International Journal of Research in Social Sciences
Vol. 9 Issue 1, January 2019,
ISSN: 2249-2496 Impact Factor: 7.081
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

LENDING RATE STICKINESS IN INDIA: AN APPLICATION OF THRESHOLD CO-INTEGRATION ANALYSIS

Jatinder Pal*

Abstract

Reserve Bank of India had made a lot of efforts to activate the interest rate channel by working out various methodological changes in determination of prime lending rates. Application of marginal cost of funds based lending rates and demonetization in 2016 are the recent attempts to improve the working of monetary transmission through rate of interest. In this context, the present study attempts to analyze the interest rate pass-through in India using threshold co-integration. Utilizing monthly data for a period of twenty two years (1996:4 to 2018:3), it has been concluded that interest rate pass-through in India is still incomplete. The lending rates responded instantaneously in case of increasing discrepancy, but, it got worse for the decreasing discrepancy. The rigidity in lending rates can be attributed to ever increasing non-performing assets, oligopolistic structure of Indian credit markets and structural rigidities resulting from rigidities in re-pricing of fixed deposits, subsidized credit facilities and government borrowings.

Keywords: interest rate pass-through; monetary transmission mechanism; threshold autoregressive model; error correction mechanism; prime lending rate

* **Assistant Professor, PG Department of Economics, Kanya Maha Vidyalaya, Jalandhar, Punjab**

Section-I

1. Introduction

The monetary transmission mechanism, the process by which policy signals are transmitted to the final economic objectives, is very crucial for the effectiveness of monetary policy. In a liberalized economy, the interest rate channel along with the credit channel is expected to play an important role. [1], [2], [3], [4], [5] However, doubts have been casted over the smooth working of interest rate channel even in well developed financial markets also. It was argued that interest rate pass-through was incomplete and non linear as far as the adjustment of lending rates and deposit rates are concerned. In other words, the lending rates and deposit rates did not adjust immediately and fully to decrease or increase in official interest rates. Hofmann and Mizen [6] concluded that banks may not adjust their lending rates following very small or temporary official rate changes. Harbo and Welz [7] for Sweden and Hristov et al. [8] for Euro Area, using VAR methodology, confirmed that global financial crisis led to incomplete interest rate pass-through which was complete before crisis. They concluded that incomplete pass-through can be linked to structural parameters.

In the context of upward rigidity of interest rates, it was argued that high interest rates may lead to riskier loan portfolio of banks which may contribute towards increased probability of bank failures or financial crises [9], [10]. This is referred to as the credit-rationing hypothesis for adverse selection of borrowers. At the same time, in the anticipation of adverse customers' response, higher degree of competition among banks also lead to upward rigidity of lending rates. [11] In this context, Enders and Siklos [12] confirmed the upward rigidity interest rates using MTAR model. Matemilola et al. [13] also found that interest rate pass-through in South Africa was incomplete and non-linear. They confirmed the presence of customer reaction hypothesis, where the lending rates were rigid upward. Another important argument in favor of rigid banks' behavior was that banks avoid real economic effects of random monetary policy shocks through adjustments in liquid financial instruments. The existence of a liquidity demand for securities in the period of tight money implies that banks use the securities as a buffer against reserve shock, leaving the loans unchanged [14], [15], [16], [3].

The downward rigidity of interest rates, on the other hand, can be explained in the context of consumers' response to changes in interest rates. Broadly, a tighter monetary policy leads to shift in firms' mix of external financing in the context of information asymmetries in credit markets [17]. Romer and Romer [18] suggested that the bank loans are highly imperfect substitute for other assets. Kashyap, Stein and Wilcox [19] confirmed the two presumptions listed by Bernanke and Blinder [20] that the loans and securities, and loans and non-bank source of funds are imperfect substitutes at least in case of small borrowers. The higher market power of banks and rigidity of lending rates can also be explained in terms of market structure. In relatively collusive and concentrated markets, the interest rates on lending exhibit partial and sticky reaction to input costs [1], [14]. In this context, Yildirim [22], within Enders and Siklos [12] framework, found the downward rigidity in lending rates for Turkey. Further, the degree of reluctance of banks to follow decrease in money market rate appears to vary across lending rates, suggesting the existence of sectoral heterogeneities besides asymmetries.

