ANALYZING THE RELATIONSHIP BETWEEN EONIA AND EONIASWAP RATES. A COINTEGRATION APPROACH

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Abstract: *The aim of this paper is to analyze the behavior of Eoniaswap rates at different maturities during the 2007-2013 period. This index is representative for the Eurozone interbank swap market and its evolution is significantly influenced by the monetary policy of the European Central Bank. In order to asses this influence, we apply stationarity tests, cointegration tests and a variance decomposition analysis for the interbank swap rates. The results show that Eoniaswap rates exhibit structural breaks, long-term memory and a persistent behavior. The variance* of *Eoniaswap rates at a certain maturity is influenced by shocks to other maturities of Eoniaswap rates, but shocks coming from Eonia interbank rate are rapidly absorbed. Johansen cointegration test confirms the existence of long-run equilibrium relationship between Eonia and Eoniaswap rates.*

Keywords: Eoniaswap rates; interbank markets; cointegration; structural breaks; variance decomposition

JEL Classification: E43, E50, G10, G21

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1. Introduction

The most important market risk faced by the banks operating in the European banking system is the interest rate risk. This can be managed through interest rate swap contracts, which underlying assets are directly linked with the interbank markets interest rates. The literature accounts for several studies which evaluate the effectiveness of interbank markets. Because of the role they play in the implementation of monetary policy, the overnight interest rates are an anchor for the term structure of interbank interest rates. According to a study of the European Central Bank (2007), the swaps that have as underlying asset the interbank overnight rate (Eonia) form the most liquid interbank market in the Euro Area. The explanation is that the Eoniaswap rates are the most used tools for speculation and hedging against interest rate risk. Also, they are very good indicators of market expectations regarding the long run evolution of the swap rates during the maturity of the contract.

Most studies in the literature focus on the factors that determine banks to use derivatives as well as the relationship between the use of derivatives and banking risks. Some of the most representative studies are those of Brewer, Minton and Moser (2000), Gunther and Siems (2002), Kim and Koppenhaver (1992) and Sinkey and Carter (1994) which found that the probability of banks trading financial derivatives depends on several key factors such as the size of the banks, the interest rate gap, the net interest margin, the commercial lending and the capital adequacy ratio.

Regarding the impact of financial derivatives on market risk, Chaudhry and Reichert (2002) and Shanker (1996) and Venkatachalam (1996) point out that some instruments are effective in reducing the interest rate risk, while Choi and Elyasiani (1997) emphasize the role of derivatives to reduce foreign exchange risk. Chaudhry, Christie-David Koch and Reichert (2000) examined the impact of various derivative contracts on currency risk and showed that swaps tend to reduce the total risk.

Applying the expectations hypothesis of the term structure of Eoniswap rates, Hernandis and Torró (2013) found that the implied forward rates of Eoniaswap reflected market expectations in respect with Eonia before august 2007. However, after the crisis the evidence was weak due to high liquidity and credit risk in the banking market, making difficult the transmission of the ECB monetary policy. Beirne (2012) found that ECB liquidity provision eliminated the liquidity risk after the crisis, but not the credit risk, explaining the spread between EONIA and the ECB's monetary policy rate across alternative non-crisis/crisis regimes.

Analyzing the interbank market after August 2007, De Socio (2013) found evidence of liquidity risk being responsible for the increase of Euribor (European interbank offered rate) and Eonia spread. After October 2008 this reacted to the systemic responses of the central banks. But, between May 2009 and February 2010 the spread was influenced mostly by the credit risk. In F., et al. (2012) investigated the overnight index swap (OIS) and London interbank offered rate (Libor), founding lead–lag relations and volatility transmission between interbank, commercial paper and jumbo mortgage markets, during the subprime crisis period.

The Libor-OIS spread has been intensively monitored since the May 2009, when several global important banks were accused of manipulating the Libor rates when looking for cash.

