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Abhandlungen

Reassessing the Asymmetries and Rigidities in the Interest Rate Pass-Through Process: A Hidden Co-Integration Approach

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Abstract

This paper reassesses the existing asymmetries and rigidities in the interest rate pass-through transmission channels, applied in the advanced economies of the US, the UK, Canada, Japan and the Eurozone. A Crouching Error Correction Model econometric methodology is implemented. The accurate measurement of the different aspects of the pass-through interest rate process has upgraded our understanding related to the behavior of the retail interest rate markets and, perhaps more importantly, enhances our practical efficiency in conducting monetary policy actions, at both a country-by-country and a coordinating level. Our empirical results suggest that monetary policy targeting should rather focus more directly on the money market rates transmission channel, instead of the central bank rates channel. Also, a non-homogenous price-rigid and asymmetric behaviour was found regarding the loan-deposit markets.

Neubewertung der Asymmetrien und Rigiditäten in dem Zinssatz Übertragungsprozess: Ein Ansatz versteckter Kointegration

Zusammenfassung

Diese Arbeit untersucht die bestehenden Asymmetrien und Rigiditäten der Zinstransmissionskanäle in den Industrieländern USA, GB, Kanada, Japan und der

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Eurozone. Wir verwenden ein „Crouching Error Correction Model“ als ökonometrische Methodologie. Die akkurate Messung verschiedener Aspekte des Zinstransmissionsmechanismus verbessert unser Verständnis vom Verhalten der Zinssätze im Kundengeschäft. Des Weiteren kann hierdurch die Effizienz geldpolitischer Maßnahmen auf nationaler und supranationaler Ebene gesteigert werden. Die Ergebnisse unserer empirischen Analyse deuten an, dass sich die Geldpolitik verstärkt an den Transmissionskanälen der Marktzinsen anstelle der Zentralbankzinsen ausrichten sollte. Weiterhin konnte ein inhomogenes, preisstarres und asymmetrisches Verhalten in den Kredit/Einlage-Märkten beobachtet werden.

Keywords: Interest rates pass-through, hidden co-integration, crouching error correction model

JEL Classification: E52, C22

I. Introduction

The interest rate pass-through (IRPT) process, from the wholesale to the retail rates, is one of the most crucial processes initiated by every central bank (CB) for achieving its monetary policy goals. These goals are often related to price stability (e.g. applying an anti-inflationary policy) and to real economic activity (e.g. smoothing the business cycles). A quick and full IRPT of wholesale to retail bank rates strengthens monetary policy transmission (*Bondt* (2002)) and thus may affect price stability (*Bondt* (2005)).

Our empirical investigation focuses on the advanced economies of the US, the UK, Canada, Japan and the Eurozone (G5 hereafter). We are looking for the existence of any asymmetries and rigidities related to this IRPT transmission process. Three types of asymmetries are examined here: First, we derive (estimate) the positive/negative long-run relationship in the IRPT transmission process, i.e. the "size" of long-run elasticity or rigidity. In practice, we examine whether these two elasticities are equal to each other and if any increases/decreases of the wholesale rates are fully transmitted to the increases/decreases of the retail rates, i.e. we apply some long-run IRPT rigidity tests.[1] Second, we are looking for any possible asymmetries regarding the positive/negative medium-run ad-

[1] Theoretically, the long-run interest rate rigidity or sluggishness is associated with structural and/or institutional aspects of the financial market, i.e. the concentration level (degree of oligopoly) of the retail market as well as the temporal or non-temporal nature of wholesale interest rate changes. A number of Cost Theories have been developed in order to give some theoretical reasoning to the observed retail interest rates sluggishness phenomenon (for a short discussion on these theories see *Toolsema/Sturm/De Haan* (2001)).

justment process, i.e. the "speed" of reaction of the retail rate to the wholesale rate changes.[2] The positive/negative medium-run adjustment process describes "how fast" an increase/decrease of the wholesale interest rates in the past period will be transmitted in the current period in order to restore the ex-ante long run IRPT equilibrium relationship. The third type of asymmetry is related to the issue of the short-run adjustments, which differ with respect to the so-called impact multipliers of up and downward movements of interest rates. More specifically, we estimate the positive/negative mean adjustment lag operators, i.e. the "time needed" for the IRPT process to be completed. The aforementioned lag operators (multipliers) represent the time requirements (e.g. number of months, weeks, days, etc.) for a given positive/negative change in the wholesale interest rate to be fully transmitted -apart from the instant effect- to the retail rates.

For deriving answers about the magnitude and the features of the aforementioned asymmetries and rigidities, we employ a symmetric/asymmetric Error Correction (EC) approach, developed by *Granger/Yoon* (2002) known as the "hidden co-integration" (HC) approach which, in its dynamic representation, leads to the Crouching Error Correction Model (CECM).

The structure of the paper is as follows: in section II, we briefly discuss the literature review on the symmetry/asymmetry methodologies implemented to the IRPT studies. In section III, we analyse the Crouching Error Correction Model together with the advantages of its implementation on the IRPT process; in section IV, we present data and the empirical results and finally, in section V, we conclude.

II. The Literature Review

Different studies are utilized in the pass-through symmetric/asymmetric transmission models, not only in the interest rates market but also in other markets (e.g. the exchange rates market, the oil market, etc.).[3] Here we briefly review the main symmetric/asymmetric models implemented

[2] This issue is basically connected to the bank manager's willingness to transfer any wholesale rate changes to his/her clients (retail rates). Such speed is possibly affected by the degree of a bank's retail market competitiveness.

[3] For a complete survey on econometric models of asymmetric price transmission, see *Frey/Manera* (2007).

in such markets like the Asymmetric Error Correction [AECM], the LSE-Hendry General-to-Specific (GETS) and the Threshold Autoregressive [TAR/MTAR] models.

Commencing with the AECM, it was *Granger/Lee* (1989) who extended the simple ECM specification to the case of asymmetric adjustments. More specifically, in order to allow for asymmetries, co-integration residuals and first differences of the estimated equation could now be decomposed into positive and negative values. In this line of studies *Scholnick* (1996), *Frost/Bowden* (1999) and *Hofmann/Mizen* (2004) implemented this AECM approach in testing for IRPT asymmetries.[4] *Bachmeier/Griffin* (2003) and *Rao/Rao* (2008) presented an alternative dynamic symmetric/asymmetric approach, originating from the LSE-Hendry (1987) general-to-specific (GETS) methodology. Their applications are based on an ex post differentiation of the data in positive and negative values. Actually, they simultaneously estimated the short-run and long-run coefficients in the same dynamic asymmetric model. Also, in this line of thought some recent IRPT studies appear in the literature, see for example, *Panagopoulos/Reziti/Spiliotis* (2010) and *Karagiannis/Panagopoulos/Vlamis* (2014).

