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Krzysztof Jajuga
Lucjan T. Orlowski
Karsten Staehr *Editors*

Contemporary Trends and Challenges in Finance



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Editors

Contemporary Trends and Challenges in Finance

Proceedings from the 2nd Wroclaw
International Conference in Finance

 Springer

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Preface

This volume presents papers from the 2nd Wrocław International Conference in Finance held at Wrocław University of Economics on September 27–28, 2016. We have sought to assemble a set of studies addressing a broad spectrum of recent trends and issues in finance, particularly those concerning markets and institutions in Central and Eastern European countries. In the final selection, we accepted 28 of the papers that were presented at the conference. Each of the submissions has been reviewed by at least two anonymous referees, and the authors have subsequently revised their original manuscripts and incorporated the comments and suggestions of the referees. The selection criteria focused on the contribution of the papers to the modern finance literature and the use of advanced analytical techniques.

The chapters have been organized along the major fields and themes in finance, i.e. the econometrics of financial markets, stock market investments, macrofinance, banks and other financial institutions, public finance, corporate finance and household finance.

The part on the econometrics of financial markets contains seven papers. The paper by Ewa Dziwok investigates some liquidity measures using data from the Polish market. The paper by Agata Kliber analyses the impact of sovereign CDS on other instruments in financial markets. The paper by Paweł Kliber examines the factors influencing overnight interest rates on the Polish interbank market. Blanka Łęt studies in her paper whether the listings of natural gas prices in different derivative markets are linked. Paweł Miłobędzki examines whether the US dollar, the pound sterling, the Swiss franc and the Japanese yen are hedges or safe havens for Polish stocks and bonds. Marta Chylińska and Paweł Miłobędzki provide an application of a VEC DCC-MGARCH model for copper futures. The paper by Piotr Pluciennik and Magdalena Szyszko presents an analysis of the dependences between inflation expectations extracted from inflation-linked swaps and the exchange rate, oil prices and the interbank rate.

The part on stock market investments contains four papers. The paper by Agata Gluzicka applies the risk parity idea to the portfolios of stocks on the Warsaw Stock Exchange. Sabina Nowak in her paper uses modified versions of models by Fama

and French to include order imbalance factors. The paper by Joanna Olbryś studies the interaction between market depth and market tightness on the Warsaw Stock Exchange. In their paper Paulina Roszkowska and Łukasz Langer investigate mispricing in equity markets by studying abnormal excess returns determined by classical and modern asset pricing models.

The part on macrofinance contains five papers. The paper by Małgorzata Iwanicz-Drozdowska and Paweł Smaga presents an analysis of factors influencing the development of financial systems in 40 countries. The paper by Marta Karaś and Witold Szczepaniak discusses an alternative method for calculating the CoVaR of the banking system. In their paper Darko Lazarov, Tanja Lakovic and Emilija Miteva-Kacarski investigate the influence of the quality of financial information on the development of stock markets in 38 countries. The paper by Magdalena Ligus and Piotr Peternek examines the preferences of home buyers in relation to urban environmental attributes. Małgorzata Olszak and Iwona Kowalska study the effect of macroprudential policies and microprudential regulations on the sensitivity of leverage and liquidity-funding risks to the business cycle.

The part on banks and other financial institutions contains five papers. The paper by Beata Lubinska presents a model of the optimization used for management of banking books. Marta Małecka investigates VaR model testing for no-failure cases. The paper by Helmut Pernsteiner and Jerzy Węclawski contains an analysis of relationship banking in Poland. Alicja Wolny-Dominiak analyses the prediction of total loss reserves in non-life insurance company by using a generalized linear model. In their paper Ewa Wycinka and Tomasz Jurkiewicz investigate the use of a mixture cure model for a sample of consumer credit accounts of a Polish financial institution.

The part on public finances contains three papers. Elena Querci and Patrizia Gazzola present an analysis of a model of health care providing low costs and high value. The paper by Petra Jánošíková and Radka MacGregor Pelikánová analyses the real estate transfer tax in different EU countries. The paper by Tomasz Skica, Jacek Rodzinka and Ruslan Harasym contains an analysis of the impact of the financial policy of local government units on the development of entrepreneurship.

The part on corporate finance contains two papers. Julia Koralun-Bereźnicka examines how the capital structure of companies in 13 EU countries depends on the firm size and debt maturity. The paper by Elżbieta Rychłowska-Musiał describes investment decision rules using real options theory.

The part on household finance contains two papers. Katarzyna Kochaniak analyses the risk profiles of household financial asset portfolios and their determinants in 15 euro area countries. The paper by Beata Lewicka contains the analysis of factors which have a significant impact on having a consumer credit or a mortgage loan among people over the age of 50.

We wish to thank the authors for making their studies available for our volume; their collegial, professional efforts and research inquiries made this volume possible. We are also indebted to the anonymous referees for providing insightful reviews with many useful comments and suggestions.

In spite of our intention to address a wide range of problems pertaining to financial markets, institutions and business organizations, we recognize that there are myriad issues that still need to be researched. We hope that the studies included in our volume will encourage further research and analyses in the interesting field of modern finance.

Wrocław, Poland
Fairfield, CO
Tallinn, Estonia
December 23, 2016

Krzysztof Jajuga
Lucjan T. Orlowski
Karsten Staehr

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Part I
Econometrics of Financial Markets

Chosen Measures for Pricing of Liquidity

Ewa Dziwok

Abstract The financial crisis of 2007–2009 showed that especially liquidity risk was underestimated or was not taken seriously into account. The existing liquidity measures proved to be inadequate or incorrectly used. This is why the alternative measures should be considered. The aim of the article is to examine the specific measures of liquidity using a sample of daily data. The particular attention will be paid to the yield curve fitting error, precisely to root mean squared error. The analysis covers the time series of errors calculated from daily WIBOR data and yield curve construction using two types of parametric models—Nelson-Siegel and Svensson one. By employing chosen liquidity measures into Polish financial market one can confirm their effectiveness in case of market disturbances.