Yuksel and Ozcan [23], on the other hand using same methodology, found that there exist significant and complete pass-through between policy rate and loan rates in Turkey . Positive and negative departures from the equilibrium converge to long run path almost at the same speed. Aliyu and Ismail [24] for Nigeria found that pass-through was incomplete during post consolidation period relative to pre-consolidation period. Further, rigidity in lending rates was downward during pre-consolidation period and upward during post-consolidation period.

The inconclusive evidence on a definite interest rate pass-through also attracted the attention of scholars in India. Recently, Ansari [25] concluded that the policy rates are not the lone determinant of lending rate. There are several other parameters, such as interest elasticity of loan, the loan default risk, the prudential capital requirement, and the response of yield on government securities to the policy rate, which adversely affected the adjustment in lending rates. Banerjee et al. [26] found that the base money shocks have a larger and more persistent effect on output than an interest rate shock. They showed that the presence of an informal sector hinders the monetary transmission. Kumar and Sarkar [27], using EGARCH and error correction model, found that about 58 percent of the change in the weighted average call rate (WACR) gets passed on the primary commercial paper market (CPDR). The CPDR adjusts almost evenly to an increase or a decrease in WACR at various lags. Further, response of CPDR to positive or negative changes in WACR was also similar. For asymmetric adjustment of lending rates, Raj [28] found that lending rates were rigid downward. Das [29], using stepwise estimation of vector error correction models on fortnight Indian data, tried to find evidence for interest rate pass-through in India. She found a slow and asymmetric pass-through where the lending rate adjusted more quickly to monetary tightening than to loosening. She also found that in recent years there was increase in speed of adjustment after the introduction of liquidity adjustment facility. Mishra et al. [30], using a heterogeneous structural panel VAR, found that lending rates responded in expected directions to monetary policy shocks in countries with better institutional frameworks, more developed financial structures, and less concentrated banking systems.

All these empirical evidences suggested that the rigidity in lending rate varied across countries. In India, most of the studies identified that adjustment in lending rates was incomplete, but did not attempt to analyse extent of asymmetric adjustment. The studies which tried to analyse asymmetry they utilized methodologies meant to examine linear relationship. Thus, the present study tried to contribute to the literature by analyzing the possibility of non-linear relationship between official interest rates and lending rates in India using Enders and Siklos [12] threshold co-integration analysis. This methodology allows for the analysis of asymmetric adjustment in lending rates. In addition, paper also tried to find the optimum lag structure of the variables. The study has been organized in five sections. Section I introduces the issues involved in rigidity of interest rates. Section II briefly presents the recent policy reforms in India to activate the interest rate channel. Section III discusses the database and methodology. Section IV presents the discussion on empirical estimates of threshold co-integration. Finally, section V presents the conclusions and policy implication.