Turning now to the TAR adjustment speed models, *Enders/Granger* (1998) and *Enders/Siklos* (2001) propose an alternative ECM strategy which appears in the literature as TAR (Threshold Autoregressive Model) and/or as MTAR (Momentum Threshold Autoregressive Model) models. According to *Enders/Granger* (1998), in the standard EC models, tests for unit roots and co-integration have low power in the presence of asymmetric adjustment as they implicitly assume symmetric and linear adjustment processes. So the TAR models are aimed, primarily, at testing for the presence of non-linear transaction costs, and, generally, for the existence of price bands (data discontinuity) where there is no obvious transmission.[5] In econometric terms, they look for the presence of a threshold in the equilibrium correction mechanism that minimizes the residuals. *Sander/Kleimeier* (2004), *Wang/Nguyen Thi* (2010) and *Beck-*

[4] Actually, in their IRPT applications, they decomposed the co-integration residuals into negative and positive values (from the long-run equations) but they did not do the same for the short-run dynamics (the regressions in first differences).

[5] There is also a further development on this line of models which investigates the possibility for a smooth transition instead of assuming discrete jumps between the two states of the ECM (for positive and negative errors) (see *Teräsvirta* (1994) and *Beckmann/Czudaj* (2014)).

er/Osborn/Yildirim (2012), are only some applications of this methodology on the IRPT asymmetries. However, the aforementioned studies have computational difficulties and often impose ex ante non-theoretical restrictions. Additionally, they do not incorporate any positive and negative ex ante decomposition of the Data Generation Process (DGP).

In the same general symmetric/asymmetric framework lies the CECM, actually derived from the *Ganger/Yoon's* (2002) hidden co-integration approach. This model is more flexible than the TAR/MTAR models, as it is not limited to two (or more) regimes and we can investigate all possible combinations of co-integration between data components. Additionally, it looks more like an extension of the AECM and GETS than the TAR/MTAR models since it does not initially presuppose any threshold and it contains an ex ante positive and negative decomposition of the data and then a cumulative aggregation of these two parts in the Data Generation Process (DGP). Consequently, the hidden co-integration approach allows for distinct co-integrating relationships between subcomponents (positive and negative) of two time series even when co-integration between them is not identified at the aggregate level.

The CECM methodology contains all the advantages of the GETS methodology (that we can simultaneously estimate the short-run and long-run coefficients in the same dynamic model). Additionally, allows for cumulative positive and negative long-run estimators to be embedded in its dynamic structure. This last advantage allows for: a) a differentiation of the long-run rigidity in the upward and/or downward channel and, consequently, b) the derivation of more accurate estimates of the positive and/or negative mean adjustment lag operators.

III. The Crouching Error Correction Model

Granger/Yoon's (2002) hidden co-integration approach aims to identify the dynamics between cumulative positive and negative changes of data components. If these components of the two data series (negative or positive) are co-integrated, then the data are said to have a hidden co-integration. Suppose X_t and Y_t are two random walk time series described by:

(1a) $$X_t = X_{t-1} + \varepsilon_t = X_0 + \sum_{i=1}^{t} \varepsilon_t$$

(1b) $$Y_t = Y_{t-1} + \eta_t = Y_0 + \sum_{i=1}^{t} \eta_t$$

Where, X_0, Y_0 denote initial values and ε_i and η_i are mean zero white noise disturbance terms.

In the *Granger/Yoon* (2002) methodology we define positive and negative shocks as follows: $\varepsilon^+ = \max(\varepsilon_i, d)$, $\varepsilon^- = \min(\varepsilon_i, d)$, $\eta^+ = \max(\eta_i, d)$ and $\eta^- = \min(\eta_i, d)$, where, d stands for an unknown threshold value (with $d = 0$ as the most popular choice).

Thus equations (1a) and (1b) are transformed to:

(2a) $$X_t = X_{t-1} + \varepsilon_t = X_0 + \sum_1^t \varepsilon^+ + \sum_1^t \varepsilon^- \text{ and}$$

(2b) $$Y_t = Y_{t-1} + \eta_t = Y_0 + \sum_1^t \eta^+ + \sum_1^t \eta^-, \text{ respectively.}$$

Following the *Granger/Yoon* (2002) approach, we can simplify to:

$$X_t^+ = \sum_1^t \varepsilon_i^+,\ X_t^- = \sum_1^t \varepsilon_i^-,\ Y_t^+ = \sum_1^t \eta_i^+,\ Y_t^- = \sum_1^t \eta_i^-,$$

Thus, we take that: $X_t = X_0 + X^+ + X^-$ and $Y_t = Y_0 + Y^+ + Y^-$.

It follows that: $\Delta X_t^+ = \varepsilon^+, \Delta X_t^- = \varepsilon^-, \Delta Y_t^+ = \eta^+, \Delta Y_t^- = \eta^-$.

In empirical terms, to apply this method, we calculate the first difference for both of the time series $\{X_t, Y_t\}$ and sort observations into positive and negative movements (e.g. $\Delta X_t^+, \Delta X^-$, $\Delta Y_t^+, \Delta Y^-$). Next we calculate the cumulative sum of positive (and negative) changes at a given time for all (four) variables (e.g. $X_t^+ = \sum \Delta X^+$, $X_t^- = \sum \Delta X^-$, $Y_t^+ = \sum \Delta Y^+$, $Y_t^- = \sum \Delta Y^-$).

Then we move to the presentation of the alternative long-run co-integration hypotheses which can be tested between the four different components of the two time series (e.g. $X_t^+, X_t^-, Y_t^+, Y_t^-$).

The alternative (long-run) hypotheses

Two variables $\{X_t, Y_t\}$ are hidden co-integrated if their positive and negative components are co-integrated. According to *Granger/Yoon* (2002), *Honarvar* (2009) and *Alexakis* et al. (2013), we might have one of the following four alternative hypotheses between the pre-selected pairs of X_t and Y_t {e.g. X_t^+, Y_t^+ and X_t^-, Y_t^-}:

Hypothesis 1: Neither $\{X_t^+, Y_t^+\}$ nor $\{X_t^-, Y_t^-\}$ are hidden co-integrated.

Hypothesis 2: Either $\{X_t^+, Y_t^+\}$ or $\{X_t^-, Y_t^-\}$, but not both, are hidden co-integrated. In this case, X_t and Y_t are subject to positive or negative shocks.

Hypothesis 3: Both $\{X_t^+, Y_t^+\}$ and $\{X_t^-, Y_t^-\}$ are hidden co-integrated, but with different co-integrating vectors. In this case, the common shocks of X_t and Y_t are not co-integrated.

Hypothesis 4: Both $\{X_t^+, Y_t^+\}$ and $\{X_t^-, Y_t^-\}$ are hidden co-integrated. In this case, X_t and Y_t are co-integrated with the same co-integrating vector.