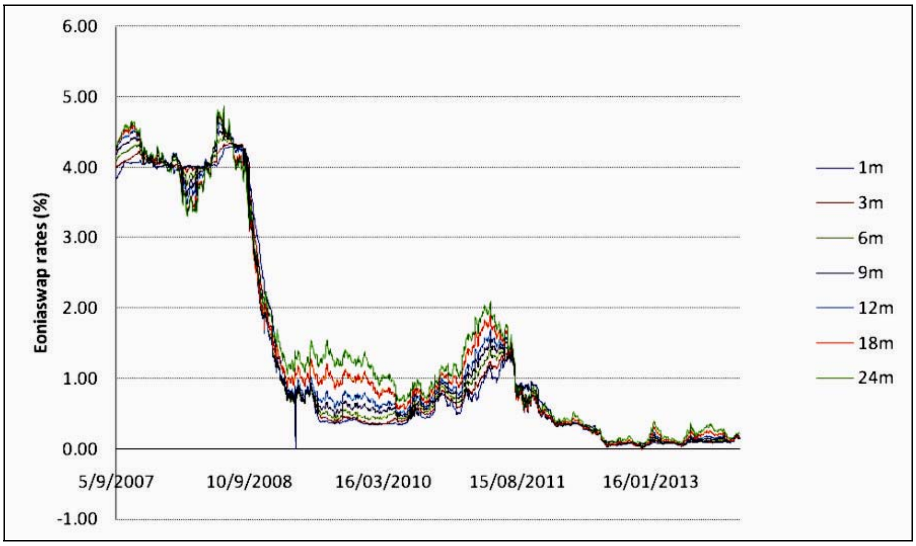
However, Abrantes-Metz et al. (2012) found inconsistent evidence of manipulation, after comparing Libor with other short-term borrowing rates, individual bank quotes to CDS spreads and market capitalization.

Focusing on the European interbank market, we analyze the behavior of Eoniaswap rates during the 2007-2013 period. This index is representative for the Eurozone interbank swap market and its evolution is significantly influenced by the monetary policy of the European Central Bank. In order to asses this influence, first we apply stationarity tests for the Eoniaswap rates at different maturities. Second, we use cointegration tests for analyzing the long run relationship between Eonia and the swap rates. Finally, we apply variance decomposition analysis to the interbank swap rates. The paper is organized as follows: Section 2 provides the data and the methodology, Section 3 presents the results and Section 4 concludes.

2. Data and methodology

We use daily data of Eoniaswap rates for different maturities (1 month, 3 months, 6 months, 9 months, 12 months, 18 months and 24 months) during September 5 2007-December 31 2013. They present a pattern similar to EONIA. In Figure 1 the daily evolutions of Eoniaswap rates at different maturities during the analyzed period are represented. Eoniaswap values followed a downward trend after September 2008 (time marked by the collapse of Lehman Brothers) from 4% to 1% on average, followed by a stabilization period of around 1% until 2010, due to the reduction in ECB interest rate policy reference for the EUR. During 2011-2013 the rates fall below 1%. The explanation is given by the excess liquidity in the Euro Area as a result of monetary policies applied by ECB to mitigate the effects of the financial crisis.

Figure 1. Eoniaswap rates



Source: authors' calculations

Descriptive statistics of Eoniaswap rates for different maturities are presented in Table 1. When an increase in the monetary policy interest rate of ECB is expected, the 12 months, 18 months and 24 months maturity swaps have a higher interest rate compared with shorter-term maturities (1-6 months). This is caused by the expectations of a higher EONIA rate in the future and by the liquidity preferences.

Persistent deviations from the monetary policy rate are a direct consequence of the the central bank's communication policy to maintain an adequate liquidity level in the European monetary system. Liquidity problems encountered on the international financial markets caused an increase in the volatility of swap rates especially after September 2008 and in their spread from Eonia, as banks have avoided mutual lending, preferring to borrow from the ECB. As a consequence, there was a substantial excess liquidity in the Euro system and a reduction in the interest rates.

Following the downward trend of the swap rates after September 2008, our aim is to investigate if the swap rates return to the long-term equilibrium or if they follow a random walk process. To address these issues we perform stationarity tests for the Eoniaswap rates, cointegration tests for analyzing the long term relationship between Eonia and the swap rates and the variance decomposition analysis. In order to perform the cointegration analysis we transformed the daily data into logarithmic rentabilities.

