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Symmetric or Asymmetric Interest Rate Adjustments? Evidence from Greece, Bulgaria and Slovenia

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ABSTRACT

The purpose of this paper is to examine how effectively the wholesale interest rates are transmitted to the retail rates, and whether the interest rate pass-through is symmetric or asymmetric in Greece, Bulgaria and Slovenia. The disaggregated general-to-specific methodology is applied for testing the symmetry hypothesis in these economies. It is evident from our results that across the countries examined there exist variations regarding the monetary transmission process and the symmetry hypothesis alike. This can be interpreted as an indication of a different level of competition, development and liberalization among the banking systems in these South Eastern European economies.

Keywords: Interest rate pass-through, disaggregated general-to-specific model, South Eastern Europe.

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Symmetric or Asymmetric Interest Rate Adjustments?
Evidence from Greece, Bulgaria and Slovenia

1. Introduction

The main aim of this paper is to reveal the existence of a symmetric or asymmetric interest rate pass-through (hereafter PT) in Greece, Bulgaria and Slovenia. These South Eastern European (SEE hereafter) countries were selected since all three are EU members; Greece joined Euro in 2001, Slovenia has been a member of the EMU since 2007 and Bulgaria was admitted to the European Union in 2007. The three economies belong to the SEE region but their level of income, growth performance and size in terms of population, differ substantially (Table 1 in Appendix A). A feature common for those countries is the relatively fast growth that has been experienced in recent years. Monetary performance across the region has also seen significant improvements, in the recent past, accompanied with decreasing interest rate spreads (Figures 1-3 in Appendix A).

The adjustment of retail bank interest rates (that is deposit rates that commercial banks offer to savers and lending rates that banks charge to borrowers) in response to changes in wholesale rates (that is the base rate that central bank sets and the interbank rates determined by the interaction of the money market participants) is a fundamental element of the interest rate transmission mechanism. Wholesale rates are both exogenous to commercial banks. The money market rate can be considered as a policy controlled variable as Central Bank authorities can influence and control it through their short-term interest rate policy. In our case, the central bank rate represents similar policy regimes and thus it carries similar information content across the countries considered. For an efficient monetary policy, any change in the central bank policy rate is meant to be transmitted to retail interest rates, ultimately influencing consumer and business lending rates, and therefore aggregate domestic demand and output. In effect, if the interest rate transmission is not efficient, the required policy measure by the monetary authorities will have to be more drastic in order to achieve the same end-result. Indeed, if deposit rates are rigid upward, expansionary monetary policy will have more impact than contractionary monetary policy, as deposit rates adjust rapidly to declining market rates, but are slow to adjust in response to increasing market rates. Moreover, adjustment of the central bank and money market rates may make highly leveraged firms more vulnerable to business cycle fluctuations, than firms that have access to stock exchange and bond markets. For all these reasons, the regular monitoring and assessment of the pass-through is critical for policymaking, for the conduct and evaluation of monetary policy.

In this paper, we focus on whether responses to upward and downward interest rate changes are symmetric or asymmetric in Greece, Bulgaria and Slovenia. The symmetry hypothesis tests the magnitude of the negative and positive adjustment of the deposits and lending rates in response to changes in central bank and money market rates. In conjunction with this issue, we analyse how effectively the wholesale rates are transmitted to the retail rates. We employ the disaggregated general-to-specific (hereafter GETS) methodology to examine the symmetric or asymmetric interest rate behaviour in the above mentioned SEE economies. To the best of our knowledge, it is the first attempt made to unveil the existence and importance of the interest rate PT behaviour, for the sample of the economies examined. It is evident from our results that variations across these economies are present as far as the PT monetary transmission process and the symmetry hypothesis is concerned. Our results for Greece indicate that there is not enough support for asymmetry hypothesis in the adjustment of retail rates in response to changes in the central bank rate. In contrast, for Bulgaria and Slovenia, we find support for negative asymmetry in the adjustment of loan rate in response to changes in the money market rate.

There are mainly two explanations to describe the asymmetric adjustment of retail rates to wholesale rates changes (Scholnick, 1999); the *consumer behaviour* or *customer reaction hypothesis* (Hannan and Berger, 1991) and the bank concentration or *bank's collusive pricing hypothesis* (Berger and Hannan, 1989; Hannan and Berger, 1991; Neumark and Sharpe, 1992). The consumer behaviour hypothesis is related to the degree of consumer sophistication with respect to capital markets. The more sophisticated depositors and borrowers are, the more reluctant banks will be to exercise market power to their own benefit. The customer reaction hypothesis supports the asymmetric adjustment of interest rates, with lending rates being rigid upwards and the deposit rates rigid downwards. This is the case, particularly, when banks operate in a highly competitive environment and, thus, banks may fear a negative reaction from customers in response to lending rate increases or deposit rate decreases. On the other hand, the bank concentration hypothesis states that banks are more likely to decrease deposit rates and increase lending rates, when they are able to exercise their market power and adjust interest rates to their advantage. In the case of the bank concentration hypothesis, the lending rates are rigid downwards and the deposit rates upwards.

