and the effect of sovereign rating announcements, which is the main purpose of our research, can also be measured. Therefore, in this paper we follow the idea from Jansen and Hann's research and apply an EGARCH model to analyze the effects of sovereign rating news on the mean level and volatility of both USD/EUR and USD/SEK rates.

3.2 A General Introduction of EGARCH Model

An EGARCH model is an extension of generalized autoregressive conditionally heteroskedastic model (GARCH model), which was developed by Bolerslev (1986) and Taylor (1986) independently. Generally in a GARCH model, the current conditional variance is allowed to depend on lags of the squared error term and the conditional variance itself. This can be written as follows,

for an AR (k) process,

$$y_t = \delta + \sum_{i=1}^k \rho_i y_{t-i} + u_t, u_t \sim (0, \sigma_t^2) \quad (1)$$

defining $\sigma_t^2 = h_t$,

a GARCH (p, q) process can be expressed as

$$h_t = \alpha_0 + \sum_{i=1}^p \alpha_i u_{t-i}^2 + \sum_{j=1}^q \beta_j h_{t-j}, \quad (2)$$

where $h_t = Var [u_t | u_{t-1}, u_{t-2}, \dots, u_1]$.

Using a GARCH model, both the mean level (equation (1)) and the volatility (equation (2)) of a series can be captured. In general, it is sufficient to use a GARCH (1, 1) model to measure financial data.

Since the lagged error term is squared in the conditional variance equation, it can only measure its magnitude and the sign is ignored. Thus the GARCH model can only capture symmetric reaction of volatility to shocks, that is, a negative shock has the same impact on the volatility as a positive shock. There have been a number of empirical researches proving the asymmetry of volatility in financial markets. Such a restriction can be solved by extending the GARCH model to the exponential GARCH model (the EGARCH model).

An EGARCH (1, 1) model can be written as

$$\ln(h_t) = \omega + \beta \ln(h_{t-1}) + \gamma \frac{u_{t-1}}{\sigma_{t-1}} + \alpha \frac{|u_{t-1}|}{\sigma_{t-1}}, \quad (3)$$

where $\sigma_{t-1} = \sqrt{h_{t-1}}$.

The logarithm of variance guarantees the positivity and the inclusion of $\frac{u_{t-1}}{\sigma_{t-1}}$ enables the model to capture the asymmetry. If $\gamma < 0$, the positive shock has less impact on the volatility than the negative shock.

The estimation of the model uses the maximum likelihood approach instead of the least squares method. This estimation method is based on the assumption of normality. If the error term is not normally distributed, the parameter estimates will still be consistent but the estimates of the standard error will be inappropriate, resulting in a biased statistical inference. Therefore, when the assumption of normality is violated, Bollerslev-Wooldridge standard error and variance-covariance matrix should be used to robust non-normality. This is known as quasi-maximum likelihood method, which is developed by Bollerslev and Wooldridge (1992).

3.3 Modeling Strategy

The event variables are defined as dummies with the value equal to one if there is an event on a certain day and zero otherwise. A problem is that there might be more than one event per day. To solve this, we simulate the idea of Jansen and Hann (2005), adding up the scores if more than one events occurs per trading day. Another problem is that an event might be published on weekends, while on weekends there are no transactions on foreign exchange markets. We still follow Jansen and Hann's idea, adding the events issued on weekends to the scores on Monday.

Additionally, due to the "weekday effect", financial series might behave differently on different days. There have been abundant empirical researches proving such a calendar anomaly. For instance, French (1980) find that the average market return in the US is negative on Monday, whereas positive on Friday. Yu et al. (2008) investigate the weekday effect focusing on yen/dollar spot exchange rate in Tokyo, London, and New York. The results indicate that the Monday and Friday effects disappear but the return on Tuesday is significantly negative and lower, and on Thursday is positive and higher than other days. Therefore, in order to capture this anomaly, we control weekdays as dummy variables with value equal to one for Monday observations and zero otherwise, so on and so forth.

Except for weekdays, we do not introduce other control variables. Of course, other events might influence the exchange rate at the same time, for instance different monetary policies in different countries, positive or negative statements by officials, and so forth. According to Kaminsky and Schmukler (2002), we suppose that these factors will affect the exchange rate both positively or negatively in a random way. Therefore we assume that on average there is no significant bias without controlling other variables.

The exchange rate series generally follow I (1) processes⁴, thus the first difference is taken to make the series stationary. In addition, the series are taken a natural logarithm. Thus the model is specified as

⁴ This can also be proved by a unit root test.

$$R_t = \alpha + \sum_{i=1}^N \rho_i R_{t-i} + \sum_{k=1}^K \sum_{i=0}^j \beta_{ki} X_{k,t-i} + \varphi W + u_t, u_t \sim (0, h_t) \quad (4)$$

$$\ln h_t = \omega + \delta \ln h_{t-1} + \gamma \frac{u_{t-1}}{\sigma_{t-1}} + \theta \frac{|u_{t-1}|}{\sigma_{t-1}} + \sum_{k=1}^K \sum_{i=0}^j \beta_{ki} X_{k,t-i} + \tau W, \quad (5)$$

where $R_t = \Delta \ln(\text{Exchange rate})_t = \ln(\text{Exchange rate})_t - \ln(\text{Exchange rate})_{t-1}$,

X is a matrix of dummies of event variables,

and W is a matrix of dummies of weekdays.

Since the exchange rates are denoted with direct quotation, the increase in R_t represents the depreciation of the euro or Swedish kronor. Equation (4) models the mean level of changes in exchange rates while Equation (5) measures the volatility. To keep the comparability, the same specification is applied to the analyses of the two exchange rates.

During the empirical process, we start from a general model and many lags of the autoregressive term and event variables are included in the model. The results present insignificant estimates and the Schwarz criterion increases when more lags are used. That is, adding more lags into the model does not provide more information. In addition, the inclusion of the control variables also gives such results, which means that the weekday variables are robustly insignificant. To keep the model parsimonious, the control variable is excluded from the model and only one lag of the autoregressive term and event variables are kept in the equation.