Section II

2. Policy Reforms to Revive Interest Rate Channel in India

Since the Narasimham Committee [31] made its recommendations on financial sector reforms, the ball was set rolling to activate the interest rate channel. The use of rate variables was stressed in place of quantity variables. Accordingly, first of all, the interest rate structure was rationalized and the numbers of categories of lending rates were reduced to four. Further, the government borrowings were to be made at market determined interest rates. As reforms progressed, money market instruments like CDs, CPs, MMMFs, TBs of varying maturities, liquidity adjustment facility, repurchases and reverse repurchases were introduced to deepen and widen the money markets. The interim liquidity adjustment facility, which was introduced in 1999 to correct the day to day liquidity mismatch arising from the factors other than the maintenance of reserve requirements, was replaced with full fledged liquidity facility effective May 1, 2000. The lending rates were linked to prime lending rates (PLR hereafter) and banks were free to decide their own PLRs [32]. In April 2001, for the loans above Rupees two lakhs, the banks were allowed to extend credit below their PLR. However, it continued to act as ceiling for loans below Rupees two Lakhs and hence, as a benchmark measure [33]. However, it was observed that the spread over PLRs continued to be high during 2000-03 when interest rates were falling and inflation was low. The banks were advised to declare their spread over PLRs and switch to all costs concept to comply with benchmark PLR. By 2004, almost all the banks adopted this new system of benchmark PLRs. Further, in the interest of customer protection and also to infuse healthy competition among banks, the Reserve Bank institutionalized a system of collecting actual lending rates from scheduled commercial banks [excluding Regional Rural Banks (RRBs)] in June 2002 [34]. However, it could not improve the scenario and major commercial banks continued to extend credit at sub-BPLR due to the comfortable liquidity position and low demand for funds. This compromised the transparency in determination of interest rate leading to the cross subsidization and downward stickiness of BPLR. Taking the note of this issue, Working Group on BPLR [35] recommended the replacement of BPLR with Base Rate system. The new system worked well till March 2011 as 75 percent rise in repo rate led to on an average 58 percent adjustment in base rate. However, after the second half of 2011-12, it was found that the pace of adjustment in base rate was delayed on account of higher weighted average cost of outstanding deposits, government borrowings, increase in NPAs and inflation [36]. In addition, the rigidities in credit markets were also on account of rigidity in re-pricing of fixed deposits. Moreover, base rate system has also developed anomalies as these were not directly linked to the changes in repo rate and their calculation was based upon the cost of wholesale funding. Further, banks hardly readjusted their base rates during the expansionary credit policy instead, they steeply increased their margins. In the wake of such irregularities, RBI in April 2016 suggested the use of base rates determined on the basis of marginal cost of funds. This system included marginal cost of deposits and other borrowings, return on net worth, negative carry on account of

CRR, operating costs and term premium [37]. Despite the introduction of new system, the transmission mechanism continued to be weak and asymmetric across different sectors of economy reflecting structural rigidities. However, the transmission mechanism was expected to be better in post demonetization period due to the excess liquidity with the banks and fall in overall cost of borrowings.

Section III

3.1 Database

The study utilized the monthly data on lending rates and official rates for a period of twenty two years from 1996:4 to 2018:3. Regarding the choice of official rate variables, Goyal [38], in Indian context, recommended the pass-through from call money rates to bank lending rate. Further, Sengupta [39] also showed that the pass-through elasticities were better with respect to call rate as compare to Treasury Bills. On the other hand, Raj [28] listed various shortcoming of call money rate and suggested that the T-Bill rate, the CD rate and the Reserve Bank's policy repo rate are better suited to serve as external benchmarks. Therefore, in present study, 91 day TB rate was included as measure of official rate. In addition, call money rate (MMR) was also utilized since this is the only authentic money market rate available with monthly frequency over a longer span of time[1]. These two variables were modeled alternatively with bank lending rates (LR hereafter). The data for lending rate was collected from International Financial Statistics, IMF (2018) and data for MMR and TB were collected from RBI [40]. All the variables were deflated using whole sale price index on 2011-12 prices. Thus, using these three variables, two bi-variate models (MMR-LR and TB-LR) were formulated.