The paper is structured as follows. In Section 2, we refer briefly to the structure of the Greek, Bulgarian and Slovenian banking systems. Section 3 presents literature review on interest rate PT, the econometric methodology and data. The empirical results on estimates of the speed of adjustment and symmetry hypothesis are given in Section 4. Section 5 concludes the paper.

2. Structure of the Greek, Bulgarian and Slovenian Banking Systems

During the 1980s, the Greek banking system was decisively state controlled and highly and strictly regulated[1]. This started changing in the late 1980's when the prospects for participating in the Single European Market initiated the first efforts to liberalize the Greek financial system. A number of institutional actions (Karatzas Committee, 1987) were taken and the process of deregulation of the banking system has been carried out at an accelerating pace, in the light of the need for a more flexible and market-oriented financial system.

[1] For an overview of the historical evolution of the Greek banking system see Soumelis (1995), Ericsson and Sharma (1996), Eichengreen and Gibson (2001), Garganas and Tavlas (2001), Karousos and Vlamis (2010).

Government measures involved the abolition of various regulatory credit ceilings (that is, banks are allowed to extend credit on their own terms), the abolition of the system of administrative fixed interest rates (that is, all deposit rates and almost all lending rates are freely determined) and the initiation of an extensive privatization programme[2] of the majority of the state controlled commercial banks in the late 1990s. As a result of the latter, the Greek banking sector is not anymore state controlled as it used to be fifteen years ago. Also, foreign exchange controls were lifted in 1992 and capital movements were completely liberalized in May 1994, which allowed Greek enterprises and households to borrow in lower-yielding foreign currencies. "In addition, investment requirements imposed on commercial banks for the financing of small and medium sized enterprises and public enterprises are gradually being abolished and the compulsory securities ratios on government bonds are being phased out, whereas the public sector should meet its borrowing requirements exclusively through the money and capital markets" (Tsionas et al, 2003). These developments and the liberalisation measures introduced throughout the 1990s increased competition among financial institutions.

The Greek financial system is dominated by banking institutions. More specifically, Greek commercial banks control 81.2% of total banking sector's assets, foreign banks 10.1% and special credit institutions (the Postal Savings Bank and the Deposits & Loans Fund) a further 8.3%. The presence of cooperative and regional banks is rather limited; they control only about 0.8%

[2] For an overview of the mergers and acquisitions carried out in the Greek banking sector over the period 1996-2008, see Karousos and Vlamis (2010).

of total banks' assets and their activities are concentrated in particular geographic areas of the country (Eurobank, 2006). As far as it concerns the Greek banking system, this is one of the most concentrated in the Euro-zone. Some researchers believe that "this high degree of concentration in small banking systems is unavoidable if banks in these economies are to achieve a size that will allow them to compete with foreign banks" (Eurobank, 2006). More specifically, the five biggest commercial banks of Greece (National Bank of Greece, Alpha Bank, Eurobank EFG, Piraeus Bank and Agricultural Bank of Greece) own more than 80% of total assets of the Greek banking sector, while accounted for 77.9% of the total private deposits and 77% of the loans to the private sector (Karousos and Vlamis, 2010). Although out of those five commercial banks, only the Agricultural Bank of Greece is state controlled. Thus, it does not come as a surprise that newer empirical evidence (Hondroyiannis et al, 1999; Hardy and Symiyiannis, 1998) show that there has been a gradual shift of the Greek banking system away from conditions of oligopoly to those of monopolistic competition.

After the collapse of the communist regime in 1989-1990, there was a widespread privatization and liberalization across all sectors of the Bulgarian economy, which inevitably affected its banking system. Initially, the progress was quite slow and the situation was exacerbated due to the financial crisis that hit the Bulgarian banking system in 1996-1997. The privatization of the banking system was completed in 2001-2002 (Frömmel and Karagyozova, 2008). "In a number of cases, foreigners acquired some of the countries' largest credit institutions, one after the other, and thus took over the lion's share of the sector in a few years. This "sweep" on the part of mostly Western European and Euro-area investors fundamentally changed banking in the region and structurally linked it up with EU banks" (Barisitz, 2008).