Thus the final model is specified as

$$R_t = \alpha + \rho R_{t-1} + \beta_1 \text{Downgrade}_t + \beta_2 \text{Downgrade}_{t-1} + \beta_3 \text{Outlook}_t + \beta_4 \text{Outlook}_{t-1} + \beta_5 \text{Review}_t + \beta_6 \text{Review}_{t-1} + u_t, u_t \sim (0, h_t) \quad (6)$$

$$\ln h_t = \omega + \delta \ln h_{t-1} + \gamma \frac{u_{t-1}}{\sigma_{t-1}} + \theta \frac{|u_{t-1}|}{\sigma_{t-1}} + \beta_1 \text{Downgrade}_t + \beta_2 \text{Downgrade}_{t-1} + \beta_3 \text{Outlook}_t + \beta_4 \text{Outlook}_{t-1} + \beta_5 \text{Review}_t + \beta_6 \text{Review}_{t-1}, \quad (7)$$

4. Data

The purpose of this study is to investigate the effect of sovereign rating announcements of Eurozone countries on the exchange rates, including both the direct influence on the exchange rate of euro and the indirect influence on Swedish kronor. Both exchange rates are denoted with direct quotation, that is, the amount of currency per US dollar. Daily data of USD/EUR are obtained from the European Central Bank's database, while those of USD/SEK are collected from the database of Sveriges Riskbank, which is the central bank of Sweden. The sample period ranges from January 1, 2009 until March 31, 2010.

The efficient market hypothesis implies that the asset price will immediately adjust to the new information when the announcement is published. Therefore, the asset price on the day after the news will already reflect the event having occurred. For instance, Cheung and Chinn (2001) investigate exchange rates in US by applying a survey study and the results indicate that news about macroeconomic variables is rapidly incorporated into exchange rates. It seems that using higher frequency data, for example ten-minute data or continuous data, can better capture the intrinsic adjustments of exchange rates to news within one day. Additionally, the use of higher frequency data can better separate the news effect from other potential elements which influence the exchange rate. However, in this study, the purpose is to examine the effects of sovereign rating announcements, following Jansen and Hann (2005), it is sufficient to use daily data to measure behaviors of exchange rates on sovereign rating news, since if the effects must be measured by using higher frequency data, they cannot affect the foreign exchange market because they would have been digested by the market immediately.

First of all, we present the movements of USD/EUR and USD/SEK from January 1, 2009 to March 31, 2011 in order to get a rough idea about the Eurozone sovereign debt crisis and exchange rates.⁵ Based on the frequency of rating announcements, we consider there are five rounds of downgrade concerning Eurozone sovereign debt crisis, that is, January 2009,

⁵ In general, the last sovereign rating adjustments concerning Eurozone countries date back to 2005.

December 2009, April 2010, December 2010 and March 2011.⁶

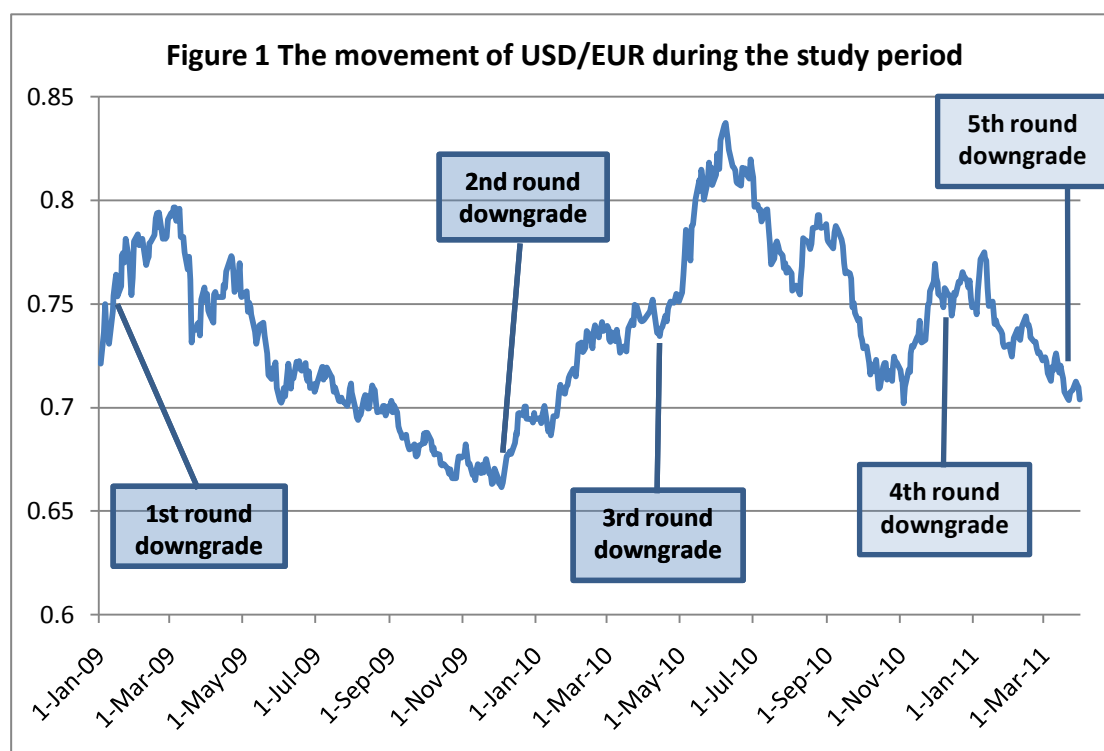


Figure 1 shows the movement of USD/EUR during the study period. In January 2009, there was the first round of downgrade for Eurozone countries. We can observe a minor depreciation of euro right after this. It is then followed by an appreciation until the end of 2009, when the second round of downgrade struck several Eurozone countries. Since then euro began to depreciate against US dollar for half a year. After the third round of downgrade swept the beleaguered Eurozone countries in April 2010, euro depreciated more sharply (Due to the direct quotation, the line of USD/EUR climbed abruptly in figure 1). After the fourth round of downgrade in December 2010, Euro firstly fluctuated for several days and then appreciated against dollar, rather than depreciated as in previous cases. It is unreasonable to conclude that euro was not affected by the fourth round of downgrade. Rather, we shall notice that US dollar depreciated against most of the currencies since November 2010, due to America's second round of "quantitative easing" policy announced on Nov 4, 2010. As to the fifth of round downgrade in March 2011, we cannot fully observe the market response due to the completion of the study period.