3.2 Research Methodology

The present study utilized Enders and Siklos [15] framework of threshold autoregressive model (TAR) and momentum threshold autoregressive models (MTAR) to discuss the possibility of asymmetric (non-linear) relationship between official interest rate and lending rates in India. This method is superior to Engle and Granger [41] and Johnson [42] methodology which capture only linear co-integration relationship. Enders and Siklos [15] framework allows for asymmetric adjustment in interest rates by classifying the residuals as above threshold and below threshold value(s). In this endeavor, the following equation was estimated to formulate TAR and MTAR models:

$$\Delta U_t = \rho_1 I_i e_{t-1} + \rho_1 (1 - I_i) e_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta U_{t-i} + V_t \qquad \text{---3.1}$$

Where I_i is Heaviside indicator function to formulate TAR and MTAR models. Here ρ_1 signifies the upward correction in disequilibrium (in lending rates) when there is increase in official interest rate and ρ_2, on the other hand, signifies the downward correction of disequilibrium when there is fall in official interest rate. The value of k was decided using AIC and SIC criteria. Further, the values of I_i for TAR and MTAR models were formulated as follows:

$$I_i = \begin{Bmatrix} 1 \text{ if } U_{t-1} \geq \tau \\ 0 \text{ if } U_{t-1} < \tau \end{Bmatrix} \qquad \text{---3.2}$$

$$I_i = \begin{Bmatrix} 1 \text{ if } \Delta U_{t-1} \geq \tau \\ 0 \text{ if } \Delta U_{t-1} < \tau \end{Bmatrix} \qquad \text{---3.3}$$

Equation 3.1 signifies the formulation TAR, where the threshold value is to be estimated from residuals in levels. TAR formulation signifies that if U_{t-1} is more than the threshold value the adjustment component is $\rho_1 e_{t-1}$, otherwise, the adjustment component is $\rho_2 e_{t-1}$. On the other hand, equation 3.3 deals with the formulation of MTAR model, where the threshold value is to be estimated from differenced residuals. In this case, Enders and Siklos [15] showed that MTAR models allow a variable to display differing amount of autoregressive decay depending on whether it is increasing or decreasing. Further, MTAR strategy has good power and size properties relative to the alternative assumption of symmetric adjustment.

The application of above framework requires the time series data to be free from seasonality and integrated of same order. In this endeavour, the study utilized Osborne [43] test to check the presence of seasonality and ADF and KPSS procedure to detect the presence of unit roots. Having determined the order of integration, the equation 3.1 was estimated to verify the presence of co-integration. A common null hypothesis of no co-integration, i.e. $\rho_1 = \rho_2 = 0$, was formulated for TAR and MTAR model. This hypothesis utilized the critical values[2] ϕ and ϕ_u, for TAR and MTAR models respectively. The hypothesis of symmetry i.e. $\rho_1 = \rho_2$, on the other hand, was tested using usual F-test.

The error correction mechanism was carried out within the Hsiao framework of causality. For this, optimum lags of each variable were calculated using Akaike's Final Prediction Error (FPE) criterion. Thornton and Batten [44] reported that the FPE criterion is superior to many other alternative lag-selection procedures. By combining FPE criterion with Granger causality, a practical method for identification of a system of equations can be suggested. This procedure balances the risk of over-specification and under-specification of the model [45] [for detail see [32], [5].

Section IV

4. Empirical Analysis

As discussed in methodology, the testing for co-integration requires time series data to be integrated of order one. Since, study utilizes monthly data, it is mandatory to test the data for the presence of seasonality before testing for unit roots.

4.1 Testing for Seasonality

Following Osborne test [34], the data are said to be suffering from seasonality, if, $\beta_1 < 0$, and $\beta_2 = 0$ [t-test]. Table 1 showed that all the variables were free from seasonality as all the values of t_2 were found significant (less than zero) and the values of t_1, except for MMR, were found insignificant. In case of MMR, both t_1 and t_2 were found significant. Thus, presence of seasonality in the data was denied in all cases.

Table 1 Osborne Test for Seasonality

S. No.	Variables (In levels)	Osborne test			
		t-values	t-values	F-values	Lags
1.	LR	0.87	-22.08*	-19.09*	1
2.	MMR	-2.08*	-23.75*	41.84*	4
3.	TB	-1.30	-17.94*	23.85*	3

Source: Authors calculations; *: refers to the significant t/F-values at 5 percent.