The Bulgarian banking system consists of legally independent entities, state-owned banks, private local banks and branches of foreign banks. As of 2007, there were in total twenty nine banks[3] operating in Bulgaria. The four biggest banks (DSK Bank, Raiffeisenbank Bulgaria, United Bulgarian Bank and UniCredit Bulbank) held 43% of total banking assets, 35% of outstanding corporate loans, 45% of total deposits and 50% of total equity (Federation of French Banks, 2003). The Bulgarian banking market is not as concentrated as other European markets and it is currently considered to be fairly competitive due to the existence of a considerable number of private banks.

Commercial banks remain by far the most important financial intermediaries in Slovenia, while the share of savings banks is negligible. More specifically, commercial banks maintain a prevailing position in the banking sector's structure with a 99.4% share at the end of 2007, measured by total assets (Bank of Slovenia, 2008a). The commercial banks account for about 70% of the Slovenian financial system's assets. The remaining market share was divided

[3] These are :Allianz Bulgaria Commercial Bank, Alpha Bank- Bulgaria Branch, BNP Paribas S. A.-Sofia Branch, Bulgarian-American Credit Bank, Central Cooperative Bank, Citibank N. A.-Sofia Branch, Corporate Commercial Bank, D Commerce Bank, DSK Bank, Economic and Investment Bank, Emporiki Bank– Bulgaria, Encouragement Bank, Eurobank EFG Bulgaria, First Investment Bank, ING Bank N. V.-Sofia Branch, International Asset Bank, Investbank, MKB Unionbank, Municipal Bank, NLB West-East Bank, Piraeus Bank Bulgaria, ProCredit Bank, Raiffeisenbank, Bulgaria, Societe Generale Expressbank, T. C. Ziraat Bank-Sofia Branch, Texim Private Entrepreneurial Bank, Tokuda Bank, UniCredit Bulbank and United Bulgarian Bank.

among the savings banks. There are eighteen banks, three savings banks and three branches of foreign banks operating in Slovenia at the end of 2008. The banking sector concentration in Slovenia is higher than the Euro area average, although the gap is diminishing. The three bigger banks hold almost 50% of total banking assets (Bank of Slovenia, 2008b).

3. Literature Review, Econometric Methodology and Data

The issue of interest rate PT along with the testing of the symmetry hypothesis has been undertaken in a number of studies such as ECB (2009), Égert, Crespo-Cuaresma, and Reininger (2007), Wang and Thi (2007), Payne and Waters (2008), Hofmann (2006), Sander and Kleimeier (2004), Hofmann and Mizen (2004), Atesoglou (2003), Angeloni and Ehrman (2003), Toolsema, Sturm, and De Haan (2001), and Mojon (2000). So far, a variety of econometric models have been used in the empirical literature on PT transmission models. Such models mainly include the ECM (Engle and Granger, 1987), the Threshold Autoregressive model (Enders and Granger, 1998; Enders and Siklos, 2001) and the LSE-Hendry general-to-specific approach known as GETS model (Hendry, Pagan and Sargan, 1984; Hendry, 1987; Hendry and Krolzig, 2005). A more recent discussion of the GETS methodology as well as of other approaches (co-integrating vector error correction model, and the vector autoregression approach) on how to estimate short and long-run economic relationships is given by Rao (2007). Cramon-Taubadel (Von) and Loy (1997), Cramon-Taubadel (Von) (1998), Cramon-Taubadel (Von) and Meyer (2000) introduced the symmetric/asymmetric error correction approach through an ex-ante disaggregation of data. Within this framework, Bachmeier and Griffin (2003), Rao and Singh (2006), Rao and Rao (2008), presented an alternative dynamic approach, known as the disaggregated GETS model, originating from the LSE-Hendry GETS methodology. The main advantage of the model is that two different speeds of adjustments can simultaneously be estimated for positive and negative change in the variables included. In our case, it allows for the retail rates and the speed of adjustment coefficients to be analysed separately, when the wholesale rates are increasing or decreasing.