Stationarity. To assess whether Eoniaswap rates return to their long-term average or follow a random walk process we have used the Augmented Dickey Fuller (ADF) and the Ng and Perron (NP) unit root tests. A series is stationary if the mean and variance are constant over time, and the covariance depends only on the distance between the moments of time the variables are registered. The existence of a unit root indicates that the series is not stationary. As suggested by Willem J. (2011) in addition to the ADF test the NP test (Ng and Perron, 2001) was applied. This test takes into account the existence of structural breaks both under the null hypothesis and under the alternative one, using the generalized least squares method (GLS). This is important in the case of interest rates because the series may contain structural breaks caused by regime changes in the monetary policy or in the financial conditions in the interbank market.

Table 1. Descriptive statistics of Eoniaswap rates

Statistics	ES 1 month	ES 3 months	ES 6 months	ES 9 months	ES 12 months	ES 18 months	ES 24 months
Average	2.390	2.433	2.499	2.514	2.527	2.625	2.740
Median	2.488	2.458	2.540	2.584	2.593	2.692	2.705
Maximum	4.652	4.695	4.833	4.873	4.899	5.088	5.123
Minimum	0.367	0.380	0.428	0.469	0.497	0.516	0.500
Standard deviation	1.583	1.594	1.597	1.559	1.507	1.565	1.515
Asymmetry	0.023	0.025	0.019	0.018	0.024	0.025	0.024
Kurtosis	1.501	1.483	1.464	1.431	1.409	1.463	1.416

Source: authors' calculations

Johansen cointegration. Even if Eonia swap rates are not stationary they can evolve together over time, due to a long-term relationship. In this case the series are cointegrated, and the relationship between them can be seen as a long-term equilibrium. If there are short-term deviations from the cointegration relationship, they are only temporary. Cointegration relationship between variables can be best described by VAR models (Vector Autoregressive), which explains the behavior of a variable based on its past values and on the past values of other variables. For a vector Y_t (kx1) of k potential endogenous variables, an autoregressive model of order p VAR (p) can be described as follows:

$$Y_t = B + A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + \varepsilon_t \qquad \textit{(Equation 1)}$$

The existing condition of cointegration relationships between variables is that equation 2 has roots inside the unit circle.

$$\det(\Pi(z)) = \det(I_k - A_1 z - A_2 z^2 - .... - A_p z^p) = 0 \qquad \textit{(Equation 2)}$$

Variance decomposition. In order to estimate what proportion of the variance of one Eoniaswap rate is due to shocks on the other swap rates and Eonia interest rate, we have used the variance decomposition method. The decomposition of variance could be an informative tool, especially when we are interested in the impact of short-term swap rates variance on longer-term swap rates variance. We expect that the impact of a shock to short-term Eoniaswap rates increases as maturity increases.

3. Results

Stationarity

If interest rates series contain a unit root then a shock on them is permanent and its effect cannot be removed in time. On the other hand, if the series are stationary the shocks on them have a short-term influence. Both ADF and NP unit root tests (with MPT and MZt statistics) indicate the presence of the unit root in the levels and the stationarity of the first order differentiated series (Table 2).

Table 2. Stationarity tests

Eoniaswap rates	ADF [a]	NP[b]	NP[c]
Eoniaswap 1M	-1.581	-0.895	56.723
d Eoniaswap 1M	-12.325***	-7.260***	0.956***
Eoniaswap 3M	-1.682	-0.972	48.249
d Eoniaswap 3M	-36.017***	-3.908***	3.191***
Eoniaswap 6M	-1.644	-0.785	73.508
d Eoniaswap 6M	-36.531***	-3.833***	3.266***
Eoniaswap 9M	-1.820	-0.459	207.466
d Eoniaswap 9M	-38.191***	-2.564**	6.985
Eoniaswap 12M	-1.845	-0.472	193.205
d Eoniaswap 12M	-37.655***	-3.006**	5.107**
Eoniaswap 18M	-1.856	-0.475	194.364
d Eoniaswap 18M	-37.881***	-3.024**	5.137**