4.2 Testing for Unit Roots

Next, the data were also analyzed for presence of unit roots using ADF test and KPSS tests [see Table 2]. Lags for ADF test was selected using final prediction error test. Following ADF test, LR seems to be suffering from units in all cases, except for equation 'with drift' only. Results for MMR suggested that data was free from unit roots for equation 'without' and 'with drift'. However, when drift and trend included simultaneously the MMR seemed to be suffering from unit roots. TB, on the other hand, seemed to be suffering from unit roots for equation 'with drift' and 'with drift and trend'. Further, following KPSS test[3], all the variables were free from unit roots for the equation 'with drift' and suffering from unit roots for the equation 'with drift and trend'. Broadly, following both test the results seemed to be contradictory in their levels. Thus, all the variables were tested for unit roots after first differencing. Both test seemed to suggest that the data were free from unit roots after first differencing.

Table 2 Testing for Unit Roots

S. No.	Variables (In levels)	Augmented Dickey-Fuller test			KPSS		Lags/band width
		Without Drift	Drift	Drift & Trend	drift	Drift & Trend	
1.	LR	-1.70	-3.21*	-3.15	0.27	0.19*	1/11
2.	MMR	-2.60*	-3.03*	-3.09	0.32	0.30*	3/11
3.	TB	-2.50*	-2.81	-2.91	0.34	0.33*	1/11
	Variables (First difference)	**Without Drift**	**Drift**	**Drift & Trend**	**drift**	**Drift & Trend**	**Lags/band width**
1.	ΔLR	-5.20*	-5.18*	-5.18*	0.05*	0.02*	5/7
2.	ΔMMR	-7.72*	-7.70*	-7.70*	0.07*	0.03*	5/13
3.	ΔTB	-5.51*	-5.49*	-5.48*	0.10*	0.3*	8/3

Source: Authors calculations; *: refers to the significant t-values at 5 percent.

4.3 Testing for Linear Co-integration

Since, all the variables were integrated of order one, the presence of co-integration was examined using Engle-Granger two-step procedure. This procedure enquires into the variables for the presence of long run relation, if any, and symmetrical adjustment to short run disequilibrium. In the first step, simple bi-variate model was estimated and the resultant residuals were recorded. Afterwards, the residuals were to be analyzed for the presence of unit roots using ADF test. If the residuals turned out to be stationary, the nature of co-integration and hence, the long run relationship between variables can be examined. Interpreted thus, two models were estimated with MMR and TB as explanatory variables. Table 3 reported the results for co-integration. For model I & II when LR was considered as dependent variable, the coefficients for MMR and TB were recorded at 0.64 and 0.77 respectively. These coefficients signify the extent of pass-through to LR. Both values were significantly at 5 percent level, which implies that pass-through was incomplete. Further, the residuals from both models were tested for the presence of unit roots. Results of the ADF test were reported in Table 3. Clearly, all the values for the ADF test for both models were significant. Thus, presence of co-integration was confirmed in case of both models. However, the linear co-integration ignores the possibility of non-linear relationship and hence, possibly be miss-specified. Therefore, testing for non linear co-integration is rather more meaningful, which is elaborated in the following section.

Table 3 Testing for Co-integration: Engle-Granger Test

Dependent Variable	**Intercept**	**Slope (MMR/TB)**	**Augmented Dickey-Fuller test**			
			Without Drift	**With Drift**	**With Drift & Trend**	**Lags**
(Model-I) LR	5.48	0.64	-4.19*	-4.19*	-4.44*	1
t-values	33.09	17.12				
(Model-II) LR	5.09	0.77	-3.34*	-3.33*	-3.76*	0
t-values	34.98	22.54				

Source: Authors calculations; *: refers to the significant t-values at 5 percent.