⁶ The numbers of relevant rating announcements in the five months are 8, 6, 5, 9 and 8 respectively.

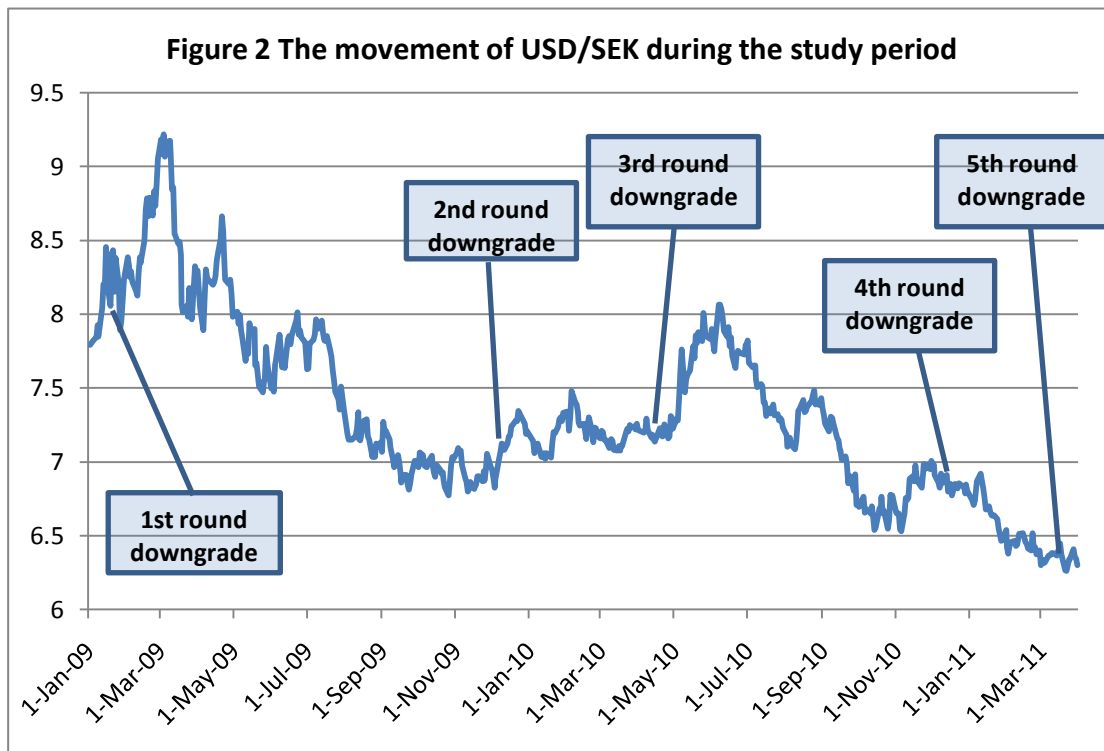


Figure 2 depicts the movement of USD/SEK during the study period. Interestingly, although Swedish kronor shows a general trend of appreciation against dollar, its movements in reaction to the rating events are similar to that of euro to some extent. Swedish kronor depreciated against dollar after the first round of Eurozone downgrade and its trend was quite similar to that of euro until the second round of downgrade. Swedish kronor did depreciate after the second and the third round of downgrade, but not as much as euro. It appreciated against dollar after the fourth and the fifth of downgrade partly because of America's second round of "quantitative easing" policy. In spite of the fluctuation, we think the general appreciation of Swedish kronor is reasonable, since Sweden has shown strong economic growth during the period.

Table 1 shows some elementary statistics of USD/EUR and USD/SEK including the mean, the variance and the standard deviation.

Table 1: Elementary Statistics of Exchange Rates

Statistics	USD/EUR	USD/SEK
Mean	0.74	7.32
Median	0.73	7.2
Variance	0.0015	0.36
Standard deviation	0.039	0.60

The mean value of USD/EUR is 0.74 while the USD/SEK is 7.32. Medians of these two rates are 0.73 and 7.2 respectively. Variance and standard deviations of dollar-euro rates are 0.0015 and 0.039, which implies a small volatility for the exchange rate. However, these two stats for the USD/SEK are 0.36 and 0.60 respectively, representing a more obvious fluctuation in the exchange rate.

During the sample period, there are totally 71 sovereign rating announcements in Eurozone countries, which are issued by Moody's, S&P, and Fitch. These data are collected from the official websites of the three issuers. Among these three leading rating agencies, S&P and Fitch adopt similar rating expressions (refer to Appendix A1). For example, when S&P or Fitch put some country on the "watchlist", it is equivalent to having that country on "review" in Moody's version. But overall, their rating measures are highly comparable. Since the beginning of 2009, all the sovereign rating changes or outlook revisions for Eurozone countries issued by these three rating agencies are downward and all the reviews are "for possible downgrade in the future". That is, we expect all the news of rating changes, outlook revisions and reviews during this period to have negative impacts on the financial markets. Thereafter in our models, we will use "Downgrade" denoting all the rating changes, "Outlook" denoting all the outlook revisions, and "Review" denoting reviews of Moody's and watchlists of S&P and Fitch.