Eoniaswap rates	ADF [a]	NP[b]	NP[c]
Eoniaswap 24M	-1.861	-0.476	194.943
d Eoniaswap 24M	-37.994***	-3.033**	5.153**

*** H_0 is rejected at 1% significance level; ** H_0 is rejected at 5% significance level; * H_0 is rejected at 10% significance level; [a] ADF Test (with trend and constant), H_0: the series has a unit root; H_1: the series is stationary, the critical values of the test are -3.96 (for 1%), -3.41 (for 5%) and -3.12 (for 10%); [b] NP Test with MZt statistic (with trend and constant), H_0: the series has a unit root; H_1: the series is stationary, the critical values of the test are -3.42 (for 1%), -2.91 (for 5%) and -2.62 (for 10%); [c] NP Test with MPT statistic (with trend and constant), H_0: the series has a unit root; H_1: the series is stationary, the critical values of the test are 4.03 (for 1%), 5.48 (for 5%) and 6.67 (for 10%).

Source: authors' calculations.

Testing for long-run equilibrium relationships

The investigation of the long-run relationships between the swap rates are of particular importance for investors. As markets present different degrees of liquidity and integration, changes in these features could alter the long-run equilibrium between the Eoniaswap rates. To check for cointegration relationships between Eonia interbank offered rate and the swap rates we have used the Johansen cointegration test (1988, 1991), which is based on the maximum likelihood method. Applying Trace and Maximum Eigenvalue statistics we tested the number of cointegrating relationships. There have been used two lags in the VAR model construction to minimize the Schwarz and Hannan-Quinn information criteria.

The results below reflect that between the swap rates at different maturities and Eonia is at least one cointegrating relationship, as confirmed both by Trace and Maximum-Eigenvalue statistics (Table 3). This highlights the existence of a common stochastic trend and support the expectations hypothesis of Eoniaswap rates, where long-term interest rates contain information on market expectations regarding the future Eonia rates.

Table 3. The Johansen cointegration test between Eonia and Eoniaswap

Eonia and Eoniaswap rates	Hypothesis	Trace Statistic [a]	Critical value (0.05) [#]	Maximum Eigenvalue Statistic [b]	Critical value (0.05) [#]
Eonia Eoniaswap 1M	H_0: r=0 vs H_1: r=1	162.004***	18.398	159.823***	17.148
	H_0: r≤1 vs H_1: r=2	2.181	3.841	2.181	3.841
Eonia Eoniaswap 3M	H_0: r=0 vs H_1: r=1	135.510***	18.398	133.005***	17.148
	H_0: r≤1 vs H_1: r=2	2.505	3.841	2.505	3.841

Eonia and Eoniaswap rates	Hypothesis	Trace Statistic [a]	Critical value (0.05) [#]	Maximum Eigenvalue Statistic [b]	Critical value (0.05) [#]
Eonia Eoniaswap 6M	H_0: r=0 vs H_1: r=1	113.149***	18.398	109.939***	17.148
	H_0: r≤1 vs H_1: r=2	3.210*	3.841	3.210*	3.841
Eonia Eoniaswap 9M	H_0: r=0 vs H_1: r=1	92.943***	18.398	89.053***	17.148
	H_0: r≤1 vs H_1: r=2	3.889**	3.841	3.889**	3.841
Eonia Eoniaswap 12M	H_0: r=0 vs H_1: r=1	76.602***	18.398	72.139***	17.148
	H_0: r≤1 vs H_1: r=2	4.463***	3.841	4.463***	3.841
Eonia Eoniaswap 18M	H_0: r=0 vs H_1: r=1	76.219***	18.398	71.778***	17.148
	H_0: r≤1 vs H_1: r=2	4.441***	3.841	4.441***	3.841
Eonia Eoniaswap 24M	H_0: r=0 vs H_1: r=1	75.989***	18.398	71.562***	17.148
	H_0: r≤1 vs H_1: r=2	4.427***	3.841	4.427***	3.841

*** H_0 is rejected at 1% significance level; ** H_0 is rejected at 5% significance level; * H_0 is rejected at 10% significance level; [#] the critical values are determined by MacKinnon-Haug-Michelis (1999); [a] Trace Statistic tests the null hypothesis H_0: the number of cointegrating relationships ≤ r versus the alternative hypothesis H_1: the number of cointegrating relationships > r; [b] Maximum Eigenvalue Statistic tests the null hypothesis H_0: the number of cointegrating relationships = r versus the alternative hypothesis H_1: the number of cointegrating relationships = r+1; For the VAR model with constant (without trend) two lags according with the information criterion Schwarz and Hannan-Quinn were used.