4.4 Testing for Non-linear co-integration Using TAR and MTAR models

Table 4 reported the results for TAR and MTAR co-integration for model I and II. In case of model I, the threshold value for TAR estimation was recorded at -0.8974006. The coefficient of ρ_2 was found significant at -0.13. However, the t-value of ρ_1 was found insignificant. The critical value of ϕ to test the asymmetrical co-integration was recorded at 7.11, which was insignificant. Moreover, the hypothesis that $\rho_1=\rho_2$ was also accepted as F-value was also insignificant (i.e.0.66). In MTAR estimation, the t- value for ρ_1 was recorded at -5.79, which was significant and of ρ_2 was found to be insignificant. Further, the hypothesis of $\rho_1=\rho_2=0$ was reject at 5 percent level of significance as the estimated value of ϕ_u (i.e. 17.96) greater than its critical value. Furthermore, the hypothesis that $\rho_1=\rho_2$ was also rejected as F-value was found to be significant (i.e. 21.12). Thus, MTAR estimation, in this particular case, confirmed the presence of co-integration relationship between LR and MMR. It suggested that adjustment before and after the threshold value (i.e. -0.5145922) was asymmetrical.

Table 4 Testing for TAR and MTAR Co-integration

	LR (Model- I with MMR)		LR (model- II with TB)	
	P-TAR	M-TAR	P-TAR	M-TAR
ρ_1	-0.07	-0.51	-0.04	-0.05
	-1.25	-5.79*	-1.21	-1.80
ρ_2	-0.13	-0.06	-0.10	-0.15
	-2.55*	-1.56	-2.85*	-2.74*
Threshold Value (Ŧ)	-0.8974006	-0.5145922	1.940837	0.3233338
$\rho_1 = \rho_2 = 0$	4.03	17.96*	4.79	5.37
Critical values ϕ/ϕ_u	ϕ =7.11 (2, 250)	ϕ_u =7.76 (2, 250)	ϕ =7.11 (2, 250)	ϕ_u =7.76 (2, 250)
$\rho_1 = \rho_2$	0.66	21.12*	1.37	2.60
Critical F-value	0.42(1, 252)	(1, 250)	0.93 (1, 244)	0.11 (1, 250)

Source: Authors calculations; *: signifies the significant values at 5 percent level.

In case of Model II (with TB as explanatory variable) both TAR and MTAR models dined the presence of asymmetrical co-integration. In both cases the hypothesis of $\rho_1=\rho_2=0$ could not be rejected. The estimated values of ϕ and ϕ_u were recorded at 4.79 and 5.37 respectively, which were less than their respective critical values.

4.5 Threshold Error Correction Mechanism

In this section, the results of MTAR co-integration between LR and MMR were utilized to frame error correction mechanism. In this context, an attempt has been made to utilize optimum structure of lags for uni-variate and bi-variate models using Akaike's Final Prediction Error (FPE hereafter) criterion. The results for uni-variate and bi-variate models were reported in table 5.

Table 5 Estimation of Final Prediction Error (FPE)

S. No.	Controlled Variables	Manipulated Variables	FPE Estimates
1.	ΔLR(1)		0.70
2.	ΔLR(1)	ΔMMR(0)	0.64*
3.	ΔLR(1)	ΔMMR(1)	0.65
4.	ΔMMR(3)		4.73
5.	ΔMMR(3)	ΔLR(0)	4.10*
6.	ΔMMR(3)	ΔLR(1)	3.94*
7.	ΔMMR(3)	ΔLR(2)	3.97

Source: Authors calculations; *: signifies the decrease in FPE value.