When there are both rating changes and outlook revisions, we consider the rating changes as the dominant news. For example, Fitch downgraded Ireland from AA+/Negative to AA-/Stable on Nov 4, 2009. We will classify this news as "downgrade" regardless of the

improved outlook revision (from “negative” to “stable”). There are 41 items of “Downgrade”, 12 items of “Outlook” and 18 items of “Review” in Eurozone countries during the sample period. More details of the sovereign rating events are shown the in the appendix (Appendix A2). Table 2 summarizes sovereign rating news issued by the three rating agencies during the sample period.

Table 2: Summary of Rating Announcements by Types

	Moody’s	Standard&Poor’s	Fitch	Total
Downgrade	11	17	13	41
Outlook	6	5	1	12
Review	9	7	2	18
Total	26	29	16	71

5. Estimation Results and Interpretation

In this section, the estimation results will be presented and discussed. Firstly, we examine the scenario including sovereign rating events from all Eurozone countries. During the study period, seven Eurozone countries were faced with various types of sovereign rating announcements, namely, Cyprus, Greece, Ireland, Portugal, Slovakia, Slovenia and Spain.⁷ Additionally, we are interested in one other scenario. Since the total nominal GDP of Cyprus, Slovakia and Slovenia are much smaller than that of the other four countries⁸ and the news about sovereign debt crises of Greece, Ireland, Portugal and Spain are the mostly reported which may draw more attention from the markets, we wonder is there any difference if we only take into account rating announcements about these four countries. Therefore, we re-estimate the model by excluding sovereign rating events from three small Eurozone economies during this period, i.e. excluding the data concerning Cyprus, Slovakia and

⁷ Although there were rating news concerning Estonia in 2009 and 2010, Estonia became a Eurozone member since Jan 1, 2011. From Jan 1, 2011 to Mar 31, 2011, Estonia didn’t have any sovereign rating events. Therefore, we exclude any rating news concerning Estonia during the study period.

⁸ Based on data provided by Wikipedia (<http://en.wikipedia.org/wiki/Eurozone>), the total nominal GDP estimated in 2010 of the seven Eurozone countries are: Cyprus 23.174; Greece 305.415; Ireland 204.261; Portugal 229.336; Slovakia 86.262; Slovenia 46.442 and Spain 1374. (Unit: \$ billion)

Slovenia.

Thus the four cases investigated in this study are: USD/EUR exchange rate in response to sovereign rating events from all Eurozone countries, USD/SEK exchange rate in response to sovereign rating events from all Eurozone countries, USD/EUR exchange rate in response to sovereign rating events from large Eurozone economies (that is, remove events from Cyprus, Slovakia, and Slovenia), and USD/SEK exchange rate with sovereign rating events in response to large Eurozone economies.

Using Equation (6) and (7), the models for all the four cases are estimated and the results are presented and discussed in the following sub-sections. More details of estimation results are attached in the appendix (Appendix A3).

5.1 Results of USD/EUR Based on Sovereign Rating Events from All Eurozone Countries

The estimation results of the exchange rate of euro against US dollar in response to sovereign-rating events from all Eurozone countries are shown in Table 3.

Table 3: Estimation Results of USD/EUR based on Sovereign Rating Events from All Eurozone Countries

Mean Equation		Variance Equation	
Downgrade	-	Downgrade	0.236640***
Downgrade (1 st lag)	-	Downgrade (1 st lag)	-
Outlook	-	Outlook	0.094070***
Outlook (1 st lag)	-	Outlook (1 st lag)	-0.171557**
Review	-	Review	0.631652***
Review (1 st lag)	-	Review (1 st lag)	-0.725053***
Constant	-0.000240	Constant	-0.100519***
AR (1)	0.005050	δ	0.987017***
-		θ	-0.046981**
-		γ	0.017288

Note: Only significant coefficients are reported. ***/**/* denotes 1/5/10% level of significance.

The results in Table 1 indicate that there is no significant effect of Eurozone sovereign rating announcements on the mean level of the exchange rate of USD/EUR. However, the volatility of the exchange rate shows quite strong sensitivity to sovereign ratings news. From the results, it can be observed that announcements of downgrades significantly increase the variance of the exchange rate. In this case, the volatility is approximately 24% higher after the sovereign rating announcements. In the meantime, outlook deteriorations also bring a 9% increase in the volatility. The most influential event to the variance is announcements of putting one country on review, which increase the variance by around 63%. Interestingly, after the day of the announcement of outlook or review, the variance of USD/EUR decreases, by approximately 17% and 73% respectively.

5.2 Results of USD/SEK Based on Sovereign Rating Events from All Eurozone Countries

The indirect relationship between sovereign rating announcements and foreign exchange markets is investigated by modeling the mean and volatility of the exchange rate of Swedish

kronor against US dollar. Table 4 shows the estimation results of Swedish kronor against US dollar. Due to the violation of normality assumption in the USD/SEK series, which may lead to biased statistical inferences, the Bollerslev-Wooldridge standard error and variance-covariance matrix is applied to the estimation.

Table 4: Estimation Results of USD/SEK Based on Sovereign Rating Events from All Eurozone Countries

Mean Equation		Variance Equation	
Downgrade	-	Downgrade	-
Downgrade (1 st lag)	0.004214***	Downgrade (1 st lag)	0.331429*
Outlook	0.005528***	Outlook	-0.664044*
Outlook (1 st lag)	-	Outlook (1 st lag)	-
Review	0.003971*	Review	-
Review (1 st lag)	-	Review (1 st lag)	-
Constant	-0.000965**	Constant	-0.396130**
AR (1)	-0.052250	δ	0.974418***
-		θ	0.201997***
-		γ	-0.013883

*Note: Only significant coefficients are reported. ***/**/* denotes 1/5/10% level of significance.*

Different from the case of euro, the results indicate that sovereign rating events affect both the mean and the volatility of USD/SEK. After the day of the announcements of downgrade events, the mean level of the exchange rate increases by approximately 0.4%, implying a slight depreciation in Swedish kronor against US dollar. The responses to the announcements of outlook and review events are more immediately. On the day of the announcement, these two events bring approximately 0.55% and 0.4% depreciation in Swedish kronor. Meanwhile, the volatility significantly changes after the day of the announcements of downgrade. In this case, the variance is 33% higher. Outlook events also significantly influence the variance of the exchange rate. On the day of the news, the variance decreases by approximately 66%.