1 Introduction

The financial crisis of the years 2007–2009 showed many shortcomings among which one of the most important was an underestimation or even omission of liquidity on specific level of its existence. Even more, recent crisis showed that its character was strictly multi-dimensional, that is why the approach to this case should be multi-dimensional as well.

A motivation for this study was caused by well-known problems with liquidity risk on international, macro, global level that comes from lack of mechanisms which coordinates national approaches, greater complexity in the international context as well as scarcity of data on international level.

From the micro-perspective the liquidity risk is the key problem to keep the enterprise healthy. The existing regulations, especially in banking system, have influenced their profitability and have changed their model of investments. An existing literature shows several examples of alternative measures of market liquidity. Duffie and Singleton (1997) showed that changes in swap spreads are related to changes in counterparty and liquidity risk, Flood et al. (2015) showed the behavior

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of liquidity measures for equity, corporate bond, and futures markets, van der Merwe (2015) describes measures of market liquidity.

The goal of this research is to investigate a range of liquidity measures with special attention to alternative ones. The main focus is put on the yield curve fitting error, precisely on root mean squared error. By calculation and analysis of the time series that consist of errors calculated from daily WIBOR data it could be found that there is strong inter-relation between turmoil in the market and level of the error. The result was confirmed by two different models used for a yield curve construction: Nelson-Siegel and Svensson one.

2 Liquidity and Liquidity Risk

The problem with liquidity takes place when there is a difficulty to fulfill all payment obligations at time when they mature, to their full amount and in the appropriate currency.

This short description shows that liquidity is a specific attribute of the institution—if the institution has enough liquidity, it could be definitely seen as one of its strengths (in a SWOT analysis of the institution). The characteristic aspect of liquidity is that it must be available all the time—regardless of the situation on the market and even in crisis situations where the probability of their occurrence is very small.

Economic theory offers at least two different concepts of liquidity (ECB 2007). One of them is called monetary liquidity and it relates to the quantity of liquid assets in the economy, which is related to the level of interest rates. A second concept is market liquidity, which is generally seen as a measure of the ability of market participants to undertake transactions without an influence on the prices. These two concepts are quite different and although there is a relationship between them, they are usually separately evaluated.

Some sources distinguish three types of liquidity (Nikolaou 2009): funding liquidity connected with cash management framework, market liquidity associated with asset-pricing models and central bank liquidity related to monetary policy context. All these types are strongly linked to each other by bilateral influence and inter-reactions. Sometimes additional, broader—in its meaning—type of liquidity is mentioned (Chorofas 1998)—macroeconomic liquidity which could be considered as surplus to the needs of the real economy and can influence market behaviour.

Following the Basel Committee of Banking Supervision (Committee of European Banking Supervisors 2009), funding liquidity is “the ability to fund increases in assets and meet obligations as they come due, without incurring unacceptable losses”. It could be understood as a flow concept where liabilities can be simply financed through different sources and at an acceptable and reasonable price. In other words, the institution is liquid while its inflows exceed the outflows. The risk that is connected with the funding liquidity appears in the situation when the institution could not fulfill its obligations without a delay.

Sometimes the sources of the risk is endogenous in nature and comes directly from the institution (moral hazard, fraud etc.), sometimes is exogenous and depends on the market situation.

Market liquidity, called sometimes as trading liquidity, is the ability to trade quickly at a low cost without large changes in their prices (O'Hara 1995) and—in its nature—is highly connected with funding liquidity. The main characteristics of liquid (healthy) market are: narrow bid-ask spreads, low transaction costs and lack of influence of large volumes of transactions (or large number of transactions) on prices. Market liquidity could be divided into several subclasses concerning asset type as well as subsets of whole financial markets (focus on the country, currency etc.). The market liquidity risk arises while there are problems to achieve a fair price of the asset immediately.

Central bank liquidity means the ability of the central bank to provide the required liquidity to the financial system. As a liquidity provider the central bank uses its tools to steer the liquidity on the desired level. Among popular tools are direct ones: open market operations (OMO), reserve requirements, and those which have an indirect influence on money in the economy—the short term interest rate (s) (target rate), credit requirements, taxes etc. The central bank liquidity risk appears on the counterparty level as a consequence of inappropriate monetary policy or unexpected turmoil.

Last type of liquidity is a macroeconomic one and is connected with a whole financial system. The risk is called the systemic liquidity risk and is usually associated with a global financial crisis and effect of contagion. Before that type of risk is measured, there is a need to answer the questions: how to measure a liquidity risk globally, whether is possible a feasibility of international regulations and which regulations are universal and which ones should be set individually for different countries.

3 Liquidity Measures

The problem how to measure liquidity has emerged together with financial market operations. The bank managers were obliged to keep money for the expenses and tried to calculate appropriate amount to cover the needs of depositors as well as the other counterparties. On the other hand supervisors started to control the system as a whole quite early to omit or at least reduce the risk of contagion.

Considering the funding liquidity the risk is measured at the institution level and in case of bank the most popular is gap analysis, building term structure of expected cash flows and term structure of expected cumulated cash flows as well as fund transfer pricing policy (Castagna and Fede 2013).