From the Table 5 it can be seen that, for regression of LR on MMR, one lag of differenced LR was appropriate for uni-variate model i.e. 0.70. It gave the minimum value of FPE. For bi-variate model, only contemporaneous value of differenced MMR gave the minimum value of FPE. It may be noted that inclusion of one more lag of differenced MMR raised the value of FPE [see S. No. 3]. For the equation on MMR on LR, three lags of differenced MMR were found appropriate. The minimum value of FPE, in this case, was recorded at 4.73. Inclusion of contemporaneous and first lag of differenced LR, in bi-variate model, further reduced the FPE values to 4.10 and 3.94 respectively. Following the above criteria the error correction mechanism was framed as follows:

$$\Delta LR_t = \alpha_0 + \rho_1 I_i \Delta e_{t-1} + \rho_2 (1 - I_i) \Delta e_{t-1} + \alpha_1 \Delta LR_{t-1} + \sum_{i=0}^{1} \alpha_i \Delta MMR_{t-i} + V_t \quad \text{---4.1}$$

$$\Delta MMR_t = \alpha_0 + \rho_1 I_i \Delta e_{t-1} + \rho_2 (1 - I_i) \Delta e_{t-1} + \sum_{i=0}^{1} \alpha_i \Delta LR_{t-i} + \sum_{j=0}^{3} \alpha_j \Delta MMR_{t-j} + V_t \quad \text{---4.2}$$

The estimates of model 4.1 and model 4.2 were reported in table 6. In the error correction model 4.1, ρ_1 signifies the upward correction in disequilibrium (in lending rates) when there is increase in official interest rate and ρ_2, on the other hand, signifies the downward correction of disequilibrium when there is fall in official interest rate. The values of ρ_1 and ρ_2 were recorded at -0.9 and -0.16, which were also significant. This implies that changes in Δe_{t-1} responded more when the discrepancy was increasing. In other words, to one unit upward deviation in MMR, lending rates adjusted upward by 90 percent. On the other hand, one unit downward deviation in MMR adjusted lending rates downward by 16 percent only. Further, adjustment in disequilibrium was also instantaneous as current value of ΔMMR was found significant. The causality analysis also confirmed the results that MMR granger caused LR as the F-value was also significant i.e. 21.83. Furthermore, past values of LR were also found significant to explain changes in current values of LR. Thus, downward rigidity in lending rates in Indian banking system confirmed Bernanke and Blinder [9] and Kashyap, Stein and Wilcox [28] findings that the loans and non-bank source of funds are imperfect substitutes. It seems that due to the oligopolistic structure of Indian credit markets and hence, the higher market power, the banks refrain from decreasing lending rates. Rather, they tried to increase the spread by lowering deposit rates. This explained the downward rigidity of lending rates in India.

Table 6 Error Correction Model with Asymmetrical Adjustment

Explanatory Variables	**Dependent Variable (ΔLR)**	**F-Test Granger Causality**	**Explanatory Variables**	**Dependent Variable (ΔMMR)**	**F-Test Granger Causality**
ΔLR(-1)	0.26 (4.50)*	23.96* [1,249]	**ΔLR**	0.78 (5.19)*	18.05* [3,246]
			ΔLR(-1)	0.55 (3.43)*	
ΔMMR	0.11 (4.89)*	21.83* [1, 249]	**ΔMMR(-1)**	-0.41(-6.22)*	25.82* [2, 246]
			ΔMMR(-2)	-0.22(-3.52)*	
			ΔMMR(-3)	-0.13(-2.30)*	
ρ_1	-0.90 (-3.65)*		**ρ_1**	0.08(1.24)	
ρ_2	-0.16 (-3.07)*		**ρ_2**	0.40 (3.00)*	
D-W Statistic	2.04		**D-W Statistic**	2.09	

Source: Authors calculations; Note: 1.*: signifies the significant t/F-values at 5 percent level of significance.
2. Values in ( ) and [ ] are t-values and degrees of freedom of F-test respectively.

In case of model 4.2, where changes in differenced MMR was expected to be exogenous [since MMR is a policy variable], was also affected by current and past levels of LR. This implies that money market rates in India are not exogenous and thus, applicability of interest rate channel through call money rates is limited. This was also supported by the evidence that historically reserve requirements remained the preferred instrument of Indian monetary policy. In the recent period (January 2012 to June 2017) also, liquidity in banking sector was injected through changes in CRR and SLR along with changes in repo rate.