The interest rate PT literature is mainly related to the way central bank (CB hereafter) and interbank money market rates (MM hereafter) are transmitted to the retail rates (deposit and lending). The equilibrium (long run) relationship between wholesale and retail rates is given by:

$$i_R = \phi_0 + \phi_1 i_W + e_t \quad (1)$$

where, i_R stands for the different kind of loan and deposit rates, i_W is the CB or MM rates, ϕ_0 is the constant term, ϕ_1 measures the long-run impact of changes in wholesale interest rates and e_t is an error term. The short run dynamic interest rate adjustment equation, without any asymmetry, based on a simple error correction model (hereafter ECM) is:

$$\Delta i_{R,t} = \sum_{i=0}^{n_1} \rho \times \Delta i_{R,t-i} + \sum_{i=1}^{n_2} \lambda \times \Delta i_{W,t-i} - \theta \times e_{t-1} + u_{ti} \qquad (2)$$

where, λ measures the short-run impact of changes in wholesale interest rates

ρ, measures the short-run impact of changes in retail interest rates

θ, is the speed of retail rates adjustment initiated from the wholesale interest rate changes and should be negatively signed.

e_t, is the error correction term

Rao & Singh (2006) and Rao & Rao (2008) provide a complete derivation, formulation, and discussion of the specifications of symmetric and asymmetric interest rate adjustment equations. The short run dynamic interest rate adjustment equation, with an embedded asymmetry (disaggregated GETS model) and a time trend variable, is a variant of equation (2) and can take the following form:

$$\Delta i_{R,t} = \sum_{i=1}^{j1} \beta^{-}_{R,t} \Delta i^{-}_{R,t-i} + \sum_{i=0}^{j2} \beta^{-}_{W,t} \Delta i^{-}_{W,t-i} + \theta^{-} (i_{R,t} - \varphi_0 - \varphi_1 i_{W,t} - \varphi_2 T)_{t-1} +$$

$$+ \sum_{i=0}^{j3} \beta^{+}_{W,t} \Delta i^{+}_{W,t-i} + \sum_{i=1}^{j4} \beta^{+}_{R,t} \Delta i^{+}_{R,t-i} + \theta^{+} (i_{R,t} - \varphi_0 - \varphi_1 i_{W,t} - \varphi_2 T)_{t-1} + \xi_t \qquad (3)$$

In GETS, θ^{-} and θ^{+} are the speed of adjustment coefficients in the positive and negative case respectively and T is the time trend. The e_{t-1} parameter in equation (2) is replaced with its equivalent ($i_{R,t}$ - φ_0 - $\varphi_1 i_{W,t} - \varphi_2 T$)$_{t-1}$ in equation (3). The latter is the error correction term of the model. Rao & Singh (2006) and Rao & Rao (2008) point out that the (+)/(–) superscript on the coefficients in equation (3), indicate a positive/negative change in the variables included in the model. For any positive change in the independent variable ($\Delta i_{W,t} > 0$), a corresponding response of all positive coefficients (β^+, θ^+), is expected. On the other hand, the corresponding negative coefficients (β^-, θ^-) is assumed to respond in any negative change of the dependent variable ($\Delta i_{W,t} < 0$). This model is estimated with Non-Linear Least Squares method.[4]

We use monthly data collected from the International Financial Statistics (IFS) produced by the International Monetary Fund. Period of analysis for Greece is 1999:01 - 2004:04 and for Bulgaria and Slovenia is 1999:01 - 2007:08. A consistent sample size across countries will be preferable, but unfortunately the IFS data for the Eurozone economies present a break in their series after 2004. For the retail rates, we use the deposit rate and the lending rate. Regarding the wholesale rates, we use the central bank and the money market rates (see also Appendix B for definitions of the IFS database series name).

Before we proceed to the disaggregated GETS model implementation, we discuss whether it is necessary to test for the number of co-integrated vectors

[4] In econometric terms the corresponding "activation" will be triggered in equation 3 with the help of dummy variables. More specifically, all positive coefficients will take the value of 1, when a positive change in the dependent variable occurs, and will be zero otherwise.

between the dependent and the independent variables. Hendry[5] repeatedly stated that if the underlying economic theory is correct, then the variables in the levels must be co-integrated and, therefore, a linear combination of the I(1) levels of the variables must be I(0). As this approach holds for the GETS model, it does not need to be pre-tested for co-integration. It can be said that the relationship between the retail interest rates (dependent variable) and wholesale interest rates (explanatory variables) in their levels, are a linear combination of I(1) variables and, thus, must be I(0).

Although it is not necessary, we report unit root and co-integration tests (following Johansen, 1995 and Phillips-Ouliaris, 1990) for our data series. Prior expectation that interest rates (as most macroeconomic variables) should be I(1) in their levels, is confirmed for almost all series examined by using Augmented Dickey and Fuller (1979) test (see Table 1 in Appendix B for the results of ADF test). The number of the existing co-integrating vectors from the Johansen's methodology, is sensitive to the number of lagged variables (n) of the initial vector (Johansen, 1995). Due to this sensitivity five different lag selection tests will be implemented; the modified Likelihood Ratio test statistic, the Final Prediction Error test, the Akaike, the Schwarz and finally the Hannan-Quinn information criteria. In most of the examined cases, the aforementioned lag selection criteria do not all agree about the optimal lag length[6]. In such cases, the majority rule is applied as a sub-optimal solution. According to the

[5] See Hendry et al (1984), Hendry (1987) and Hendry and Krolzig (2005).
[6] Results about the optimal lag structure using the five different selection criteria are available from the authors upon request.