Market liquidity could be measured by (Fleming 2003):

- bid-ask spread: calculated as the difference between the bid and ask price to show how much a trader can lose by selling an asset and buying it back right away. The spread usually increases at time of uncertainty.
- market depth: how trading volume is changing during time, trading frequency, Market depth measures the amount that can be traded at a given moment in time as indicated by the trading book
- price impact market resiliency: how many units traders can sell or buy at the current bid or ask price without moving the price

Central bank liquidity risk is usually measured by evaluating the liquidity delivered to the economy by the central bank, in form of e.g. open market operations.

At the supervisory level liquidity is measured by the enterprise (e.g. bank) and monitored by the supervisor (central bank). Basel regulations proposed two standards for liquidity risk: liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR); the indicators that allow to measure and monitor the short-term and long-term liquidity.

Apart from the well-known and often used measures there are also some other studies showing alternative liquidity measures. The research of Fleming (2000) described the yield curve fitting errors as a measure of market illiquidity. It could be implemented through noticeable influence of turbulent market on yields that are modeled with a yield curve. Yield curve fitting errors show a possibility for an alternative income especially for speculators and arbitrageurs.

4 Chosen Liquidity Measures and Application into Polish Market

The research shows the deviation between market yields and those implied by the estimated term structure of interest rates. For a given day the difference between the quoted yield of an asset and the yield implied by term structure model has been calculated. The aim is to show how these deviations are affected by liquidity considerations, especially in turmoil time when shortage of quotations, wider spread and reduced demand can influence the prices.

For the research purposes two models from parametric group of models are taken into account: first one based on four parameters (Nelson and Siegel 1987), and the second one developed by Svensson and based on six parameters (Svensson 1994). The choice of parametric models was provoked by their role in monetary policy of central banks (BIS 2005). These two vectors of parameters have been calculated day by day since 2005 by minimizing mean square errors between market and theoretical yields:

$$\frac{\sum_{l=1}^k (i_l - \bar{i}_l)^2}{k} \rightarrow \min \quad (1)$$

where: $i_l - \bar{i}_l$ — a yield error of l -th asset

k —number of assets

The data come from Polish money market, and include WIBOR (money market fixing quotations), for maturities from one day to one year (T/N-tomorrow next, 1W-one week, 2W-two weeks, 1M-one month, 3M-three months, 6M-six months, 9M-nine months, 1Y-one year), taken daily between 2005 and 2012 when the biggest volatility could be observed.

The comparison of two types of parametric models covers calculation of the mean and standard deviation over a number of days. A low mean value confirms the flexibility of each model and demonstrates its ability to fit precisely into the data. The standard deviation level enables the assessment of the reliability of the entire sample.

In the considering case the RMSE was calculated for Nelson-Siegel and Svensson parametric model. To achieve the results two macros were written in VBA code which helped to receive two panel results in form of daily vectors of parameters (a four-parameter vector for the Nelson-Siegel model and six-parameter vector for the Svensson one). Additionally, two vectors of RMSE were calculated (a goodness of fit statistics is presented in Table 1).

It is easy to notice that the mean of average price errors is very small, although the Svensson model shows a slightly better result than the Nelson-Siegel one (that appears to be less flexible). The results of RMSE statistics show that Svensson model produces lower mean value of RMSE as well as lower standard deviation.

The plots of errors for chosen methods let analyze their sensitivity to disturbances in the market (Fig. 1). From the beginning of financial crisis the volatility of financial instruments' rates had become very high which caused problems with fitting the data. As a chart shows, the most resistant to the market disturbances (starting in autumn 2008) turned out to be the Nelson-Siegel model.

The chosen measure confirms that there is a strong inter-relation between turmoil in the market and level of the error. Together with the beginning of market turmoil (IX.2007–III.2008) the difference between market and theoretical yields started to increase. The highest level of the error was noticed during last days of November and in the beginning of December 2007 regardless of the chosen model.

Table 1 Goodness of fit statistics

Model	Nelson Siegel	Svensson
Observations	1957	1957
Mean	0.00047	0.00032
Standard Deviation	0.00096	0.00061

Source: Own calculations

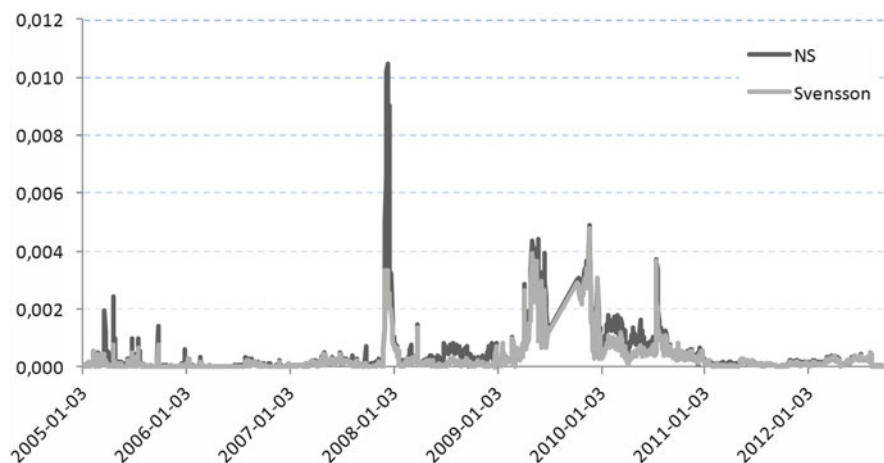


Fig. 1 RMSE errors for the different types of model fitting technique. Source: Data from www.reuters.pl, own calculations

High variability could be also observed in a whole year 2009—despite the fact that the error was not very high, we have seen an increased volatility due to lack of liquidity.

5 Summary

Two different models were applied here (based on Nelson-Siegel and Svensson research) to show the root mean squared error as a market liquidity measure. The presented summary statistics (represented through a low value for the mean and the standard deviation) let assume that both methods are suitable to analyze liquidity. The chosen measure—the root mean squared error proved to be sensitive to market turmoil when its level significantly increased (as it was expected).