Based on the above methodological framework we can easily derive the dynamic expression of this HC relation, the dynamic EC model. This model is differentiated in accordance with the prevailed long-run hypothesis between the components of the X_t and Y_t . *Granger/Yoon* (2002) refers to the EC model implied by hidden co-integration as the "crouching error correction model". In this study we choose the Hypothesis 3 CECM version to apply as it actually enhances all the others. So we assume that $\{X_t^+, Y_t^+\}$ and $\{X_t^-, Y_t^-\}$ are hidden co-integrated but with a different co-integrating vector of $(1,–k)$, where $k \neq 1$.

Theoretically speaking, the wholesale – retail interest rates relationship can now be algebraically expressed in the long-run (equation 3a) and in its dynamic version (equation 3b) as follows,

$$r_{R,t} = c + \varphi * r_{W,t} + e_t \tag{3a}$$

$$\text{and } \Delta r_{R,t} = c + \sum_{j=1}^{k} \delta_{R,i} * \Delta r_{R,t-j} + \sum_{i=0}^{n} \delta_{W,i} * \Delta r_{W,t-i} + \theta * e_{t-1} + u_t \tag{3b}$$

where: $r_{R,t}$ stands for the different (retail) loan and deposit rates (e.g. the prime loan rate, the time deposit rate, etc.); $r_{W,t}$ stands for the different (wholesale) central bank or money market rates (e.g. the overnight rate, the three-month money market rate, etc.); φ stands for the long-run pass-through elasticity; θ stands for the speed of adjustment parameter; $\delta_{R,i}, \delta_{W,i}$ stand for the short-run elasticities of the dependent and the independent lagged variables; R & W subscripts stand for retail and wholesale, respectively; the Greek letter Δ stands for first difference operator; e_t stands for the error term residuals in the long-run equation (3a); e_{t-1} and u_t stand for the EC term and the residuals, respectively, in the dynamic equation form (3b).

Going a step further and in line with the HC methodological framework, for any positive/negative asymmetries and rigidities to be captured, the pair of interest rates (wholesale and retail) should be ex ante decomposed into positive and negative values. So the dynamic EC model (3b) can be further transformed to:

$$(4)\quad \Delta r_{R,t} = c + \sum_{j=1}^{k1} \delta_{R,i}^{-} \, \Delta r_{k,t-j}^{-} + \sum_{i=0}^{k2} \delta_{W,i}^{-} \, \Delta r_{W,t-i}^{-} + \sum_{j=1}^{k3} \delta_{R,i}^{+} \, \Delta r_{R,t-j}^{+} + \sum_{i=0}^{k4} \delta_{W,i}^{+} \, \Delta r_{W,t-i}^{+}$$
$$+ \theta^{-} (r_{R,t-1}^{-} - \varphi^{-} \; r_{W,t-1}^{-})_{t-1} + \; \theta^{+} (r_{R,t-1}^{+} - \varphi^{+} r_{W,t-1}^{+})_{t-1} + \eta_t$$

where, in addition to equations (3a, 3b) variables' terminology, $r_{R,t}^{\pm}$ stands for the positive/negative (retail) loan and deposit rates; $r_{W,t}^{\pm}$ stands for the positive/negative (wholesale) central bank or money market rates; $\theta^{\pm}$ stands for the positive/negative speed of adjustment parameters, $\delta_{R,i}^{\pm}$& $\delta_{w,i}^{\pm}$ stand for the positive and negative short-run elasticities of the dependent and the independent lagged variables; $\varphi^{\pm}$stands for the positive/negative long-run elasticities and η_t stands for the error term.

The model parameters and testing interpretation

The $\varphi^{\pm}$ parameter embeds the level of the positive/negative long-run elasticity among retail and wholesale interest rates. The "size" of the long-run elasticity or rigidity describes whether an increase/decrease of the wholesale rate is fully transmitted to the increase/decrease of the retail rates. The completeness of the long-run IRPT process is not pre-determined as the two values of the long-run IRPT elasticity in equation 4 are not pre-assumed to be equal to one. The decomposed (positive and negative) long-run rigidities allow us to implement two new rigidity tests, i.e. whether $\varphi^{\pm} = 1$.

The $\theta^{\pm}$ parameter (error correction term), measures the medium-run adjustment process, the "speed" of reaction of the retail interest rates to any positive/negative changes in the wholesale rates. It describes "how fast" an increase/decrease in the wholesale interest rates in the previous period will be passed through in the current period in order for the ex ante long-run IRPT equilibrium relationship to be restored.

The $\delta_{R,i}, \delta_{W,i}$ parameters measure the short-run elasticities of the dependent and the independent lagged variables, counting for the short-run IRPT adjustments.

Based on the estimations of $\varphi^{\pm}$, $\theta^{\pm}$, $\delta_{w0}^{\pm}$ (where the $\delta_{w0}^{\pm}$ parameter, represents the instant positive/negative IRPT effect) we can produce some improved symmetry and rigidity tests.

First, we are testing whether $\theta^{-} = \theta^{+}$ which constitutes a "speed symmetry" test. Then we proceed to the construction of the two mean adjusted lag operators, which can be derived from equation 4. Analytically, the two decomposed mean adjustment lag operators are now defined as:

$\gamma^+ = (\varphi^+ - \delta^+_{w,0}) / \theta^+$ and $\gamma^- = (\varphi^- - \delta^-_{W,0}) / \theta^-$, respectively. These two $\gamma^\pm$ratios -the positive/negative mean adjustment lag operators- measure the time required (months, weeks, etc.) for the remaining value to be transmitted and the IRPT process to be completed, i.e. the value left after the instant positive/negative IRPT effect of the process. Additionally, by comparing the values of the $\gamma^\pm$ ratios (the difference of the two operators) we take a new "time symmetry" criterion, the $\psi = \gamma^+ - \gamma^-$ score. If $\psi > 0$ this implies that positive asymmetry exits and vice versa.

Also, the distinction between negative and positive cumulative changes in the data allows us to "create" an extra symmetry criterion, a by-product of $\varphi^\pm$ and $\theta^\pm$ parameters, the "total symmetry ratio" i.e. $TSR = (\varphi^+ * \theta^+)/(\varphi^- * \theta^-)$. If TSR scores are close to unity then total symmetry emerges. If TSR values are substantially greater than unity then we accept positive total asymmetry and if TSR values are smaller than unity we accept negative total asymmetry. By comparing the TSR products (values) of the two different wholesale (CB or MM) transition channels we have some information regarding which of the two specific wholesale vehicle/tool rates (CB or MM) "causes" the most symmetric IRPT results. The selection of the "best fitting" wholesale interest rate (the independent variable in the model) "indicates" which vehicle/tool must be designated as the most effective policy tool.