Eigenvalue and Trace tests from the Johansen's methodology, in some of the bivariate cases, there is a unique co-integrated vector of order 1 (r=1), which supports the hypothesis that interest rates in the SEE economies tend to co-integrate pairwise (Tables 3A-3C in Appendix B). However, the Phillips-Ouliaris procedure (Table 2 in Appendix B) does not produce similar results (with the exception of Greece) as the Johansen's methodology. This is not unusual in the relevant literature and other studies have also reported difficulty in establishing co-integrating relationships between wholesale rates and retail rates (Raunig and Scharler, 2009; Egert et al, 2007).

4. Results

We estimate the disaggregated GETS model for the two types of interest rates (wholesale and retail) in the economies analysed and we test the symmetry hypothesis, that is $\theta^{+} = \theta^{-}$. The existence of a symmetric speed of adjustment is tested by using the Wald χ^{2}- test. Our results provide an answer to the question set out at the outset; what is the effect of an upward or downward change in the policy-controlled variables to the retail rates in the there different banking systems. Our empirical tests for Greece, presented in Tables 4 and 5 in Appendix C, show that symmetry exists; banks tend to pass to depositors and borrowers equally decreases and increases of the original CB and MM rate changes. As far as the coefficients of the two error correction terms, θ^{+} and θ^{-}, is concerned, are all statistically significant in all cases (Table 4, columns 1-4).

Wholesale rates' increases and decreases are both transmitted to the deposit and loan rates, showing evidence of an efficient conduct of monetary policy. This result is in line with newer empirical evidence (Hondroyiannis et al, 1999; Hardy and Symiyiannis, 1998) about the structure of the Greek banking system, which support the hypothesis that there has been a gradual shift of the Greek banking system away from conditions of oligopoly to those of monopolistic competition.

We present the results for Bulgaria in Tables 6 and 7 in Appendix C. When the wholesale rate is the CB rate (i_{CB}) and the retail rate is the loan rate (i_L), there is a negative asymmetry, which means that banks tend to pass to borrowers only decreases of the original CB rate changes. When the wholesale rate is the MM rate (i_{MM}) and the retail rate is the loan rate (i_L), again there is a negative asymmetry, which implies that banks tend to pass to borrowers only decreases of the original MM rate changes. In all other cases, θ^{+} and θ^{-} are either incorrectly signed (Table 6, column 4) or statistically insignificant (column 1 and 3).

We present the results for Slovenia in Tables 8 and 9 in Appendix C. When the wholesale rate is the MM rate (i_{MM}) and the retail rate is the deposit rate (i_D), there is a negative asymmetry, meaning that banks tend to pass to depositors only decreases of the original MM rate changes. When the wholesale rate is the MM rate (i_{MM}) and the retail rate is the loan rate (i_L), again there is a negative asymmetry, indicating that banks tend to pass to borrowers only decreases of the original MM rate changes. Regarding the coefficients of the error correction term, only θ^{-} is statistically significant when the wholesale rate is the MM rate (i_{MM}) and the retail rates is either the deposit or the lending rate (Table 8, columns 3-4). Regarding the CB rate for Slovenia, data presents negligible variation and, thus, the GETS model does not produce any results for the speed of adjustment estimates. In this case, we can not perform the symmetry test.

Our results for Bulgaria and Slovenia are consistent with the *ccustomer reaction hypothesis* regarding the loan market. The speed of retail rates adjustment can be interpreted as the commercial bank managers' power to transmit to their clients any wholesale rate changes. Such speed is presumably affected by the degree of the retail market competitiveness in the banking sector. For example, in a competitive banking environment, bank managers are expected to decrease loan rates in response to wholesale rates decreases. The negative asymmetry results for Bulgaria and Slovenia might be explained by this framework. Asymmetry results for Bulgaria are consistent with section 2 analysis. Although, the banking system in Slovenia is quite concentrated as described in section 2, our empirical results indicate that there are some signs of competition in its loan market.