Source: authors' calculations

Variance decomposition

Results vary by maturity. Over 95% of the 1 month Eoniaswap rate variance is explained by its own shocks in the next 10 days. The 3 month Eoniaswap rate variance is influenced by its own shocks in a proportion of 30-40% and the difference is given by variance shocks to the 1 month rate (63% on the first day, dropping to 55% after 10 days of the event occurrence). For the 6 month Eoniaswap rate only 10% of its variance is explained by its own shocks, 38-40% of the variance is explained by the 1 month Eoniaswap rate variance, and the remaining 50-52% is explained by the variance of the 3 month Eoniaswap rate. The 9 month Eoniaswap variance is influenced in a small proportion of 7-9% by its own shocks, 18-20% is due to the 6 months Eoniaswap rate, 24-26% is due to the 1 month Eoniaswap rate and 45-51% is influenced by the 3 month Eoniaswap rate. Approximately the same proportion is maintained for the 12 months, 18 months and 24 months Eoniaswap rates. However it appears that the impact of the Eonia swap rates decreases as maturity increases.

The main consequence is that Eoniaswap rates quickly absorb shocks coming from Eonia. On a longer time horizon these impulses may become insignificant.

Thus, the possibility of banks trading derivatives based on assets with these rates, stemming from the past information contained in the overnight market rates, is quite low for a longer period of time.

4. Conclusions

In the European banking system, swap contracts that have as underlying asset the Eonia interbank rate form the most liquid interbank market. Eoniaswap rates are the most used tools in the speculation and hedging against interest rate risk resulting from the assets and liabilities indexed to EURIBOR. Liquidity problems registered on the international financial markets caused an increased volatility of the swap rates especially after September 2008. Moreover, the spread between Eoniaswap rates and the European Central Bank's monetary policy rate increased, as Eoniaswap rates reflect market expectations on the future evolution of monetary policy rate set by the ECB. Therefore, all the deviations of Euribor from the ECB's monetary policy is reflected in the evolution of swap rates.

Analyzing the behavior of the Eoniaswap rates and their relation with the overnight interbank interest rate over the period 05.09.2007-31.12.2013 we found that they exhibit structural breaks, long-term memory and a persistent behavior. Johansen cointegration test confirms the existence of long-run equilibrium relationship between Eonia and Eoniaswap rates. In addition, the variance of Eoniaswap rates at a certain maturity is influenced by shocks to other maturities of Eoniaswap rates, but shocks coming from Eonia interbank rate are rapidly absorbed. The results reflect the difficulty for banks to make a profit from trading derivatives based on Eoniaswap rates resulted from the past information. On the other hand, the situation is beneficial for the proper management of the market risk, because the volatility of the future development can be estimated on the basis of the previous information.

In terms of policy implications, the analysis of Eoniaswap rates at different maturities plays an important role both for the ability to predict changes in trading activity and for the term structure expectations. According to the expectations theory, long-term interest rates contain information on market expectations regarding the future short-term rates. Thus, the link between long-term and short-term interest rates are of particular interest for banks in developing profitable investment strategies using current information and also for the proper management of market risk associated with these strategies.

As further directions, it is interesting to investigate the "spillover effects" from the Eoniaswap rates evolution to the sovereign bonds market. Since the beginning of the crisis, the default risk for banks engaged in swap transactions in the European interbank market was closely linked with the sovereign bonds evolution. Also, of particular importance for the Central and Eastern banking system is the impact of Western European parent banks swaps trading on the interbank market evolutions in CEE, where they hold significant participations.

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