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 rate during the 2005-2011 period. This index is representative for the Eurozone interbank swap market. Its evolution is significantly influenced by the monetary policy of the European Central Bank. In order to asses this influence, firstly, we apply stationarity tests for the Eoniaswap rates at different maturities. Secondly, we use cointegration tests for analyzing the long run relationship between Eonia and the swap rates. Finally, we apply a variance decomposition analysis for the interbank swap rates.

Key words: *Eoniaswap rates; interbank markets; cointegration; structural breaks; variance decomposition*

JEL classification: E43, E50, G10, G21

1. INTRODUCTION

The most important market risk faced by the banks operating in the European banking system is the interest rate risk, that can be managed through swap contracts. The underlying asset of the interest rate swaps is 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 with a study of the Eueopean 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 maturiy of the contract.

Most studies in the literature focuse 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 adequancy 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.

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Focusing on the European interbank market, we analyze the behavior of Eoniaswap rates during the 2005-2011 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, firstly, we apply stationarity tests for the Eoniaswap rates at different maturities. Secondly, we use cointegration tests for analyzing the long run relationship between Eonia and the swap rates. Finally, we apply variance decomposition analysis for 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 and 12 months) during 20.06.2005-20.06.2011. They present a similar pattern with EONIA. When it is expected an increase in the monetary policy interest rate of ECB, the 12 months maturity swaps have a higher interest rate compared with shorter-term maturities (1-6 months). This is caused by expectations of a higher EONIA rate in future. In Figure 1 is represented the daily evolution of Eoniaswap rates at different maturities, during the analyzed period.

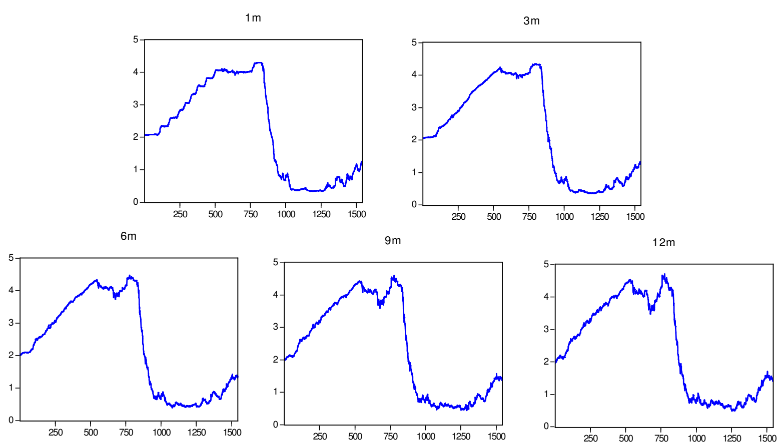

Figure 1. **Eoniaswap rates**
(*Source:* authors' calculations)

Descriptive statistics of Eoniaswap rates for different maturities are presented in the table below (Table 1).

	ES 1 month	ES 3 months	ES 6 months	ES 9 months	ES 12 months
Average	2.213316	2.253183	2.314304	2.371673	2.430227
Median	2.304000	2.276000	2.352000	2.438000	2.493000
Maximum	4.307000	4.347000	4.475000	4.597000	4.711000
Minimum	0.340000	0.352000	0.396000	0.442000	0.478000
Standard deviation	1.465817	1.475650	1.478932	1.470872	1.449392
Asymmetry	0.021197	0.022965	0.017691	0.016733	0.023056
Kurtosis	1.390102	1.372877	1.355598	1.350447	1.354964

Table 1. **Descriptive statistics of Eoniaswap rates**
(*Source:* authors' calculations)

The downward trend of the swap rates after September 2008 is due to the ECB's monetary policy rate. In these conditions 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 variance decomposition analysis.

In order to perform the cointegration analysis we transformed the daily data into loghartimic rentabilities, which are presented in Figure 2.