5. Conclusion

This study focuses on the symmetric or asymmetric effect of an upward or downward change in the policy-controlled variables (the official central bank rate or the implicitly controlled money market rate by the Central Bank) to the retail rates in selected SEE economies. The empirical results for these economies are mixed regarding the symmetry hypothesis and the monetary transmission process. Our results for Greece provide support for symmetry in the adjustment of retail rates in response to changes in the central bank rate. In contrast, for Slovenia we find support for negative asymmetry in the adjustment of loan and deposit rates in response to changes in the money market rate. Also, results for Bulgaria support the negative asymmetry hypothesis in the adjustment of loan rate in response to changes in both the central bank and money market rates. This asymmetric behaviour can be interpreted as an indication of a different level of competition, development and liberalization among the banking systems in the SEE economies. Also, it is theoretically consistent with the customer reaction hypothesis regarding the loan market in Bulgaria and Slovenia. It is also in line with the bank's collusive hypothesis regarding the deposit market in Slovenia. Policy interest rates play an important role in any economy and are crucial for Governments, commercial banks and investors' decision making. We believe that our results can be useful for the SEE's regulatory authorities in their attempt to monitor the competitiveness of their banking systems and reinforce financial system stability and effectiveness. This in turn will hopefully contribute to the macroeconomic stability of these economies.

Appendices

Appendix A. Interest Rates and General Economic Background for the SEE Economies

Figure 1. Wholesale & Retail Interest Rates in Bulgaria (1999:01 - 2007:08)

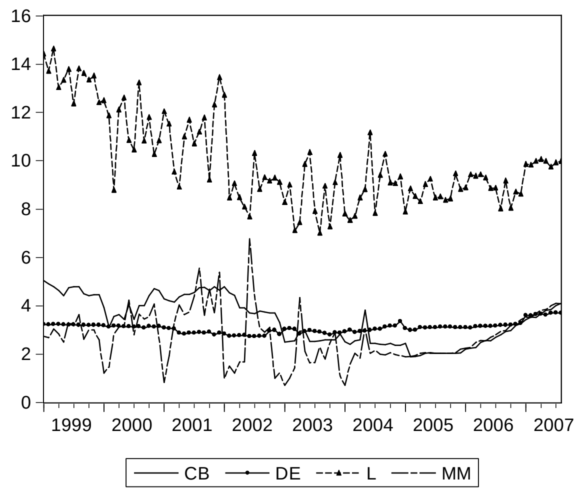


Figure 2. Wholesale & Retail Interest Rates in Greece (1999:01 - 2004:04)

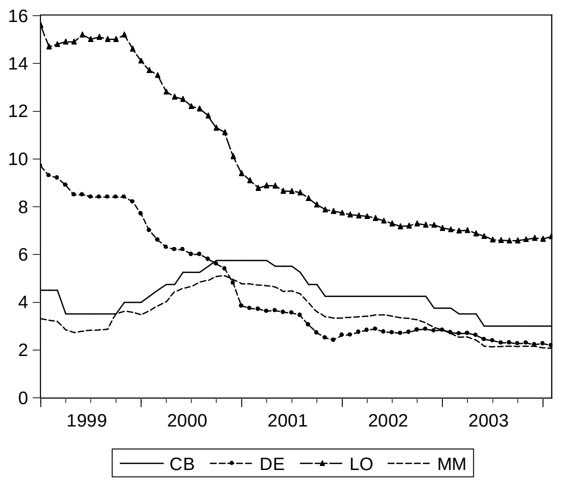
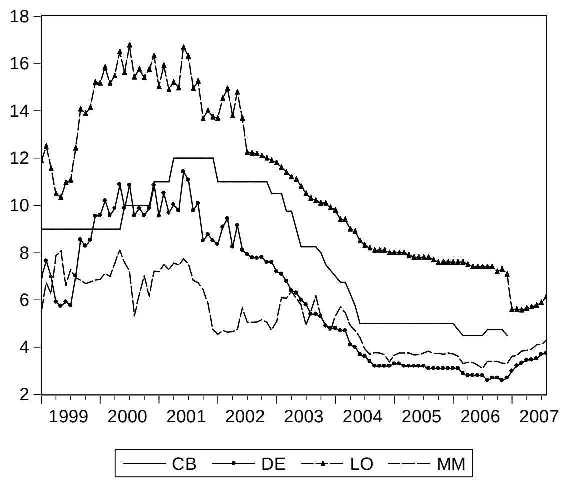


Figure 3. Wholesale & Retail Interest Rates in Slovenia (1999:01 - 2007:08)



Source: International Financial Statistics, International Monetary Fund (IMF)

Table 1. Economy & Income, 1999 – 2007

	GDP (billion $)	GDP (per capita $)	GDP (% change)	GDP (PPP pc)	Population (million)
Bulgaria	22.030	2,827.28	5.18	8,083.75	7.85
Greece	199.992	18,070.55	4.22	22,793.32	11.05
Slovenia	30.928	15,465.40	4.39	21,049.51	2.00