The most important conclusion from this study is that the goodness of fit criteria vary over time and that it can be an interesting alternative to other measures. Comparing to Basel III liquidity criteria, both measures (LCR, NSFR) are based on the asset-liability situation in banking sector that are published with time-lag (for preparation, calculation and delivering of data). In case of proposed measure, a current situation in the interbank market could be presented almost at once. In that sense the proposed measures could be treated as an alternative indicator of market liquidity. Additionally, Polish market as an emerging one, is sufficiently sensitive to new information, to implement here alternative measures of market liquidity.

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Not as Black as Is Painted? Influence of sCDS Market on Domestic Financial Markets Before and After the Ban on Naked sCDS Trade

Agata Kliber

Abstract In the article we analyze the impact of sovereign CDS on other financial market within a country and verify whether the impact changed after imposing the ban on trade of the non-covered sCDS in Europe (November 2012). We analyze European sCDS of both emerging as well as developed economies, who retained their own currencies, i.e. Poland, Hungary (emerging markets) and Sweden and United Kingdom (developed ones), over the period 2008–2013. We investigate the degree of influence between the sCDS and foreign exchange market, sCDS and sovereign bond, as well as sCDS and stock exchange ones. The results vary depending on the analyzed country, indicating clearly that the Central European markets are much prone to sunspots and volatility transmission than the Western ones. However, in general the results support the hypothesis that the impact of the CDS on the other financial markets diminished after November 2012.

1 Introduction

One of the most common indicators of a country's solvency risk is sovereign CDS spread. The construction of the instruments is as follows. The buyer of the CDS protects himself against the insolvency of his debtor entering the sCDS contract. He pays the seller a pre-specified amount, so called: premium or spread, expressed in basis points. In the case of the credit event (e.g. delay in payment, decline to pay, etc.), the seller of the CDS pays the buyer the amount pre-specified in the contract.

The underlying instrument of sovereign CDS is the government bond. Primarily, the buyer of the sCDS was not obliged to possess the bond. Thus, the instruments could have been used to simply speculate on government default. During the Greek crisis such speculators were blamed for raising the cost of the issuers of government debts (including Greek debt itself)—see also Augustin (2014). Therefore, the legislators in European Parliament and the Council of the European Union issued

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a new Regulation, which came into force on 1 November 2012. According to this Regulation (EU No 236/2012) it is forbidden to enter short position in uncovered sovereign debt through the CDS contract in European Union (ISDA 2014).

This decision has been widely criticized by the market analysts and investors, because of its negative impact on the market liquidity (ISDA 2014). In the case of Western Europe, the volume traded fell even by 50%, while in the case of the Central one—by 40%. At the same time, market participants started to utilize another indices, e.g. iTraxx Europe Senior Financials.

The aim of our research was to verify whether imposing the new regulation could have any significant impact on the interrelations between the sCDS market with other financial markets within the same country. We analyzed four different markets: Sweden and the United Kingdom (safe and developed), Hungary (risky and developing), as well as Poland (still developing but less risky). The main criterion of the choice was whether the countries retained their own currencies up to the end of 2013, since one of the analyzed financial markets was the foreign exchange one. The other sectors of interest were: the sovereign bonds and the stock exchange one. We end our sample in 2013 since in this year another regulation came into force—the Dodd-Frank one (see: ISDA 2015). We believe that taking into account longer period we would be unable to distinguish between the effect of the two different regulations.

Our article contributes to the existing literature in the following way. First, we analyze possible causality from sCDS market to the other financial markets within a country, interpreting the results as the degree of immunity against volatility transmission or herd behavior. Secondly, we analyze the role of the new regulations from November 2012 on the strength of those relationships, which up to our knowledge has not been done yet.

The remainder of the paper is as follows. First, we present the data and shortly describe the four segments of financial markets in the analyzed countries. Next, we discuss the volatility models estimation and the results of the causality-in-variance tests. We check the robustness of the results analyzing patterns of impulse response functions. We end out article with the discussion of the results.

2 The Data

We collected the data of the sCDS, bonds, exchange rates and indices for four countries that retained their own currencies up to the end of 2013, i.e. Hungary, Poland (central Europe), as well as Sweden and United Kingdom (the developed markets of Western Europe).

2.1 Bond Market

Domestic bonds market is documented as being the most isolated from the abroad incidents (Kocsis 2014). Let us compare the dynamics of the sCDS spreads together with the dynamics of the sovereign bonds yields. It appears that in the case of Sweden (Fig. 1) the bond's yield and sCDS spread changed in opposite direction. The growth of the sCDS spread was accompanied with the decline of the bond yield. This could indicate that the internal evaluation of the government solvency (yield) was different to the external one (CDS spread).

Similar pattern is observed in the case of the British sCDS and bonds (Fig. 2). The changes of the bond yield were much less dynamic than the sCDS spread, and starting from autumn 2011 the instruments started to change in opposite direction.

In the case of Poland, again, the dynamics of the bonds was more “flattened” than the dynamics of sCDS spread. However, the overall tendency was similar—see Fig. 3.