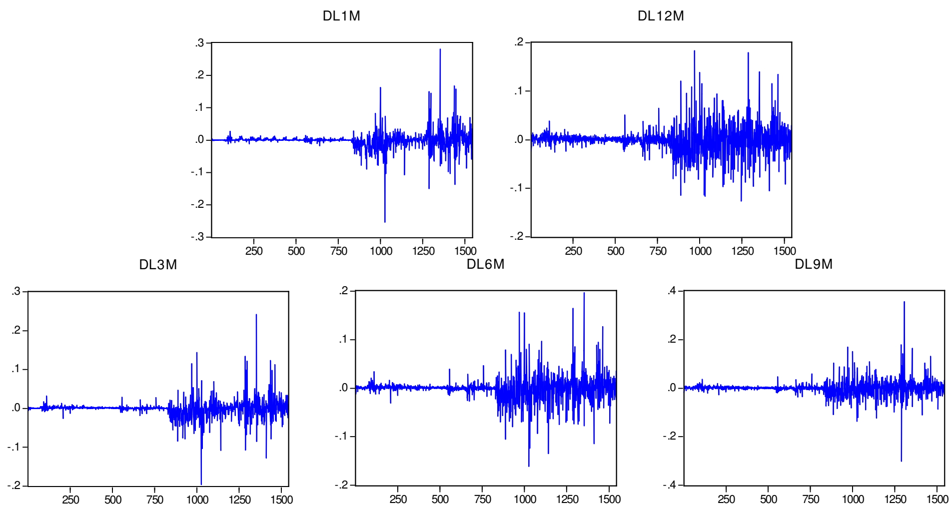

Figure 2. **Eoniaswap rates (first difference)**
(*Source:* authors' calculations)

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 it was applied the NP test (Ng and Perron, 2001). 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 of the monetary policy or of the financial conditions in the interbank market.

Johansen cointegration. Even if Eonia swap rates are not stationary they can evolve together over time, due to a long-term relationship between them. 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:

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

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

$$\det(\Pi(z)) = \det(I_k - A_1 z - A_2 z^2 - .... - A_p z^p) = 0 \quad \text{(ec. 2)}$$

Variance decomposition. In order to estimate what proportion of variance is due to shocks on the Eoniaswap rates and on the Eonia interest rate, we have used the variance decomposition method.

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 differenced series (Table 2).

	ADF [a]	**NP[b]**	**NP[c]**
Eoniaswap 1M	-1.577949	-0.89314	56.6093
d Eoniaswap 1M	-12.30019***	-7.24582***	0.95402***
Eoniaswap 3M	-1.678859	-0.96988	48.1522
d Eoniaswap 3M	-35.94477***	-3.90035***	3.18448***
Eoniaswap 6M	-1.640289	-0.78379	73.3609
d Eoniaswap 6M	-36.45853***	-3.82513***	3.25992***
Eoniaswap 9M	-1.816064	-0.45836	207.052
d Eoniaswap 9M	-38.11515***	-2.55857	6.97149
Eoniaswap 12M	-1.841193	-0.47089	192.819
d Eoniaswap 12M	-37.58015***	-3.00041**	5.09664**

*** 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%).

Table 2. **Stationarity tests**
(*Source:* authors' calculations)

Johansen cointegration. 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).

	Hypothesis	Trace Statistic	Critical value (0.5)	Maximum Eigenvalue Statistic	Critical value (0.5)
Eonia Eoniaswap 1M	H_0: r=0 vs H_1: r=1	163.6405***	18.39771	161.4377***	17.14769
	H_0: r≤1 vs H_1: r=2	2.202731	3.841466	2.202731	3.841466
Eonia Eoniaswap 3M	H_0: r=0 vs H_1: r=1	136.8787***	18.39771	134.3484***	17.14769
	H_0: r≤1 vs H_1: r=2	2.530302	3.841466	2.530302	3.841466
Eonia Eoniaswap 6M	H_0: r=0 vs H_1: r=1	114.2924***	18.39771	111.0495***	17.14769
	H_0: r≤1 vs H_1: r=2	3.242860*	3.841466	3.242860*	3.841466
Eonia Eoniaswap 9M	H_0: r=0 vs H_1: r=1	93.88162***	18.39771	89.95285***	17.14769
	H_0: r≤1 vs H_1: r=2	3.928765**	3.841466	3.928765**	3.841466
Eonia Eoniaswap 12M	H_0: r=0 vs H_1: r=1	77.37555***	18.39771	72.86736***	17.14769
	H_0: r≤1 vs H_1: r=2	4.508190**	3.841466	4.508190**	3.841466