Source: World Economic Outlook Database, International Monetary Fund (IMF)

Appendix B. International Financial Statistics Database Series Name

Central Bank rates

IFS	17460...ZF...	CENTRAL BANK RATE-Greece
IFS	91860...ZF...	BANK RATE (END OF PERIOD)-Bulgaria
IFS	96160...ZF...	CENTRAL BANK RATE-Slovenia

Money Market rates

IFS	91860B..ZF...	INTERBANK RATE-Bulgaria
IFS	17460B..ZF...	INTERBANK RATE (3-MONTH MATURITY)- Greece (Euro Area Money Market rate)
IFS	96160B..ZF...	MONEY MARKET RATE-Slovenia

Deposit rates

IFS	91860L..ZF...	DEPOSIT RATE-Bulgaria
IFS	17460L..ZF...	DEPOSIT RATE-Greece
IFS	96160L..ZF...	DEPOSIT RATE-Slovenia

Lending rates

IFS	91860P..ZF...	LENDING RATE (Mortgage Rate)- Bulgaria
IFS	17460P..ZF...	WORKING CAP INDUSTRY- Greece
IFS	96160P..ZF...	LENDING RATE-Slovenia

Appendix C. Unit Roots, Cointegration Test and Empirical Results

Table 1. Unit Root Tests

Variable	ADF I(0)	ADF I(1)
Bulgaria		
i_{CB}	-2.55	-11.72
i_{MM}	-3.04	-5.63
i_D	-2.68	-6.71
i_L	-2.74	-12.15
Greece		
i_{CB}	-0.90	-7.23
i_{MM}	-1.38	-4.92
i_D	-1.61	-4.71
i_L	-0.55	-5.21
Slovenia		
i_{CB}	-1.89	-12.41
i_{MM}	-4.58	-19.22
i_D	-3.08	-20.13
i_L	-3.61	-19.82

The critical value is -3.45 at 5% significance level and -4.04 at 1% significance level.

Table 2. The Phillips-Ouliaris Co-integration Test

Pair of variables (with constant)	P_Z test	P_u test
Bulgaria		
i_{CB} vs. i_D	18.96	20.56
i_{CB} vs. i_L	15.91	21.65
i_{mm} vs. i_D	17.20	11.79
i_{mm} vs. i_L	13.37	12.58
Greece		
i_{CB} vs. i_D	1.41	5.02
i_{CB} vs. i_L	2.62	4.10
i_{mm} vs. i_D	1.07	3.03
i_{mm} vs. i_L	2.14	3.25
Slovenia		
i_{CB} vs. i_D	20.71	19.43
i_{CB} vs. i_L	17.57	19.53
i_{mm} vs. i_D	13.49	10.44
i_{mm} vs. i_L	11.16	11.13

The critical values for the P_Z and the P_u tests are 55.22 and 33.71, respectively (at 5% significance level).

Table 3A. The Johansen Pairwise Co-intregration Tests for Greece

Causality test	No. of Lags	Rank	Max. Eigenvalue	Trace	No. of Co-integrating Vectors (r)
i_{CB} vs. i_D	**(2)**	r=0	**3.60**	5.64	**r=0**
		r≤1	2.04	2.04	
i_{CB} vs. i_L	**(2)**	r=0	8.72	11.47	**r=0**
		r≤1	2.74	2.74	
i_{mm} vs. i_D	**(1)**	r=0	7.17	9.36	**r=0**
		r≤1	2.18	2.18	
i_{mm} vs. i_L	**(1)**	r=0	6.91	11.00	**r=0**
		r≤1	4.09	4.09	

Table 3B. The Johansen Pairwise Co-intregration Tests for Bulgaria

Causality test	No. of Lags	Rank	Max. Eigenvalue	Trace	No. of Co-integrating Vectors (r)
i_{CB} vs. i_D	**(2)**	r=0	**5.98**	8.39	**r=0**
		r≤1	2.40	2.40	
i_{CB} vs. i_L	**(2)**	r=0	18.05	20.80	**r=1**
		r≤1	2.74	2.74	
i_{mm} vs. i_D	**(1)**	r=0	36.45	39.64	**r=1**
		r≤1	3.18	3.18	
i_{mm} vs. i_L	**(1)**	r=0	24.67	27.47	**r=1**
		r≤1	2.79	2.79	

Table 3C. The Johansen Pairwise Co-intregration Tests for Slovenia

Causality test	No. of Lags	Rank	Max. Eigenvalue	Trace	No. of Co-integrating Vectors (r)
i_{CB} **vs.** i_D	**(2)**	r=0	**35.35**	37.90	**r=1**
		r≤1	2.55	2.55	
i_{CB} **vs.** i_L	**(2)**	r=0	42.15	44.30	**r=1**
		r≤1	2.15	2.15	
i_{mm} **vs.** i_D	**(1)**	r=0	8.23	10.00	**r=0**
		r≤1	1.76	1.76	
i_{mm} **vs.** i_L	**(1)**	r=0	7.26	9.15	**r=0**
		r≤1	1.89	1.89	

The critical value for accepting the hypothesis that r=1 at the 5% significance level for both the Maximum Eigenvalue test and the Trace test, is 3.84.