IV. Data and Empirical Results

1. Data

We use monthly data of the G5 economies (1980:1 to 2011:11) from the Financial Statistics of the International Monetary Fund (IMF). For the US, the discount rate and the federal fund rate are used as proxies for the CB (i_{CB}) and the MM (i_{mm}) interest rates, respectively. The three-month Certificates of Deposit (CD) and the prime loan rate are used as proxies for the retail rates (deposit and loans) (i_L and i_D, respectively). Regarding Canada, the CB policy rate and the overnight MM rate are used for the CB (i_{CB}) and the MM (i_{mm}) interest rates, respectively. The 90-day fixed deposit rate (i_D) and the prime loan rate (i_L) are used as proxies for the corresponding retail rates. In the UK, the data information is sourced accordingly: the CB policy rate (i_{CB}), the overnight interbank rate (i_{mm}) and the lending (bank clearing) rate (i_L) are provided by the IMF's Financial Statistics while the three-month Sterling Certificates of Deposit interest rate, which is used as a proxy for the deposit rate (i_D), is derived from the Bank of England's Statistics. Turning now to the case of Japan, we have all the rates from the IMF's Financial Statistics: the discount rate (i_{CB}), the call money rate (i_{mm}), the deposit rate (i_D) and the lending rate (i_L). Finally, in the case of the Eurozone, the marginal lending facility rate is used as a proxy for the CB interest rate (i_{CB}) and the interbank three-month maturity rate is used as a proxy for the MM (i_{mm}) rate. Both rates are provided by the IMF's *Financial Statistics* data set. For the Eurozone's retail rates (deposit and loan), we use data from the ECB Statistical Data Warehouse database. For the lending rate (i_L), the weighted average of four different lending rates[6] is taken while, for the deposit rate (i_D), the total deposits for non-financial corporations and households is used. As an exception, the time period for the Eurozone monthly data ranges from 2003:1 to 2011:11. For all the aforementioned interest rate variables, we split the observations into positive and negative movements and then accumulate them.[7]

2. *Empirical Results*

We start by testing for the degree of integration of the time series data. According to the unit root (ADF tests) results, most of the examined data series are integrated of order one.[8] Then we search for the existence of any HC pairs between wholesale and retail rates. Regardless of the long-run HC test results (the *Johansen* results), we proceed to the second stage of the HC methodology by estimating the CECMs. We do so as in some cases co-integration exists without being clearly revealed by the pair-wise Johansen test results.[9]

Due to the prolonged examined time period, we tested our time series for the existence of any structural break. More specifically, we imple-

[6] The four lending rates are: the loans for non-financial corporations, up to 1 year (L1), up to 1 year and over 1 million euros (L2), over 5 years (L3) and the loans for consumption, from 1 to 5 years (L4).

[7] Appendix 1 presents the cumulative sum of the positive and negative components of the interest rates used.

[8] Few exceptions exist in the Eurozone case. The cumulative sum of negative components of CB (r_{CB}^{-}), the cumulative sum of positive components of Deposits (r_{DE}^{+}) and the cumulative sum of positive components of Loans (r_{LO}^{+}) were not found to be integrated of order one. The unit root results are available upon request.

[9] The pair-wise Johansen test results (Eigen values & Trace) and the long-run estimators of the HC regressions are available upon request.

Table 1: **The US Banking System**

CECM	(φ^+)	(φ^-)	H_0: $\Phi^+ = 1$	H_0: $\Phi^- = 1$	*Result*	H_0: $\Phi^- = \Phi^+$	*Result*	(θ^+)	(θ^-)	H_0^1: $\theta^+ = \theta^-$	*Result*	$(\delta_{wo}^{\ +})$	$(\delta_{wo}^{\ -})$	$\gamma^+ = (\varphi^+ - \delta_0^{\ +})/\theta^+$	$\gamma^- = (\varphi^- - \delta_0^{\ -})/\theta^-$	Ψ score[2] $\gamma^+ = \gamma^-$	*Result*	*TSR*[3]	*Result*
CB vs. De	1.02	0.92	0,8	4.75	Both Ho accepted		reject	–0.28	–0.22	7.24	Positive Asymmetry	0.59	0.58	1.53	1.54	–0.01	Symmetry	1.41	Weak Positive Total Symmetry
						7,22	Ho	(–5.45)	(–4.61)			(7.8)	(10.2)						
MM vs. De	0.98	0.95	0.20	3.35	Both Ho accepted		reject	–0.39	–0.32	4.42	Symmetry	1.22	0,89	–	0.18	–	–	1.25	Weak Positive Total Symmetry
						5,8	Ho	(–6.46)	(–5.88)			(21.0)	(22.8)						
CB vs. Lo	0.97	0.92	0.41	1.52	Both Ho accepted		accept	–0.12	–0.05	11.21	Positive Asymmetry	0.34	0.33	5.25	11.8	–6.55	Strong Negative Asymmetry	2.52	Strong Positive Total Symmetry
						3,33	Ho	(–4.50)	(–2.85)			(7.96)	(10.2)						
MM vs. Lo	0.91	0.94	2.29	0.42	Both Ho accepted		accept	–0.10	–0.05	7.84	Positive Asymmetry	0.86	0.34	0.5	12	–11.50	Strong Negative Asymmetry	1.93	Strong Positive Total Symmetry
						0,56	Ho	(–3.88)	(–2.64)			(21.4)	(9.90)						

t-Statistics in parentheses; CECM – crouching error correction model; CB – central bank interest rate; MM – money market interest rate; De – deposit interest rate; Lo – loan interest rate.

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

2: We accept Symmetry when $\psi \geq |2|$ (months) regarding the IRPT time completeness. When $|2| \leq \psi \leq |4|$ (months), we accept weak (negative or positive) asymmetry. When $\psi \geq |4|$ (months), we accept strong asymmetry.

3: Total symmetry (TSR) = $\varphi^+ * \theta^+/\varphi^- * \theta^-$. We accept total symmetry when [0.80–1.0] ≈ TSR ≈ [1.0–1.20]. We accept weak total asymmetry when [0.50–0.8] ≈ TSR ≈ [1.20–1.50] and strong total asymmetry when 0.50 ≤ TSR ≥ 1.50.

mented the unit-root tests allowing for structural breaks in all interest rate variables (see *Zivot/Andrews* (1992) and *Kazanas/Miaouli* (2014)). According to the derived results, only in the call money rate (MM rate) of Japan we did find a statistically significant structural break at 1992:4.[10]

Long-run testing results: Commencing from the long-run rigidities ($\varphi^{\pm}$coefficients), we observe that all are quite close to unity regardless of the wholesale rate choice (CB or MM).[11] This simply means that, in the long run, all changes (negative or positive) in the wholesale rates are totally transmitted to the retail rates. Then, according to the long-run IRPT symmetry tests, i.e. if $\varphi^{+} = \varphi^{-}$, we found symmetry in the loan interest rate markets and asymmetry in the deposit market, regardless of the wholesale rate chosen.