5.3 Results of USD/EUR Based on Sovereign Rating Events from Large Eurozone Economies

After removing three relatively small economies, Cyprus, Slovakia, and Slovenia, the model is re-estimated and the estimation results of USD/EUR are shown in Table 5.

Table 5: Estimation Results of USD/EUR Based on Sovereign Rating Events from Large Eurozone Economies

Mean Equation		Variance Equation	
Downgrade	-	Downgrade	-
Downgrade (1 st lag)	-	Downgrade (1 st lag)	-
Outlook	-	Outlook	-
Outlook (1 st lag)	-	Outlook (1 st lag)	-
Review	-	Review	0.766195*
Review (1 st lag)	-	Review (1 st lag)	-0.834352*
Constant	-0.000317	Constant	-0.112228***
AR (1)	-0.006016	δ	0.987853***
-		θ	-0.023516***
-		γ	0.012333

*Note: Only significant coefficients are reported. ***/**/* denotes 1/5/10% level of significance*

The estimation results of the mean equation coincide those of the above model including rating news from all Eurozone countries, that is, no variables are found to significantly affect the mean level of the exchange rate. However, for the variance equation, the results are different. In this case, only two coefficients are significant. The results indicate that the variance of the exchange rate responds immediately to the announcement of review, increasing by approximately 77% on the day of events. In addition, there is a significant decrease in the volatility (83%) after the day that review news is issued.

5.4 Results of USD/SEK Based on Sovereign Rating Events from Large Eurozone Economies

The estimation results of USD/SEK after removing small economies are shown in Table 6. As mentioned in Subsection 4.2, because of the violation of normality assumption, the Bollerslev-Wooldridge standard error and variance-covariance matrix is applied to the estimation.

Table 6: Estimation Results of USD/SEK Based on Sovereign Rating Events from Large Eurozone Economies

Mean Equation		Variance Equation	
Downgrade	-	Downgrade	-
Downgrade (1 st lag)	0.004192***	Downgrade (1 st lag)	-
Outlook	0.005825***	Outlook	-
Outlook (1 st lag)	-	Outlook (1 st lag)	-
Review	0.004626*	Review	-
Review (1 st lag)	-	Review (1 st lag)	-
Constant	-0.001013**	Constant	-0.420054**
AR (1)	-0.059176	δ	0.971651***
-		θ	0.198318***
-		γ	-0.012717

*Note: Only significant coefficients are reported. ***/**/* denotes 1/5/10% level of significance*

The results indicate that the mean of USD/SEK rate is significantly affected by Downgrade (1st lag), Outlook, and Review, which is consistent with the results of the model including rating news from all Eurozone countries. However, for the variance equation, no significant coefficient is found. This suggests that for the USD/SEK exchange rate, the market fluctuation is no longer sensitive to the events of downgrade and outlook changes and the volatility responds to events from all countries rather than only large economies (By comparing the two cases, it can be observed that removing events from small economies leads

to no significant estimates of the variance equation).

5.5 Results Interpretation

We have gotten abundant results from the two scenarios described above. We try to interpret these results from economic perspectives in this sub-section. Some results are consistent with previous empirical studies. Some results have rarely or almost not been detected by other authors. And some results seem a bit puzzling, which requires future research.

5.5.1 Under the Scenario Consisting of Rating Events from all Eurozone countries

Firstly considering the movement of USD/EUR in response to sovereign rating events from all Eurozone countries, Table 3 shows that none of the six variables can significantly affect the mean value of USD/EUR. Whereas, all the three types of rating announcements have significantly impacts on the volatility of the exchange rate. Interestingly, this is in line with the findings of Cheung and Chinn (2000) and Jansen and Haan (2005): the central bank interventions or statements mainly affect the volatility of exchange rates, rather than the mean value. It is hard to explain why only “Downgrade” does not have lag effects on exchange rate (that is, insignificant “Downgrade (1st lag)”) when both “Outlook” and “Review” notably influence the fluctuation of euro on the day after the rating event (that is, significant “Outlook (1st lag)” and “Review (1st lag)”.) But overall we can conclude that the volatility of euro is highly sensitive to Eurozone sovereign rating announcements.

Among the three types of rating news, obviously news of putting one country on review for possible downgrade in the future have the strongest power to disturb the market. The volatility increases by 63% on the day of announcement and falls by 73% on the second day. The importance of review has been detected by Reisen and Maltzan (1999) as well. The intuition behind this is that market participants might regard the news of review as a predictive signal, which not only reveal the current situation of one country, but also convey the information about future deterioration. Therefore, financial markets will make the strongest response to this type of rating events. In other words, the news of rating review helps to build up the

markets' anticipation for the economic worsening in the following months. In such way, it is easy to understand why the exchange rate does not fluctuate that much when rating changes or outlook revisions are issued. This is in line with the statements of Larrain, Reisen and Maltzan (1997). Interestingly, the financial markets react more to the "possible actions" rather than the "real actions".

Now let us turn to the movement of USD/SEK in reaction to the sovereign rating news from all Eurozone countries. Compared with the above case of USD/EUR, this shows a quite different picture. Both the mean value and the volatility of Swedish kronor are sensitive to the sovereign rating events. However, it is worth noting that the mean value of USD/SEK is just slightly affected by rating events. The coefficients of "Downgrade (1st lag)", "Outlook" and "Review" are 0.4%, 0.55% and 0.4% respectively, which means Swedish kronor experiences minor depreciation in reaction. This is reasonable considering Sweden is a non-Eurozone country and showed strong economic growth during the period. Sweden should not suffer too much due to the Eurozone debt crisis. On the other hand, Sweden has close economic bond with Eurozone countries, which contributes to this tiny fluctuation of the exchange rate.