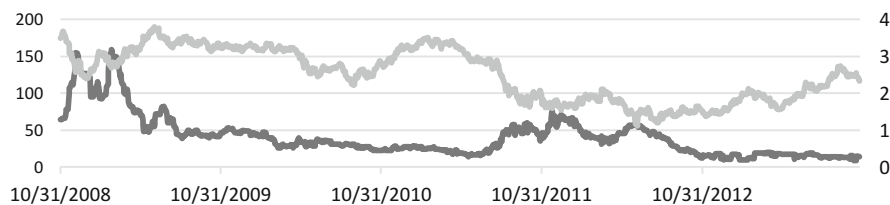


Fig. 1 Dynamics of sCDS (left axis, black line) and bonds (right axis, grey line)—Sweden

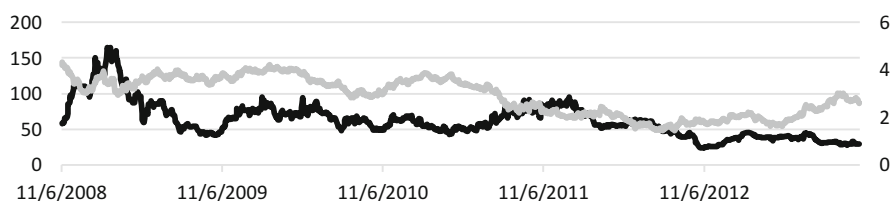


Fig. 2 Dynamics of sCDS (left axis, black line) and bonds (right axis, grey line)—UK

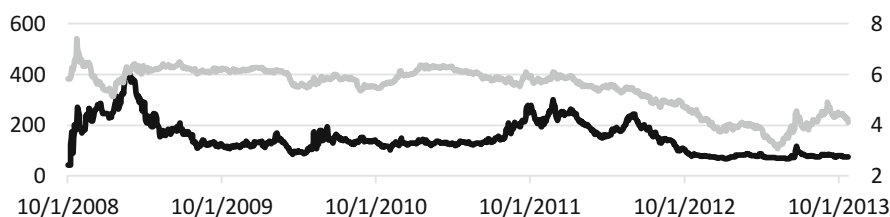


Fig. 3 Dynamics of sCDS (left axis, black line) and bonds (right axis, grey line)—Poland

In the case of Hungary (Fig. 4) the overall tendencies were similar, although the changes of the sCDS spreads were more sharp and dynamic. The Hungarian crisis of 2010 was reflected in the growth of the sCDS spread, while the yield of the domestic bonds did not react.

2.2 Exchange Rate

All of the analyzed countries retained their own currencies up to the end of 2013. However, each of the country conducted their own exchange rate policy. In the case of the United Kingdom, Sweden and Poland the exchange rate regime was free floating, and in the case of Hungary: floating.

In the case of Sweden (Fig. 5) we observe the constant upward trend, which seems to be opposite in comparison to sCDS changes. Drop of SEKEUR is accompanied with the growth of CDS—the periods of depreciation correspond to the periods of the country risk growth.

In the case of the Great Britain (Fig. 6) similar patterns were observed. However, in some periods the instruments showed common tendency (e.g. from October 2009 to March 2010 or from July 2011 to January 2012).

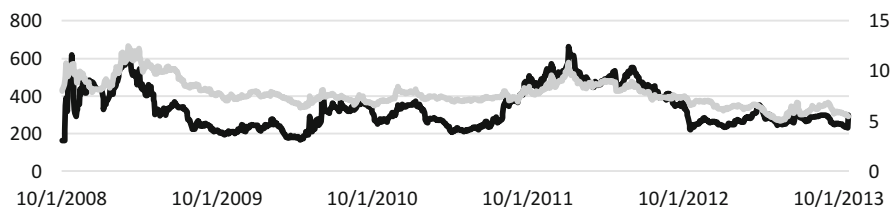


Fig. 4 Dynamics of sCDS (*left axis, black line*) and bonds (*right axis, grey line*)—Hungary

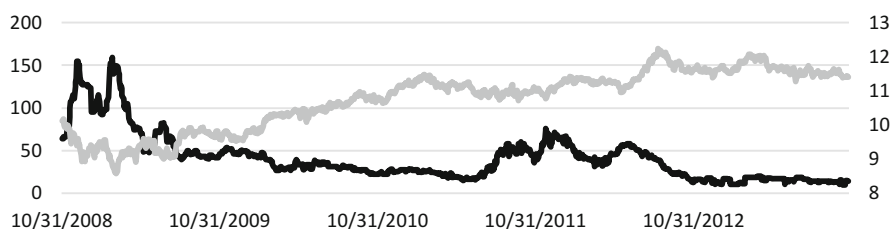


Fig. 5 Dynamics of the Swedish CDS (*left axis, black line*) and SEKEUR (*right axis, grey line*) exchange rate

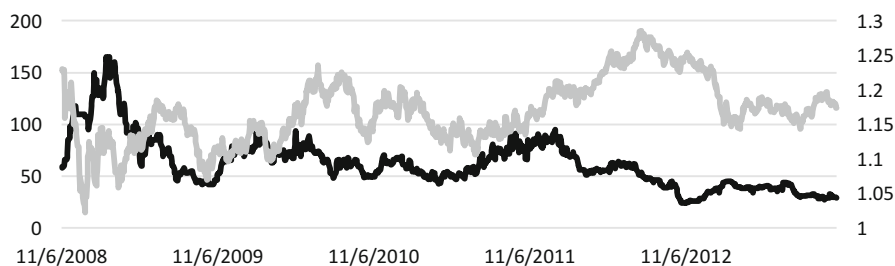


Fig. 6 Dynamics of the British CDS (*left axis, black line*) and GBPEUR (*right axis, grey line*) exchange rate