Medium and short-run adjustment process: Positive asymmetry was found as almost all $\theta^{+}$are higher than θ^{-} in both (loan and deposit) retail interest rate markets regardless of the wholesale rate chosen.[12] On the "time needed" ($\gamma^{\pm}$calibrated values), we observe that in the deposit market the necessary time for the remaining (negative or positive) adjustment process to be completed ranges from 0.18 to 1.53 months while in the loan market it takes from 0.5 to 12 months. Also, in the loan interest rate market strong negative time asymmetry appears (ψ values range from –6.55 to –11.50 months) whilst time symmetry appears in the deposit market ($\psi = \gamma^{+} - \gamma^{-}$= –0.01) [13].

Wholesale interest rate selection: From the TSR results, a clear indication towards the MM channel was revealed as the MM channel gives more symmetric results than the CB one.

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[10] The *Zivot/Andrews* (1992) unit root test results for any structural breaks are available upon request.

[11] Similar results for both retail markets are verified by *Beckmann* et al. (2013). Non-rigid results are also verified in *Panagopoulos* et al. (2010) only in the loan market, when the MM rate is used as the IRPT policy rate tool. On the other hand, rigidities appear in *Karagiannis* et al. (2010).

[12] In *Karagiannis* et al. (2010), the MM channel does not operate at all ($\theta^{\pm}$ parameters are insignificant). On the other hand, the $\theta^{\pm}$ parameters of the CB channel, although significant, operate with very low values. In *Panagopoulos* et al. (2010), where only the MM rate is used as the policy rate, similar results appear, regarding the "speed" symmetry test, for the loan market only.

[13] As we can observe, in the US case, when the MM rate is used as the wholesale interest rate the $\delta^{\pm}_{w0}$ values for the two instant IRPT effects on the loan interest rates vary between 0.34 and 0.86. In *Kwapil/Scharler'* (2013) study the aggregate US instant IRPT effect in the loan market was around 0.60.

Table 2: **The UK Banking System**

CECM	(φ^+)	(φ^-)	H_0: $\Phi^+ = 1$	H_0: $\Phi^- = 1$	*Result*	H_0: $\Phi^- = \Phi^+$	*Result*	(θ^+)	(θ^-)	H_0^1: $\theta^+ = \theta^-$	*Result*	$(\delta_{wo}^{\ +})$	$(\delta_{wo}^{\ -})$	$\gamma^+ = (\varphi^+ - \delta_0^{\ +})/\theta^+$	$\gamma^- = (\varphi^- - \delta_0^{\ -})/\theta^-$	Ψ score^2 $\gamma^+ = \gamma^-$	*Result*	*TSR*^{3}	*Result*
CB vs. De	0.94	0.95	0.48	2.82	Both Ho accepted		accept	–0.24	–0.24	0,02	Symmetry	0.95	0.95	0	0	0	Symmetry	0.98	Total Symmetry
						0,17	Ho	(–4.13)	(–3.39)			(22.1)	(17.4)						
MM vs. De	0.83	0.86	3.83	5.16	Negative Ho rejected		accept	–0.20	–0.19	0,63	Symmetry	0.58	0.11	1,25	3,94	–2,69	Weak Negative Asymmetry	1.01	Total Symmetry
						3,7	Ho	(–3.13)	(–3.11)			(11.0)	(2.2)						
CB vs. Lo	1.01	1.01	12.68	10.64	Both Ho rejected		accept	–0.44	–0.44	0,005	Symmetry	1.01	0.98	0	0,06	–0,06	Symmetry	1.00	Total Symmetry
						4,23	Ho	(–7.76)	(–7.07)			(89.2)	(71.1)						
MM vs. Lo	0.92	0.90	7.19	12.27	Both Ho rejected		accept	–0.36	–0.38	5,53	Negative Asymmetry	0.63	0.26	0,8	1,68	–0,88	Symmetry	0.96	Total Symmetry
						2,77	Ho	(–5.25)	(–5.36)			(14.9)	(6.50)						

t-Statistics in parentheses; CECM – crouching error correction model; CB – central bank interest rate; MM – money market interest rate; De – deposit interest rate; Lo – loan interest rate.

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

2: We accept Symmetry when $\psi \geq |2|$ (months) regarding the IRPT time completeness. When $|2| \leq \psi \leq |4|$ (months), we accept weak (negative or positive) asymmetry. When $\psi \geq |4|$ (months), we accept strong asymmetry.

3: Total symmetry (TSR) = $\varphi^+ * \theta^+/\varphi^- * \theta^-$. We accept total symmetry when [0.80–1.0] ≈ TSR ≈ [1.0–1.20]. We accept weak total asymmetry when [0.50–0.8] ≈ TSR ≈ [1.20–1.50] and strong total asymmetry when 0.50 ≤ TSR ≥ 1.50.

Long-run testing results: In general terms, symmetry prevails in both the UK retail interest rate markets. The values of $\varphi^{\pm}$coefficients (long-run elasticities or rigidities) are again close to unity[14] and the null hypothesis on the long-run IRPT symmetry test ($\varphi^{+} = \varphi^{-}$) is accepted in all cases, regardless of the wholesale rate chosen.

Medium and short-run adjustment process: The $\theta^{\pm}$ parameters in the loan interest rate market were found to be much higher than in the deposit market (almost double) but all null hypotheses, regarding the "speed" symmetry test, are verified i.e. $\theta^{-} = \theta^{+}$. The same symmetric picture emerges concerning the "time needed" for the remaining (after the instant effect) positive or negative wholesale rate change to be completely transmitted to the corresponding retail rate. The strong and close to unity value of $\delta^{\pm}_{w0}$ parameters[15] minimize the importance of the $\gamma^{\pm}$ parameters as there is no "remaining value" to be transmitted (after the instant IRPT effect).

Wholesale interest rate selection: As mentioned above, we observe that the values of the instant IRPT effect (the $\delta^{\pm}_{w0}$values), are very close to unity when the CB is the policy rate. This means that any change in the CB rate (positive or negative) is almost instantly and entirely passed-through to the retail interest rates (in the loan and deposit markets). This signifies the effectiveness of the CB channel. However, the "total symmetry ratios" (TSR scores) range from 0.96 to 1.0 for both wholesale interest rates. These types of symmetrical results simply imply that both wholesale (CB and MM) interest rates can equally "serve" as the transmission monetary policy "vehicle".

Long-run testing results: In contrast to the UK & US banking systems, most of the $\varphi^{\pm}$coefficients were found not very close to unity.[16] This im-

[14] On the issue of rigidity existence, the Wald tests accept the null hypothesis of perfect IRPT completeness in the deposit market but it is rejected in the loan market. However, even in the loan market the long-run positive and negative IRPT elasticity ranges very close to unity (from 0.90 to 1.01). Similar results concerning the aggregate values of ϕ coefficients for both UK retail markets are also derived by *Ahmand* et al. (2013) and *Beckmann* et al. (2013). The same results appear with the corresponding decomposed $\phi^{\pm}$ coefficients in *Panagopoulos* et al. (2010).