Whereas, we notice that although the volatility of USD/SEK is sensitive to "Downgrade (1st lag)" and "Outlook", the signs of the coefficients are a bit confusing. After the day of downgrade events, the volatility of USD/SEK increases by 33%. And on the day of outlook revision events, the volatility decreases by 66%. Usually we will expect more fluctuation on the day of the announcements and less fluctuation on the second day. We have not met any similar findings of other empirical studies. This may call for future researches.

5.5.2 Under the Scenario Consisting of Rating Events from large Eurozone economies

After excluding the rating events from Cyprus, Slovakia and Slovenia, the results are somewhat similar to those under the first scenario, but meanwhile have some new features. As to the exchange rate of euro, the mean value of USD/EUR is not sensitive to any of the six variables as before. "Review" and "Review (1st lag)" are the only significant variables in this case, which influence the volatility of euro. What's more, the absolute values of their

coefficients are greater than those under the first scenario (0.77 versus 0.63, -0.83 versus -0.73). This implies that the announcements of review concerning large Eurozone economies have the dominant impact on the exchange rate. This effect has been diluted when we incorporate rating news concerning small economies into our analysis. In addition, financial markets do not respond to the sovereign rating events of downgrade or outlook revision concerning large economies at all. As discussed above, this can be explained by the market expectations. Financial markets have already been prepared for the further deterioration after the announcements of review, that is, the currency already depreciates before the real action of rating changes or outlook revisions. Actually we can expect similar response in other financial markets, such as the stock market and the bond market.

Another noteworthy point is that the volatility is no longer sensitive to “Downgrade”, “Outlook” and “Outlook (1st lag)” as under the first scenario, which means their significance completely attribute to the rating events from small Eurozone economies. By comparing the two scenarios, we may deduce that financial markets only react to rating news of review concerning large economies and form the anticipation for future worsening. This results in the relatively calm market response to the real rating action, i.e. downgrade or outlook revision. On the contrary, financial markets tend to ignore the rating events of putting some small countries on review. The adjustments will be made when the real rating actions come. This kind of selective reactions coincides with our expectation.

Finally, by comparing Table 4 and Table 6, it can be observed that the mean value of USD/SEK is sensitive to the same variables. Except for “Downgrade (1st lag)” whose coefficient is a little smaller after excluding rating events from small economies (0.004192 versus 0.004214), “Outlook” and “Review” have a bit larger coefficients (0.005825 versus 0.005528, 0.004626 versus 0.003971). This indicates that in general Swedish kronor are more influenced by rating events from large Eurozone economies as well. Another distinction under this scenario is that no variable can significantly affect the volatility of Swedish kronor. Affected mean value combined with unaffected volatility has not been mentioned by other authors. This may require future researches.

6. Conclusion

The three leading rating agencies have been widely blamed for their “supernational power” to disturb the financial systems especially during crises. The current Eurozone sovereign debt crisis has aroused discussion on the role of rating agencies again. Previous studies have led to various conclusions of the impacts of sovereign credit rating on financial markets. In this paper, we try to explore this question through another angle. We use the exchange rate as the indicator of the financial markets and most importantly classify sovereign rating news concerning different Eurozone countries as in one group. What’s more, inspired by the high degree of economic integration of Europe, we not only investigate the direct effect of sovereign rating events on Eurozone countries, but also extend the research to the indirect effect on non-Eurozone countries, such as Sweden. Therefore, the behavior of both USD/EUR and USD/SEK are studied in this paper. In addition, we exclude sovereign rating announcements concerning some relatively small economies to observe whether there exist different results.

We have several main findings. Firstly, the movement of mean level of USD/EUR is not affected by sovereign rating announcements concerning Eurozone countries, whereas the volatility behaves differently. For the case based the sovereign rating news from all Eurozone economies, the variance of USD/EUR are significantly influenced by sovereign rating events. The results indicate that “Downgrade”, “Outlook”, “Outlook (1st lag)”, “Review”, and “Review (1st lag)” all have impact on the fluctuation of euro. The one with strongest effect is putting a country on review for possible downgrade in the future, whereas the news of rating changes and outlook revisions has relatively smaller influence (despite their significance). The intuition behind such results is that the markets behave more sensitively to “possible actions” than “real actions”. On the other hand, for the case based on events from large Eurozone economies, only the news of review (“Review” and “Review (1st lag)”) has significant impact on the variance. This implies that the events of review from large Eurozone economies have dominant effects on the exchange rate and justifies our viewpoint of market expectation. Markets tend to ignore the news of review concerning small economies and will

be adjusted when the real rating actions concerning small economies happen.

Compared with euro, Swedish kronor have different responses to the sovereign rating events. For the case based on events from all Eurozone countries, both the mean and the variance react to the events. The mean level is significantly affected by “Downgrade (1st lag)”, “Outlook” and “Review”, while the volatility by “Downgrade (1st lag)” and “Outlook”. However, for the large-economy case, the volatility is no longer affected by any sovereign rating announcements while the mean is still sensitive to the same variables for the all-country case.

In spite of the findings above, there are still some issues which need more exploration. Firstly, for the all-country case, the variance of USD/SEK decreases on the day of outlook revision and increases after the day of downgrade. However, it is usually expected a larger volatility on the day of news publication and a lower one on the second day. There has not been enough empirical proof and theoretical explanation we have met.

Secondly, the mean of USD/SEK is significantly affected by sovereign rating events (despite of the small coefficients), while the volatility generally behaves insensitively to these variables. Previous empirical evidences show that news may exert more impacts on the volatility, rather than the mean. Such confusing results have not been explained by other researches, as far as we know.