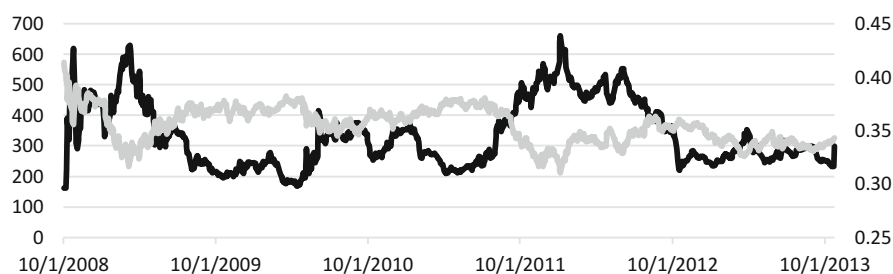


Fig. 7 Dynamics of the Hungarian sCDS (*left axis, black line*) and HUFEUR (*right axis, grey line*) exchange rate

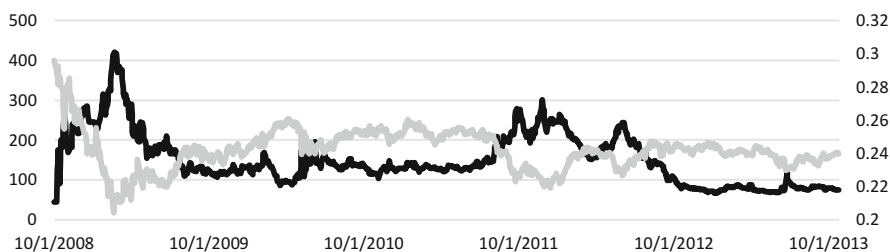


Fig. 8 Dynamics of the Polish CDS (*left axis, black line*) and PLNEUR (*right axis, grey line*) exchange rate

In the case of Polish CDS the relationship was clearly opposite—the same concerns Hungary. At the end of 2008 and beginning of 2009, due to the crisis transmission and speculative attacks on the East-European currencies, we observe depreciation in all the cases (Figs. 7 and 8).

2.3 Stock Exchange

In the case of Sweden we take into account OMXS30 index: OMX Stockholm 30 Index (see: NASDAQ OMX 2014). In the case of United Kingdom we analyze the FTSE250 index (see: FTSE Group 2015). In the case of Poland we study the dynamics of WIG20 index (Warsaw Stock Exchange Index, see: WSE 2013), while in the case of Hungary—BUX: the official index of blue-chips shares listed on the Budapest Stock Exchange (see: <http://bse.hu/>).

Figures 9, 10, 11 and 12 present the dynamics of the sCDS series together with the stock indices. In all the cases the dynamics was similar but changes went in opposite directions. The values presented in the charts are the close values of the indices and close values of the sCDS contracts (in basis points). The relationships between the measures are obvious—the increase of the index value is considered a

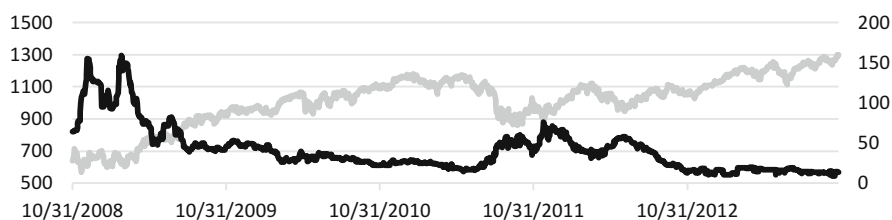


Fig. 9 Dynamics of OMXS30 (left axis, grey line) and Swedish CDS (right axis, black line)

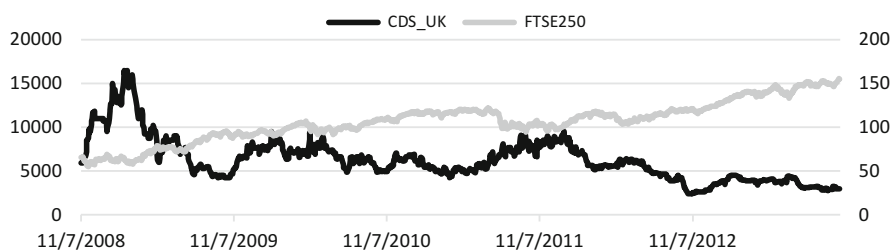


Fig. 10 Dynamics of FTSE250 (left axis, grey line) and British sCDS (right axis, black line)

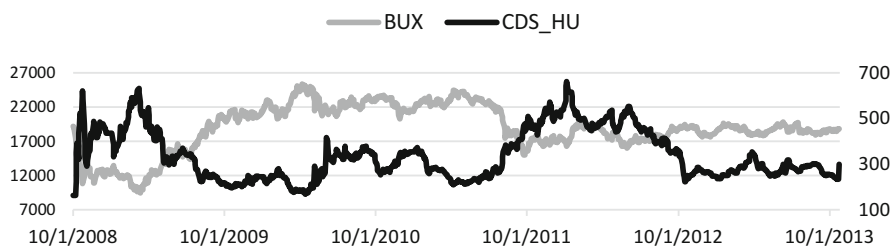


Fig. 11 Dynamics of BUX (left axis, grey line) and Hungarian sCDS (right axis, black line)

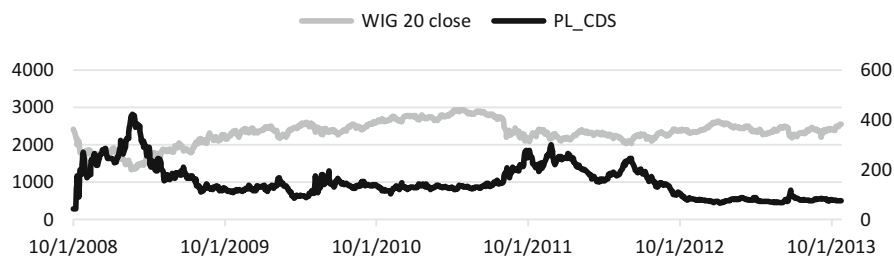


Fig. 12 Dynamics of WIG20 (*left axis, grey line*) and Polish sCDS (*right axis, black line*)

positive phenomenon and thus the risk of the country should diminish. The decline of the index value is considered as negative information and thus should be accompanied with the growth of the risk of the country.