*** 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) were used two lags according with the information criterion Schwarz and Hannan-Quinn.

Table 3. **The Johansen cointegration test between Eonia and Eoniaswap**
(*Source:* authors' calculations)

Variance decomposition.

Results vary by maturity (Appendix 1). Over 94% 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 (65% on the first day, dropping to 56% after 10 days of the event occurrence). For the 6 month Eoniaswap rate only 10% of its variance is explained by its own shocks, 34-40% of the variance is explained by the 1 month Eoniaswap rate variance, and the remaining 49-54% is explained by the variance of the 3 month Eoniaswap rate. The 9 month Eoniaswap variance is influenced in a small proprtion of 5-8% by its own shocks, 17-20% is due to the 6 months Eoniaswap rate, 24-26% is due to the 1 month Eoniaswap rate and 46-53% is influenced by the 3 month Eoniaswap rate. Approximately the same proportion is maintained for the 12 months Eoniaswap rates. However it appears that the impact of the Eonia swap rates decreases as maturity increases.

4. CONSLUSIONS

Analyzing the behavior of the Eoniaswap rates and their relation with the overnight interbank interest rate over the period 20.06.2005-20.06.2011 we found that they exhibit structural breaks, long-term memory and a persistent behavior. Johansen cointegration test confirmes 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.

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Appendix. Variance decomposition of Eoniaswap rates

Variance decomposition of EONIASWAP 1M

Period	S.E.	EONIA	EONIASWAP1	EONIASWAP12	EONIASWAP3	EONIASWAP6	EONIASWAP9
1	0.096851	1.292293	98.70771	0.000000	0.000000	0.000000	0.000000
2	0.115511	0.937618	99.04308	0.008809	8.96E-05	0.000781	0.009623
3	0.124421	0.609116	99.32221	0.006100	0.046284	0.001676	0.014610
4	0.129238	0.487365	99.28634	0.013688	0.189630	0.007062	0.015914
5	0.132281	0.490946	98.98979	0.033359	0.451334	0.018141	0.016432
6	0.134570	0.551419	98.48813	0.064091	0.843882	0.035590	0.016892
7	0.136558	0.628059	97.81585	0.104357	1.374024	0.060160	0.017546
8	0.138439	0.699567	96.99251	0.152580	2.044189	0.092666	0.018487
9	0.140283	0.756301	96.02952	0.207245	2.853218	0.133969	0.019749
10	0.142109	0.795162	94.93471	0.266924	3.796928	0.184933	0.021340

Variance decomposition of EONIASWAP 3M

Period	S.E.	EONIA	EONIASWAP1	EONIASWAP12	EONIASWAP3	EONIASWAP6	EONIASWAP9
1	0.036093	1.168873	65.02062	0.000000	33.81051	0.000000	0.000000
2	0.052232	1.093228	65.66010	0.017980	33.22785	0.000528	0.000316
3	0.064739	0.876420	65.28352	0.012483	33.79928	0.026361	0.001940
4	0.075435	0.695821	64.45935	0.010293	34.75025	0.081419	0.002866
5	0.085011	0.562599	63.38528	0.014736	35.86771	0.166017	0.003654
6	0.093815	0.465240	62.15184	0.025550	37.07469	0.278264	0.004423
7	0.102051	0.392883	60.81262	0.041694	38.33119	0.416395	0.005221
8	0.109850	0.337827	59.40343	0.061993	39.61202	0.578673	0.006057
9	0.117301	0.294979	57.95001	0.085333	40.89932	0.763433	0.006924
10	0.124471	0.261025	56.47177	0.110722	42.17961	0.969068	0.007806