Thirdly, in our study, we do not control for similar rating announcements across rating agencies. For example, S&P downgraded Greece on Dec 7, 2009, which is followed by Fitch downgrading Greece on Dec 8, 2009. We consider these as two data points. Therefore, it calls for the further investigation on how the coordinated rating announcements concerning the same country across rating agencies may affect the financial markets. Will they be regarded as stronger signals about the economic situation compared with isolated rating events so as to trigger larger market fluctuation? Or will they be absorbed by the markets only when the rating news is firstly published by one agency so that the markets are comparatively calm when the similar news is published by other agencies?

The last one, and maybe also the most important one is that in this study, we restrict our investigation to the impact of sovereign rating announcements on the exchange rate, and these announcements are actually all negative news. Other news and factors that might be positive and potentially influence the foreign exchange markets are not observed. Admittedly, these unobserved variables might influence the exchange rate and the exclusion of them might cause possible bias of the results of our research. Thus for further studies, it is suggested to include these factors in the analysis.

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Appendix

A1: Comparison of Credit Rating Measures Applied by Three Rating Agencies

Interpretation	Moody's	Standard&Poor's	Fitch
<i>Investment-Grade Ratings</i>			
Highest quality	Aaa	AAA	AAA
High quality	Aa1	AA+	AA+
	Aa2	AA	AA
	Aa3	AA-	AA-
Strong payment capacity	A1	A+	A+
	A2	A	A
	A3	A-	A-
Adequate payment capacity	Baa1	BBB+	BBB+
	Baa2	BBB	BBB
	Baa3	BBB-	BBB-
<i>Speculative-Grade Ratings</i>			
Likely to fulfill obligations, but with ongoing uncertainty	Ba1	BB+	BB+
	Ba2	BB	BB
	Ba3	BB-	BB-
High-risk obligation	B1	B+	B+
	B2	B	B
	B3	B-	B-
Highly vulnerable to nonpayment	Caa1	CCC+	CCC
	Caa2	CCC	CC
	Caa3	CCC-	C
Payment default	Ca	CC	DDD
	C	SD	DD
		D	D

Sources: Compiled based on the interpretations of credit rating symbols provided by Moody's Investor Service, Standard&Poor's and Fitch.

A2: Eurozone Sovereign Rating Announcements from 01/01/2009 to 03/31/2011

	Date	Country	Types	Rating Agency
1	01-09-09	Greece	Review	S&P
2	01-09-09	Ireland	Outlook	S&P
3	01-12-09	Spain	Review	S&P
4	01-13-09	Portugal	Review	S&P
5	01-14-09	Greece	Downgrade	S&P
6	01-19-09	Spain	Downgrade	S&P
7	01-21-09	Portugal	Downgrade	S&P
8	01-30-09	Ireland	Outlook	Moody's
9	02-25-09	Greece	Outlook	Moody's
10	03-06-09	Ireland	Downgrade	Fitch
11	03-08-09	Ireland	Downgrade	Fitch
12	03-27-09	Slovakia	Outlook	Moody's
13	03-30-09	Ireland	Downgrade	S&P
14	03-31-09	Slovenia	Outlook	Moody's
15	04-17-09	Ireland	Review	Moody's
16	05-12-09	Greece	Downgrade	Fitch
17	06-08-09	Ireland	Downgrade	S&P
18	07-02-09	Ireland	Downgrade	Moody's
19	09-03-09	Portugal	Downgrade	Fitch
20	10-22-09	Greece	Downgrade	Fitch
21	10-29-09	Portugal	Outlook	Moody's
22	10-29-09	Greece	Review	Moody's
23	11-04-09	Ireland	Downgrade	Fitch
24	12-07-09	Greece	Review	S&P
25	12-07-09	Portugal	Outlook	S&P
26	12-08-09	Greece	Downgrade	Fitch
27	12-09-09	Spain	Outlook	S&P
28	12-16-09	Greece	Downgrade	S&P
29	12-22-09	Greece	Downgrade	Moody's
30	03-16-10	Greece	Outlook	S&P
31	03-24-10	Portugal	Downgrade	Fitch
32	04-09-10	Greece	Downgrade	Fitch
33	04-22-10	Greece	Downgrade	Moody's
34	04-27-10	Greece	Downgrade	S&P
35	04-27-10	Portugal	Downgrade	S&P
36	04-28-10	Spain	Downgrade	S&P
37	05-05-10	Portugal	Review	Moody's
38	05-28-10	Spain	Downgrade	Fitch
39	06-14-10	Greece	Downgrade	Moody's
40	06-30-10	Spain	Review	Moody's

**Eurozone Sovereign Rating Announcements from 01/01/2009 to 03/31/2011
(Continued)**

	Date	Country	Types	Rating Agency
41	07-13-10	Portugal	Downgrade	Moody's
42	07-19-10	Ireland	Downgrade	Moody's
43	07-21-10	Cyprus	Review	S&P
44	08-24-10	Ireland	Downgrade	S&P
45	09-30-10	Spain	Downgrade	Moody's
46	10-05-10	Ireland	Review	Moody's
47	10-06-10	Ireland	Downgrade	Fitch
48	11-16-10	Cyprus	Downgrade	S&P
49	11-23-10	Ireland	Downgrade	S&P
50	11-30-10	Portugal	Review	S&P
51	12-02-10	Greece	Review	S&P
52	12-09-10	Ireland	Downgrade	Fitch
53	12-15-10	Spain	Review	Moody's
54	12-16-10	Greece	Review	Moody's
55	12-17-10	Ireland	Downgrade	Moody's
56	12-21-10	Portugal	Review	Moody's
57	12-21-10	Greece	Review	Fitch
58	12-22-10	Slovenia	Outlook	S&P
59	12-23-10	Portugal	Downgrade	Fitch
60	01-13-11	Cyprus	Review	Moody's
61	01-14-11	Greece	Downgrade	Fitch
62	02-02-11	Ireland	Downgrade	S&P
63	02-24-11	Cyprus	Downgrade	Moody's
64	03-07-11	Greece	Outlook	Moody's
65	03-10-11	Spain	Downgrade	Moody's
66	03-15-11	Portugal	Downgrade	Moody's
67	03-24-11	Portugal	Downgrade	Fitch
68	03-25-11	Portugal	Downgrade	S&P
69	03-29-11	Portugal	Downgrade	S&P
70	03-29-11	Greece	Downgrade	S&P
71	03-30-11	Cyprus	Downgrade	S&P

Sources: Compiled based on the sovereign rating histories provided by Moody's Investor Service, Standard&Poor's and Fitch.