3 Causality in Mean and Variance

In the first step of the research we computed the unrestricted VAR system for the markets in each country separately. The number of lags (1) was chosen based on the value of Schwarz information criterion. Next, we computed the statistics of Granger causality from sCDS to the system of the other variables, for each country separately. We took into account both Granger and instantaneous causality. The results are presented in Table 1. We observe that before the ban, feedback occurred in the case of Sweden, UK and Poland, while in the case of Hungary—feedback and Granger causality. However, after the ban was imposed, the relationships ceased in the case of Sweden and the United Kingdom. In the case of Poland and Hungary, feedback has been present even in the second period.

Since in financial markets the relationships in volatility are even stronger than in mean (although volatility itself is in fact not observed) we decided to check also the causality in conditional variance. We estimated the univariate volatility models of GARCH-type (Bollerslev 1986) for each series in each country and performed the Hong (2001) test on the squared standardized residuals obtained in this way. We chose the best model based upon its ability to explain all linear and non-linear dependencies of the data, as well as upon the significance and stability of the parameters.

For the sake of consistency we do not present the results of the GARCH estimation (they are available upon request). For the same reason, we do not present the formula of the Hong test in the article, as well. We refer the Readers to the original work of Hong (2001), to the work of Cheung and Ng (1996), as well as to: Osińska (2008, 2011) and Łęt (2012).

We performed the Hong test using Daniell and Tuckey-Hanning kernels, taking into account both feedback (including the lag 0) and Granger causality (excluding the lag 0). We took into account short-term and long term relationships, running the

Table 1 Results of the causality test in mean and variance before and after November 2012—summary of the results

Market	Sweden	United Kingdom	Hungary	Poland
Before November 2012				
CAUSALITY in MEAN				
CDS to all markets	FEEDBACK	FEEDBACK	FEEDBACK and Granger causality	FEEDBACK
CAUSALITY in VARIANCE				
Stock exchange	FEEDBACK and Granger causality for large M	FEEDBACK	FEEDBACK and Granger causality	FEEDBACK and Granger causality
Bonds	FEEDBACK	FEEDBACK	FEEDBACK and Granger	FEEDBACK and Granger
Foreign exchange	FEEDBACK and Granger causality for larger M	NO	FEEDBACK and Granger	FEEDBACK and Granger
After November 2012				
CAUSALITY in MEAN				
CDS to all markets	NO	NO	FEEDBACK	FEEDBACK
CAUSALITY in VARIANCE				
Stock exchange	NO	NO	NO	NO
Bonds	NO	NO	NO	NO
Foreign exchange	NO	NO	Granger for M = 20 and M = 50	NO

Note: feedback denotes that the causality was depicted when lag 0 was included, Granger causality—when lag 0 was excluded in the test statistics

test for the following lags: $M = 1, 5, 10, 20, 50$. We report the results in short form in Table 1. We present the results for the whole period, then the period up to November 2012 and the period starting from November 2012.

In the case of Sweden, we observe that the null hypothesis of no causality was rejected almost in each case in the full period, and also in the period prior to the new regulation. The exception was the Granger causality between CDS and bonds. However, after November 2012 we do not reject the null hypothesis in any case but the lag 50 (i.e. over 2 months history). The results undoubtedly suggest that there has been a change in the interrelations between the sCDS market and the remaining financial markets and that the change coincide with the implementation of the new regulations.

When we take into account the United Kingdom, it appears that before the new regulations there existed instantaneous causality between CDS and bonds as well as CDS and FTSE250. No causality between CDS and GBPEUR was observed.

However, after implementing the new regulations, all the interrelationships ceased. Again, the results strongly support the thesis that the new regulations contributed to weakening of the relationships between the analyzed markets.

The results differ in the case of Poland and Hungary. In Hungarian markets, in the period prior to November 2012 the null hypothesis was rejected in each case. Thus, we conclude that the changes of CDS volatility influenced significantly volatility of the other instruments. However, as the new regulation had been implemented, this influence ceased. We did not reject the null hypothesis in any case, apart from interrelations with HUFEUR for lags 20 and 50, Daniell kernel.

The results obtained for Poland are similar to the results obtained for Hungary. Causality from CDS market used to be strong prior to November 2012, and afterwards the relationships disappeared (Table 1).

4 Robustness Check: Volatility Impulse Response

In order to check the robustness of the results, we computed the accumulated impulse response functions for the system of variables before and after the 2012-ban. We took into account the results of the VAR model, which was computed in the first step of the research. We present the results in Figs. 13, 14, 15, and 16. We present the values of impulse response, and we assess their significance based on the upper and lower value of the 95%-confidence interval, which is not present in the figures for the sake of clarity. We observe that the responses of bond (dark gray dashed line), exchange rates (light gray dotted line) and stock indices (black solid line) diminished drastically in the second sub-period.