Variance decomposition of EONIASWAP 6M

Period	S.E.	EONIA	EONIASW AP1	EONIASW AP12	EONIASW AP3	EONIASW AP6	EONIASW AP9
1	0.019847	0.263576	38.78085	0.000000	49.11668	11.83889	0.000000
2	0.029354	0.285384	40.05172	0.043230	49.75196	9.817137	0.050573
3	0.036738	0.236618	39.97629	0.042813	50.17156	9.519202	0.053521
4	0.043103	0.189384	39.50620	0.036417	50.69744	9.514268	0.056290
5	0.048861	0.153477	38.85746	0.029755	51.26413	9.637081	0.058091
6	0.054216	0.127047	38.11471	0.024326	51.85371	9.820816	0.059391
7	0.059288	0.107406	37.31957	0.020419	52.45323	10.03905	0.060331
8	0.064155	0.092503	36.49622	0.017947	53.05370	10.27861	0.061017
9	0.068870	0.080959	35.66010	0.016702	53.64842	10.53229	0.061526
10	0.073472	0.071877	34.82167	0.016447	54.23231	10.79578	0.061916

Variance decomposition of EONIASWAP 9M

Period	S.E.	EONIA	EONIASW AP1	EONIASW AP12	EONIASW AP3	EONIASW AP6	EONIASW AP9
1	0.025604	0.123490	24.91653	0.000000	46.26395	20.66534	8.030691
2	0.037633	0.121590	26.11041	0.080880	47.53295	18.04855	8.105620
3	0.047019	0.093269	26.35339	0.110012	48.16660	17.58916	7.687577
4	0.055126	0.070429	26.30545	0.128223	48.73670	17.47837	7.280828
5	0.062461	0.055344	26.11621	0.141377	49.27528	17.52140	6.890393
6	0.069275	0.045635	25.84503	0.151700	49.79824	17.63634	6.523047
7	0.075717	0.039205	25.52158	0.160133	50.30845	17.79106	6.179574
8	0.081880	0.034681	25.16345	0.167173	50.80569	17.96959	5.859419
9	0.087828	0.031246	24.78220	0.173118	51.28875	18.16327	5.561420
10	0.093606	0.028442	24.38591	0.178171	51.75626	18.36702	5.284204

Variance decomposition of EONIASWAP 12M

Period	S.E.	EONIA	EONIASW AP1	EONIASW AP12	EONIASW AP3	EONIASW AP6	EONIASW AP9
1	0.019843	0.091860	19.92856	6.467079	44.28271	26.10770	3.122088
2	0.029289	0.096507	20.72788	6.501084	45.91298	23.28345	3.478100
3	0.036463	0.069854	20.94767	6.299316	46.46285	22.75224	3.468070
4	0.042493	0.051501	20.98578	6.063084	46.84115	22.62744	3.431052
5	0.047801	0.041730	20.92615	5.822793	47.15728	22.67300	3.379051
6	0.052598	0.037501	20.80561	5.588510	47.45142	22.79628	3.320677
7	0.057012	0.036362	20.64342	5.363786	47.73668	22.96050	3.259251
8	0.061130	0.036732	20.45155	5.149870	48.01765	23.14761	3.196589
9	0.065017	0.037680	20.23813	4.947026	48.29552	23.34790	3.133745
10	0.068723	0.038694	20.00905	4.755073	48.57007	23.55573	3.071383

Cholesky Ordering: EONIA EONIASWAP1 EONIASWAP3 EONIASWAP6 EONIASWAP9 EONIASWAP12