[15] When the MM rate is used, as the explanatory variable in the models, the $\delta^{\pm}_{w0}$ values for the two instant IRPT effects in the loan market vary between 0.30 and 0.69. Very similar results, regarding the aggregate UK instant IRPT effect, appear in *Kwapil/Scharler'* (2013) work.

[16] In *Panagopoulos* et al. (2010) the corresponding aggregate ϕ coefficients for the two retail markets diversify. More specifically, in the loan market a non-rigid behavior appears, while in the deposit rate we observe an overshooting behavior. Diversification also exists with respect to the two instant IRPT effects.

Table 3: **The Canadian Banking System**

CECM	(φ^+)	(φ^-)	H_0: $\Phi^+ = 1$	H_0: $\Phi^- = 1$	*Result*	H_0: $\Phi^- = \Phi^+$	*Result*	(θ^+)	(θ^-)	H_0^1: $\theta^+ = \theta^-$	*Result*	(δ_{wo}^+)	(δ_{wo}^-)	$\gamma^+ = (\varphi^+ - \delta_0^+)/\theta^+$	$\gamma^- = (\varphi^- - \delta_0^-)/\theta^-$	Ψ score[2] $\gamma^+ = \gamma^-$	*Result*	*TSR*[3]	*Result*
CB vs. De	0.69	0.79	5.66	19.16	Both Ho rejected		accept	–0.16	–0.08	4.76	Symmetry	0.47	0.55	1.38	3.00	–1.62	Symmetry	1.75	Strong Positive Total Symmetry
						1,25	Ho	(–3.50)	(–2.61)			(6.72)	(7.0)						
MM vs. De	0.67	0.75	16.47	35.89	Both Ho rejected		reject	–0.27	–0.20	12.93	Positive Asymmetry	0.32	0.05≠	1.29	3.50	–2.21	Weak Negative Asymmetry/ Symmetry	1.20	Total Symmetry
						55,66	Ho	(–6.65)	(–5.14)			(8.4)	(1.0)						
CB vs. Lo	0.94	0.94	5.90	6.75	Both Ho rejected		accept	–0.45	–0.31	2.66	Symmetry	0.72	0.88	0.48	0.19	–0.28	Symmetry	1.45	Weak Positive Total Symmetry
						0,14	Ho	(–4.01)	(–2.97)			(12.2)	(14.3)						
MM vs. Lo	0.80	0.84	3.08	4.70	Both Ho accepted		reject	–0.21	–0.19	3.39	Symmetry	0.46	0.11	1.61	3.84	–2.23	Weak Negative Asymmetry/ Symmetry	1.05	Total Symmetry
						19,23	Ho	(–3.12)	(–2.81)			(11.4)	(2.05)						

t-Statistics in parentheses; CECM – crouching error correction model; CB – central bank interest rate; MM – money market interest rate; De – deposit interest rate; Lo – loan interest rate.

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

2: We accept Symmetry when $\psi \geq |2|$ (months) regarding the IRPT time completeness. When $|2| \leq \psi \leq |4|$ (months), we accept weak (negative or positive) asymmetry. When $\psi \geq |4|$ (months), we accept strong asymmetry.

3: Total symmetry (TSR) = $\varphi^+ * \theta^+/\varphi^- * \theta^-$. We accept total symmetry when [0.80–1.0] ≈ TSR ≈ [1.0–1.20]. We accept weak total asymmetry when [0.50–0.8] ≈ TSR ≈ [1.20–1.50] and strong total asymmetry when 0.50 ≤ TSR ≥ 1.50.

plies that, in the long run, all changes (negative or positive) in the wholesale rates are not totally transmitted to the retail rates and therefore there is rigidity in both retail markets. Additionally, we reject the null hypothesis in the long-run IRPT symmetry test ($\varphi^+ = \varphi^-$), whenever the MM rate is chosen as the wholesale rate.

Medium and short-run adjustment process: In contrast to the long-run results, the strong statistical significance of $\theta^{\pm}$parameters denotes that the IRPT transition process still exists. Also, similarly to the UK case, the instant IRPT effects ($\delta^{\pm}_{w0}$values) seem to favor the CB channel compared to the MM one. In the loan market, the IRPT transition process from the CB rate to the retail rates appears to be the quickest one. The "preference" of this channel is advocated from both the "speed" of the IRPT adjustment process ($\theta^{\pm}$coefficients range from 0.31 to 0.45) and the instant IRPT effect ($\delta^{\pm}_{w0}$ coefficients range from 0.72 to 0.88) .[17] Similarly to the UK case, almost all the medium and short-run symmetry tests ($\gamma^{\pm}$& $\theta^{\pm}$ parameters) for Canada produce quite symmetrical results, when the CB rate is chosen as the explanatory variable in the CECM, i.e. $\theta^- = \theta^+$ and $\gamma^- = \gamma^+$. When the MM rate is chosen, then the medium and short-run symmetry results diversify.

Wholesale interest rate selection: Initially, due to the values of the instant IRPT effects ($\delta^{\pm}_{w0}$) from the derived estimators, the CB channel seems to be the preferable one. Additionally, the IRPT transition process in the loan market, initiated from the CB rate, appears to be the quickest one. However, according to the TSR scores, which are counted for more holistic answers to the problem of the "channel selection" the MM interest rate transmission channel yields to better (more) symmetric results.

Long-run testing results: Commencing from the $\varphi^{\pm}$coefficients, we found that in the case of the deposit market the $\varphi^{\pm}$values range from 0.61 to 0.89 while in the loan market they are even lower, ranging from 0.47 to 0.67.[18] So we can accept the hypothesis that all the long-run IRPT elasticities are quite low (confirmed by the Wald tests). This result verifies the existence of rigidities in both retail markets. Additionally, according to the long-run IRPT symmetry tests ($\varphi^+ = \varphi^-$), we reject the null hypothesis whenever the MM rate is chosen as the independent

[17] Differentiation with the corresponding decomposed instant IRPT effects also exists in *Panagopoulos* et al. (2010).

[18] Similar results regarding the aggregate ϕ coefficients for both Japanese interest rate retail markets are verified by *Beckmann* et al. (2013). Long-run rigidities for both retail markets appear in *Wang/Lee* (2009) and *Wang* (2010) as well.