In the case of Sweden we observe a significant response of bonds and FX rate to the sCDS shock before the ban. After the ban only the response of the stock market became significant, but much lower (Fig. 13), while the other markets did not respond significantly to the sCDS shocks. In the case of the United Kingdom the

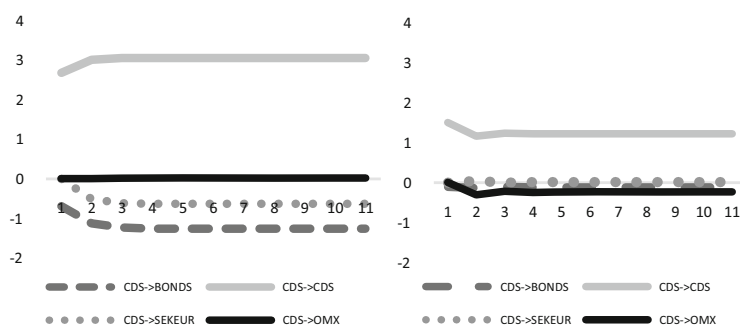


Fig. 13 Cumulative impulse response function—Sweden before the ban (*left panel*) and after the ban (*right panel*)

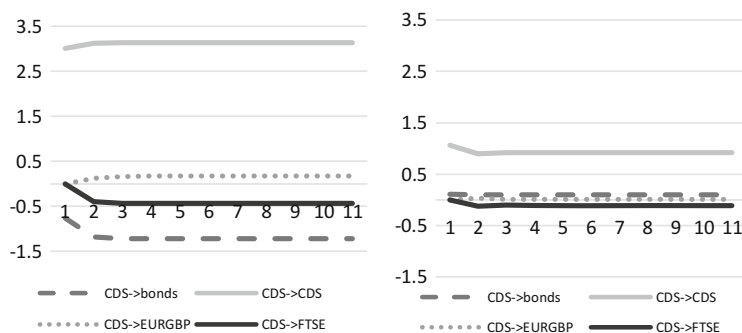


Fig. 14 Cumulative impulse response function—United Kingdom before the ban (*left panel*) and after the ban (*right panel*)

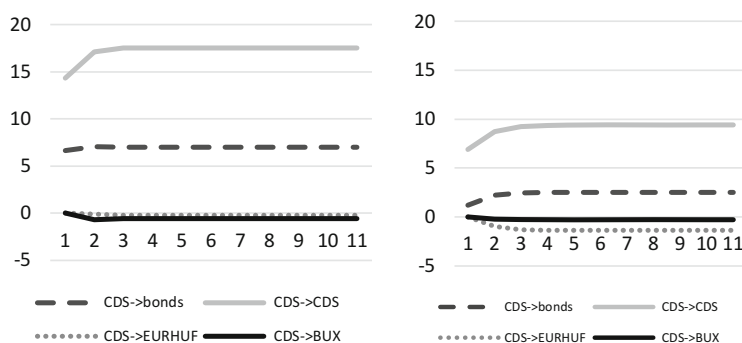


Fig. 15 Cumulative impulse response function—Hungary before the ban (*left panel*) and after the ban (*right panel*)

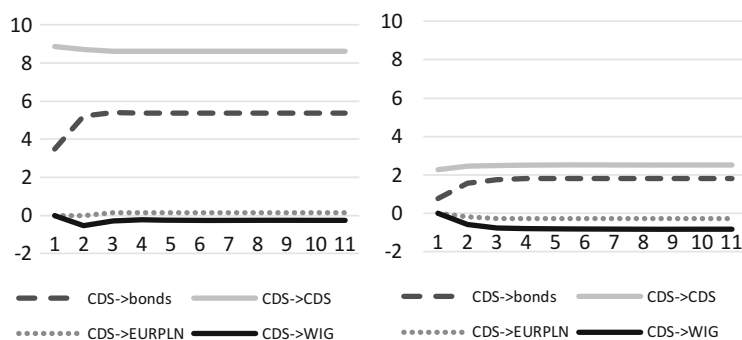


Fig. 16 Cumulative impulse response function—Poland before the ban (*left panel*) and after the ban (*right panel*)

responses of the stock, bonds and foreign exchange markets were significant before the ban and became insignificant afterwards (Fig. 14).

In the case of Poland and Hungary the situation was different. The response of FX rate and stock market proved to be insignificant before the ban. After the ban was imposed, in the case of Hungary (Fig. 15) the reaction of exchange rate became significant, while in the case of Poland (Fig. 16)—the reaction of stock exchange. In both cases the response of bonds remained significant, as well. However, the strength of response diminished drastically, as in the case of Sweden and the United Kingdom (including the reaction of sCDS to its own impulses). It is worth noting that the value of response was much higher in the case of the emerging economies, and even after the ban their values exceeded the before-ban values of responses in the developed ones.

We can interpret the results in a similar way to Orlowski (2016)—the high response of a given market to sCDS one is a sign of strong integration between them. We observe that in general the most integrated were the sCDS and bonds one. As the response became much weaker after the ban, we can suppose that the markets became much less integrated.

5 Conclusions

In the article we compare the behavior of various financial markets in developing and developed European economies. The group of the developing economies comprised of Hungary and Poland, while the developed ones were represented by the United Kingdom and Sweden. The choice of the countries depended on whether the country retained its own currency up to the end of 2013. We analyzed interdependencies between the following pairs of markets: CDS and bonds, CDS and foreign exchange, CDS and stock market. We investigated the strength of the interdependencies during the financial crisis and verified whether the ban on uncovered CDS trade could contribute to weakening of those relationships. We estimated GARCH-type models of volatility and run a series of causality-in-variance tests.

The obvious drawback of the study is the lack of additional variables, that could have influenced the interactions among the markets (i.e. the proxy of global volatility). Moreover, there is no evidence that the reason of the change of relationships was this particular ban on uncovered sCDS trade. The relationships started to cease during the year 2012 (see also Kliber 2016) and in fact it is impossible to determine whether the reason was the ban, any other international event or a group of events, or was it just a coincidence. However, if we assume that the ban was the reason of the relationships end, the conclusions are as follows.

First, the results differ significantly depending on whether the analyzed country was an immune and safe Western-European market or a more risky and developing one. When we analyze the interrelationships in variance in the case of *Sweden* it appears that before the crisis only the bond market was free from the sCDS