Table 4. Estimates for Speed of Adjustment for Greece

Independent variable	**Central bank (i_{CB}) rate**		**Money Market (i_{mm}) rate**	
Dependent variable	**Deposit rate (i_D)**	**Loan rate (i_L)**	**Deposit rate (i_D)**	**Loan rate (i_L)**
	(1)	(2)	(3)	(4)
	Coefficients - t-ratios	Coefficients - t-ratios	Coefficients - t-ratios	Coefficients - t-ratios
θ^+	-0.15 (-3.16)	-0.13 (-3.20)	-0.14 (-2.82)	-0.13 (-2.91)
θ^-	-0.15 (-3.21)	-0.14 (-3.23)	-0.15 (-3.00)	-0.13 (-2.94)

Table 5. Symmetry Hypothesis: Results for Greece

Model	**Hypothesis H$_0$: ($\theta^+ = \theta^-$)***	**Result**
i_{CB} **vs.** i_D	**0.76**	**symmetry**
i_{CB} **vs.** i_L	**1.10**	**symmetry**
i_{mm} **vs.** i_D	**4.68**	**symmetry**
i_{mm} **vs.** i_L	**0.006**	**symmetry**

Table 6. Estimates for Speed of Adjustment for Bulgaria

Independent variable	**Central bank (i_{CB}) rate**		**Money Market (i_{mm}) rate**	
Dependent variable	**Deposit rate (i_D)**	**Loan rate (i_L)**	**Deposit rate (i_D)**	**Loan rate (i_L)**
	(1)	(2)	(3)	(4)
	Coefficients - t-ratios	Coefficients - t-ratios	Coefficients - t-ratios	Coefficients - t-ratios
θ^+	-0.000002 (-0.002)	-0.08 (-1.84)	-0.0000008 (-0.002)	0.12 (2.96)
θ^-	-0.000007 (-0.002)	-0.13 (-2.67)	-0.0001 (-0.002)	-0.22 (-4.12)

Table 7. Symmetry Hypothesis: Results for Bulgaria

Model	Hypothesis H₀ : ($\theta^{+} = \theta^{-}$)	Result
i_{CB} vs. i_D	-	-
i_{CB} vs. i_L	Only the negative change (θ^{-}) is statistically significant	Negative (-) asymmetry
i_{mm} vs. i_D	-	-
i_{mm} vs. i_L	Only the negative change (θ^{-}) is statistically significant	Negative (-) asymmetry

We test the symmetry hypothesis by applying the Wald (x^2) test. The critical value of x^2 statistic with one degree of freedom is 3.84 at 5% confidence level and 5.02 (at 2.5% confidence level).

Table 8: Estimates for Speed of Adjustment for Slovenia

Independent variable	Central bank (i_{CB}) rate		Money Market (i_{mm}) rate	
Dependent variable	**Deposit rate (i_D)**	**Loan rate (i_L)**	**Deposit rate (i_D)**	**Loan rate (i_L)**
	(1)	(2)	(3)	(4)
	Coefficients - t-ratios	Coefficients - t-ratios	Coefficients - t-ratios	Coefficients - t-ratios
θ^{+}	GETS N/A	GETS N/A	0.009 (0.13)	0.11 (1.54)
θ^{-}			-0.37 (-5.88)	-0.24 (-4.27)

Table 9. Symmetry Hypothesis: Results for Slovenia

Model	Hypothesis H₀ : ($\theta^{+} = \theta^{-}$)	Result
i_{CB} vs. i_D	-	-
i_{CB} vs. i_L	-	-
i_{mm} vs. i_D	Only the negative change (θ^{-}) is statistically significant	Negative (-) asymmetry
i_{mm} vs. i_L	Only the negative change (θ^{-}) is statistically significant	Negative (-) asymmetry

We test the symmetry hypothesis by applying the Wald (x^2) test. The critical value of x^2 statistic with one degree of freedom is 3.84 at 5% confidence level and 5.02 (at 2.5% confidence level).

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