Table 4: **The Japanese Banking System**

CECM	(φ^+)	(φ^-)	H_0: $\Phi^+ = 1$	H_0: $\Phi^- = 1$	*Result*	H_0: $\Phi^- = \Phi^+$	*Result*	(θ^+)	(θ^-)	H_0^1: $\theta^+ = \theta^-$	*Result*	$(\delta_{wo}^{\ +})$	$(\delta_{wo}^{\ -})$	$\gamma^+ = (\varphi^+ - \delta_0^{\ +})/\theta^+$	$\gamma^- = (\varphi^- - \delta_0^{\ -})/\theta^-$	Ψ score[2] $\gamma^+ = \gamma^-$	*Result*	*TSR*[3]	*Result*
CB vs. De	0.89	0.77	1.20	25.8	Negative Ho rejected		accept	–0.10	–0.11	0.27	Symmetry	0.04≠	0.08	8.5	6.27	2.22	Weak Positive Asymmetry/ Symmetry	1.05	Total Symmetry
						4,42	Ho	(–3.81)	(–3.81)			(0.6)	(1.92)						
MM vs. De	0.70	0.61	14.6	99.7	Both Ho rejected		reject	–0.10	–0.12	6.89	Negative Asymmetry	0.19	0.15	5.1	3.83	1.26	Symmetry	0.95	Total Symmetry
						5,23	Ho	(–4.67)	(–4.85)			(2.84)	(3.4)						
CB vs. Lo	0.62	0.63	170.0	17.0	Both Ho rejected		accept	–0.12	–0.03	11.67	Positive Asymmetry	0.13	0.07	4.08	18.6	–14.5	Strong Negative Asymmetry	4.11	Strong Positive Total Symmetry
						0,02	Ho	(–4.36)	(–5.00)			(4.70)	(4.7)						
MM vs. Lo	0.47	0.67	96.9	45.7	Both Ho rejected		reject	–0.05	–0.03	11.61	Positive Asymmetry	0.003≠	0.07	9.34	20	–10.66	Strong Negative Asymmetry	1.15	Total Symmetry
						48,63	Ho	(–5.53)	(–5.33)			(0.11)	(4.46)						

t-Statistics in parentheses; CECM – crouching error correction model; CB – central bank interest rate; MM – money market interest rate; De – deposit interest rate; Lo – loan interest rate.

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

2: We accept Symmetry when $\psi \geq |2|$ (months) regarding the IRPT time completeness. When $|2| \leq \psi \leq |4|$ (months), we accept weak (negative or positive) asymmetry. When $\psi \geq |4|$ (months), we accept strong asymmetry.

3: Total symmetry (TSR) = $\varphi^+ * \theta^+/\varphi^- * \theta^-$. We accept total symmetry when [0.80–1.0] ≈ TSR ≈ [1.0–1.20]. We accept weak total asymmetry when [0.50–0.8] ≈ TSR ≈ [1.20–1.50] and strong total asymmetry when 0.50 ≤ TSR ≥ 1.50.

variable whilst we accept the null hypothesis (of symmetry) whenever the CB interest rate is chosen.

Medium and short-run adjustment process: on the other hand, the strong statistical significance of $\theta^{\pm}$ denotes that the IRPT process from the wholesale to the retail rates exists. Asymmetric behavior appears in the Japanese loan market ($\theta^{\pm}$ parameters) regardless of the wholesale interest rate choice. In particular the "speed" of adjustment and the "time needed" tests gave positive ($\theta^{-} < \theta^{+}$) and negative ($\gamma^{-} > \gamma^{+}$) asymmetries, respectively. In the deposit market, the two wholesale rates give contradictory results. When the CB rate is chosen, the results appear quite symmetrical, i.e. $\theta^{-} = \theta^{+}$(symmetry) and $\psi = \gamma^{+} - \gamma^{-} = 2.22$ months (almost symmetry). When the MM rate is chosen as the wholesale explanatory variable, the results are reversed at least regarding the speed symmetry result, i.e., $\theta^{-} > \theta^{+}$ and $\psi = 1.26$ months.

Wholesale interest rate selection: Although the $\theta^{\pm}$parameters appear with strong statistical significance, their values are very low ($\theta^{\pm}$coefficients range from 0.03 to 0.12) escorted by similar $\delta^{\pm}_{w0}$values ($\delta^{\pm}_{w0}$ coefficients range from 0.003 to 0.19).[19] So no "preference" on the selected channel emerges from either the "speed" and/or the instant IRPT effect. Following now the TSR score criterion, both wholesale rates give symmetric results with respect to the deposit market (TSR) ranges from 0.95 for MM to 1.05 for CB). On the other hand, in the loan market the MM rate gives more symmetrical results than the CB rate (*TSR* is 1.15 for MM and 4.11 for CB).

It is true that treating the Euro zone as a "single economic entity" can be misleading and therefore its IRPT results should be treated with caution. However, according to the unit root results, which allows for structural breaks on both the wholesale and the retail rates, neither the anti-inflationary ECB policy of 2005 nor the financial crisis of 2008 turned out to be statistically significant (tests available upon request).

Long-run testing results: $\varphi^{\pm}$ long-run elasticity estimators produce a lot of variety. The degree of the long-run IRPT rigidities ranges from 88 % up to 139 % (overshooting).[20] The implemented Wald tests accept

[19] Very low aggregate instant IRPT effect also appears in *Beckmann* et al. (2013).

[20] A variety of aggregate ϕ long-run elasticity estimators but with a rather strong undershooting flavor appears in *Karagiannis* et al. (2010). The data, however, are not extended beyond 2007 (pre-crisis period). Consequently, although not empirically tested, a rigid behavior seems to appear.

Table 5: **The Euro Zone Banking System**

CECM	(φ^+)	(φ^-)	H_0: $\Phi^+ = 1$	H_0: $\Phi^- = 1$	*Result*	H_0: $\Phi^- = \Phi^+$	*Result*	(θ^+)	(θ^-)	H_0^1: $\theta^+ = \theta^-$	*Result*	$(\delta_{wo}{}^+)$	$(\delta_{wo}{}^-)$	$\gamma^+ = (\varphi^+ - \delta_0{}^+)/\theta^+$	$\gamma^- = (\varphi^- - \delta_0{}^-)/\theta^-$	Ψ score[2] $\gamma^+ = \gamma^-$	*Result*	*TSR*[3]	*Result*
CB vs. De	0.88	0.95	13.5	4.89	Positive Ho rejected		accept	–0.27	–0.81	14.10	Negative Asymmetry	0.09≠	0.19	0.97	2.81	1.84	Symmetry	0.30	Strong Negative Total Symmetry
						1,77	Ho	(–4.58)	(–4.25)			(0.98)	(3.1)						
MM vs. De	1.39	0.82	–	4.70	Negative Ho accepted		reject	–0.11	+0.10	–	–	0.29	0.50	10.0	-	-	-	-	-
						5,16	Ho	(–1.96)	(0.65)			(5.14)	(3.88)						
CB vs. Lo	0.86	0.95	2.43	2.19	Both Ho accepted		accept	–0.19	–0.42	15.50	Negative Asymmetry	0.08≠	0.20	4.10	1.78	2.32	Weak Positive Asymmetry/ Symmetry	0.40	Strong Negative Total Symmetry
						0,89	Ho	(–3.93)	(–5.55)			(0.66)	(3.3)						
MM vs. Lo	1.11	0.83	12.47	1.88	Positive Ho rejected		reject	–0.21	–0.20	0.01	Symmetry	0.44	0.18	3.19	3.25	–0.06	Symmetry	1.40	Strong Negative Total Symmetry
						20,26	Ho	(–2.75)	(–2.24)			(2.4)	(2.4)						

t-Statistics in parentheses; CECM – crouching error correction model; CB – central bank interest rate; MM – money market interest rate; De – deposit interest rate; Lo – loan interest rate.