A3: Details of Empirical Results**A3-1: Results of USD/EUR Based on Sovereign Rating Events from All Eurozone****Countries**

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
Constant	-0.000240	0.000245	-0.979120	0.3275
AR (1)	-0.005050	0.039710	-0.127174	0.8988
Downgrade	0.001533	0.001104	1.388527	0.1650
Downgrade(1st lag)	0.000305	0.001117	0.272633	0.7851
Outlook	-0.000743	0.002417	-0.307353	0.7586
Outlook (1st lag)	0.003474	0.002774	1.252319	0.2105
Review	0.002523	0.002115	1.192845	0.2329
Review (1st lag)	-0.001058	0.001535	-0.689132	0.4907
Variance Equation				
Constant	-0.100519	0.013751	-7.310153	0.0000
Downgrade	0.236640	0.034997	6.761817	0.0000
Downgrade(1st lag)	-0.076811	0.100362	-0.765339	0.4441
Outlook	0.094070	5.65E-09	16646540	0.0000
Outlook (1st lag)	-0.171557	0.067054	-2.558484	0.0105
Review	0.631652	0.018583	33.99079	0.0000
Review (1st lag)	-0.725035	0.045936	-15.78362	0.0000
δ	0.987017	0.002043	483.2390	0.0000
θ	-0.046981	0.019016	-2.470583	0.0135
γ	0.017288	0.010600	1.631000	0.1029

A3-2: Results of USD/SEK Based on Sovereign Rating Events from All Eurozone Countries

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
Constant	-0.000965	0.000465	-2.075479	0.0379
AR (1)	-0.052250	0.045048	-1.159884	0.2461
Downgrade	1.86E-05	0.001053	0.017643	0.9859
Downgrade(1st lag)	0.004214	0.001420	2.967081	0.0030
Outlook	0.005528	0.001992	2.774567	0.0055
Outlook (1st lag)	0.002983	0.001975	1.510476	0.1309
Review	0.003971	0.002324	1.708405	0.0876
Review (1st lag)	-0.001694	0.002015	-0.840579	0.4006
Variance Equation				
Constant	-0.396130	0.185892	-2.130975	0.0331
Downgrade	-0.262383	0.222905	-1.177108	0.2392
Downgrade(1st lag)	0.331429	0.201369	1.645880	0.0998
Outlook	-0.664004	0.342229	-1.940233	0.0524
Outlook (1st lag)	0.215675	0.339440	0.635385	0.5252
Review	-0.108496	0.293565	-0.369582	0.7117
Review (1st lag)	0.197670	0.332405	0.594668	0.5521
δ	0.974418	0.017472	55.77125	0.0000
θ	0.201997	0.063040	3.204260	0.0014
γ	-0.013883	0.032906	-0.421912	0.6731

A3-3: Results of USD/EUR Based on Sovereign Rating Events from Large Eurozone Economies

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
Constant	-0.000317	0.000297	-1.064443	0.2871
AR (1)	-0.006016	0.041015	-0.146676	0.8834
Downgrade	0.001741	0.001255	1.387427	0.1653
Downgrade(1st lag)	0.000398	0.001204	0.330469	0.7410
Outlook	-0.002131	0.004436	-0.480234	0.6311
Outlook (1st lag)	0.003071	0.003283	0.935477	0.3495
Review	0.003354	0.002925	1.146790	0.2515
Review (1st lag)	-0.001252	0.001665	-0.751518	0.4523
Variance Equation				
Constant	-0.112228	0.011420	-9.827312	0.0000
Downgrade	0.208136	0.227125	0.916395	0.3595
Downgrade(1st lag)	-0.038762	0.225067	-0.172224	0.8633
Outlook	0.148844	0.695868	0.213897	0.8306
Outlook (1st lag)	-0.204152	0.696217	-0.293230	0.7693
Review	0.766195	0.421023	1.819843	0.0688
Review (1st lag)	-0.834352	0.431921	-1.931722	0.0534
δ	0.987853	0.001032	957.2668	0.0000
θ	-0.023516	0.000699	-33.65166	0.0000
γ	0.012333	0.011319	1.089588	0.2759

A3-4: Results of USD/SEK Based on Sovereign Rating Events from Large Eurozone Economies

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
Constant	-0.001013	0.000458	-2.214815	0.0268
AR (1)	-0.059176	0.045645	-1.296420	0.1948
Downgrade	0.001143	0.001185	0.964257	0.3349
Downgrade(1st lag)	0.004192	0.001386	3.024804	0.0025
Outlook	0.005825	0.002172	2.681458	0.0073
Outlook (1st lag)	0.002008	0.002017	0.995239	0.3196
Review	0.004626	0.002551	1.813299	0.0698
Review (1st lag)	-0.000275	0.002632	-0.104298	0.9169
Variance Equation				
Constant	-0.420054	0.204968	-2.049362	0.0404
Downgrade	-0.068960	0.242539	-0.284326	0.7762
Downgrade(1st lag)	0.116563	0.241911	0.481841	0.6299
Outlook	-0.506270	0.358226	-1.413272	0.1576
Outlook (1st lag)	0.121372	0.366700	0.330986	0.7407
Review	-0.165865	0.322478	-0.514347	0.6070
Review (1st lag)	0.302659	0.358848	0.843420	0.3990
δ	0.971651	0.019200	50.60739	0.0000
θ	0.198318	0.064603	3.069785	0.0021
γ	-0.012717	0.033657	-0.377824	0.7056