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

2: We accept Symmetry when $\psi \geq |2|$ (months) regarding the IRPT time completeness. When $|2| \leq \psi \leq |4|$ (months), we accept weak (negative or positive) asymmetry. When $\psi \geq |4|$ (months), we accept strong asymmetry.

3: Total symmetry (TSR) = $\varphi^+ * \theta^+/\varphi^- * \theta^-$. We accept total symmetry when [0.80–1.0] ≈ TSR ≈ [1.0–1.20]. We accept weak total asymmetry when [0.50–0.8] ≈ TSR ≈ [1.20–1.50] and strong total asymmetry when 0.50 ≤ TSR ≥ 1.50.

the null hypothesis of non-rigidity in all cases in the negative channel irrespectively of the wholesale rate chosen. On the other hand, in the positive channel, rigidities (rejections of the null hypothesis) appeared with the only exception being the CB and the loan IRPT relationship. Additionally, regarding the long-run IRPT symmetry test ($\varphi^+ = \varphi^-$), like in Canada and Japan, we reject null hypothesis whenever the MM rate is regressed.

Medium and short-run adjustment process: according to $\theta^{\pm}$ values, the CB channel functions faster than the MM channel in both (loan and deposit) markets.[21] However, this result is not accompanied by an analogous instant IRPT effect ($\delta^{\pm}_{w0}$). More analytically, very low $\delta^{\pm}_{w0}$ values, ranging from 0.08 to 0.20, are observed regarding the instant IRPT effect when the CB rate is used. Also, as expected, the positive δ^{+}_{w0} values were found statistically insignificant. Opposite results appear regarding the MM channel: relatively higher and statistically significant $\delta^{\pm}_{w0}$ values (0.18 to 0.50) which, however, are accompanied by lower speed of adjustment $\theta^{\pm}$ parameters (ranging from 0.11 to 0.21) than the one of the CB rate.

Wholesale interest rate selection: According to the "total symmetry ratio" measurements (TSRs), in the loan market the MM wholesale interest rate produces more symmetrical results, as TSR equals to 1.40 (compared to the 0.40 of the CB channel). In the deposit market, the TSRs are not applicable as in several cases the error correction terms ($\theta^{\pm}$ parameters) were found positively signed.

V. Conclusion

The aim of this paper is to reassess the IRPT transmission processes in G5 countries by utilizing the technical advantages that the *Granger/Yoon* (2002) Crouching Error Correction Modeling methodology provides. We estimated the long-run and short-run coefficients in the same dynamic model. We empirically distinguished and measured the components of the existing different types of asymmetries and rigidities, allowing for cumulative, positive and negative, long-run estimators to be embedded in the structure. This last advantage allows for a differentiation of the long-run rigidity in the upward and/or downward IRPT channel and the der-

[21] This is not the case in *Karagiannis* et al (2010). The CB rate does not function at all in the deposit market and in the loan market only the positive channel of the CB rate is faster than the MM one but not the negative channel. However these are pre-crisis empirical findings.

ivation of more accurate estimates of the positive and/or negative mean adjustment lag operators.

Based on the above approach we extracted some interesting information contained in the data. First, from the 'total symmetry ratio' (TSR) analysis, it is indicated that in the cases of the US and Canadian monetary systems, policy targeting should rather focus on the MM wholesale rate transmission channel instead of the direct CB interest rate channel. This is somewhere supported, although less categorically, in the other G5 systems, as well. Second, a quite non-homogenous and asymmetric behaviour was revealed regarding the G5 loan and deposit markets.

Last but not least, the differentiation and the accurate measurement of all the different aspects of the IRPT process – i.e. the instant IRPT effect, the speed and the time of the adjustment, the long-run elasticity (degree of rigidity) and/or a combination of these elements – clearly enriched our understanding of the entire IRPT process. It can become a useful and practical guideline in the hands of policy practitioners at country and/or a coordinating (G5) level.

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Appendix 1

Diagrams of the Cumulative Sum of Positive and Negative Components of Interest Rates

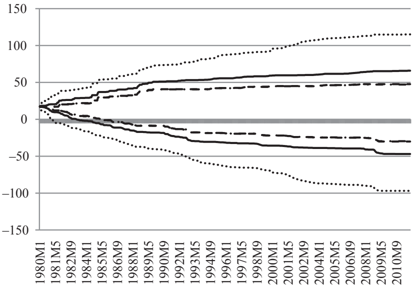

Figure 1: UK

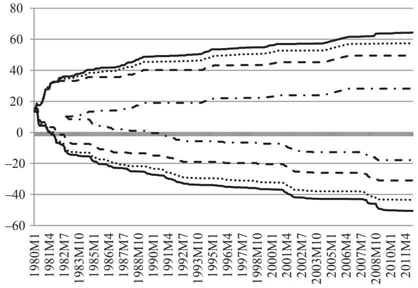

Figure 2: US

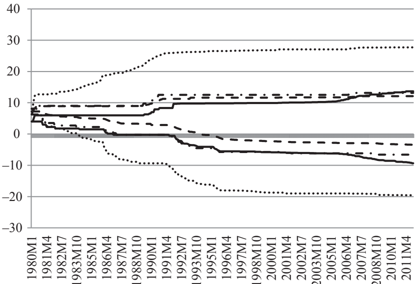

Figure 3: Japan

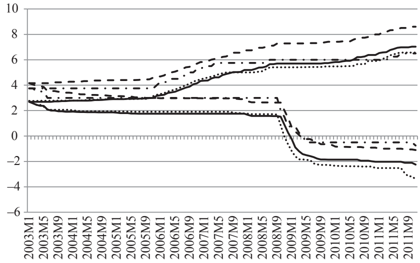

Figure 4: Eurozone

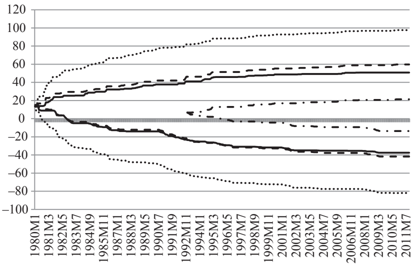

Figure 5: Canada

CB(−) MM(−) De(−) Lo(−)
CB(+) MM(+) De(+) Lo(+)

Note: Central Bank (CB), Money market (MM), Loan market (LO) and Deposit market (DE).