5. Conclusions and Policy Implications

In the present study an attempt has been made to analyze the interest rate pass-through in India within Enders and Siklos [15] framework. The study has highlighted that RBI had made a lot of efforts to activate the interest rate channel by working out various methodological changes in the determination of PLRs. Recently, in 2016, the application of MCLR and demonetization expected to improve the working of transmission mechanism of monetary policy through interest rates. The empirical estimation broadly concluded that that interest rate pass-through in India is incomplete, be it the increasing discrepancy or decreasing. Specifically, the rigidity in interest rate pass-through was stronger and was worsen when the discrepancy was decreasing. The lending rate adjusted only by 16 percent when there was fall in call money rates. On the other hand, lending rates adjust by 90 percent when there was increase in call money rates. However, for treasury bills (TBs), asymmetric adjustment was not identified.

This has important implications for the development of credit markets and monetary policy in India. Although, efforts have been made to develop financial system and activate interest rate channel, there is still a lot of scope to develop alternative sources of finance to lower the external finance premium. Further, in presence of incomplete interest rate pass-through the success of inflation targeting seems to be limited. Alarming increase in NPAs in public sector banks, the probable reason for asymmetric adjustment, calls for more transparency in extending loans and stringent regulations, particularly, on account of identification of riskier borrowers.

References

[1] Bernanke, B.S. and Gertler, M. "Inside the Black Box; The Credit Channel of Monetary Policy Transmission", *Journal of Economic Perspectives*, 9(4), pp.27-48, 1995

[2] Iturriaga F.J.L. "More on Credit Channel of Monetary Policy Transmission: An International Comparison", *Applied Financial Econometrics*, 10(4), pp.423-434, 2000

[3] Garretsen, H. and Swank, J. “The Bank Lending Channel in the Netherlands: The Impact of Monetary Policy on Household and Firms”,[online] www.eco.rug.nl, pp.1-18, 2005

[4] Kashyap, A. K. Mojom, B. and Terlizzese, D. ‘Monetary Transmission in the Euro Area: Does the Interest Rate Channel Explain All’, *National Bureau of Economic Research*, *Working Paper #9984*, pp.2-45, 2003

[5] Verma S. and Pal J. “Transmission Mechanism of Monetary Policy in Pre and Post reforms Period in India”, Prajnan, 2008

[6] Hofmann, B. and Mizen, P. “Interest Rate Pass-Through and Monetary Transmission: Evidence from Individual Financial Institutions' Retail Rates’, *Economica, 71 (281), pp.99-123,* 2004.

[7] Harbo Hansen, N. and Welz, P. “Interest Rate Pass-through During the Global Financial Crisis: The Case of Sweden”, *OECD Economics Department Working Papers*, No. 855, OECD Publishing, Paris. http://dx.doi.org/10.1787/5kgdx1j025ln-en, 2011

[8] Hristov, N., Hülsewig, O., & Wollmershäuser, T. “The interest rate pass-through in the Euro area during the global financial crisis”, *Journal of Banking & Finance*, [Online] https://doi.org/10.1016/j.jbankfin.2014.08.004, 2014

[9] Stiglitz, J. E. and Uy, M. “Financial Markets, Public Policy and The East Asian Miracle’, *The World Bank Research observer*, 11 (2), pp.249-276, 1996

[10] Stiglitz, J. E. and Weiss, A. “Credit Rationing in Markets with Imperfect Information”, *American Economic Review*; 71(3), pp. 392-405, 1981

[11] De-Bondt, G. J. “Interest rate pass-through: empirical results for the Euro area”, *Germany Economic Review,* 6(1), pp.37-78, 2005

[12] Enders, W. & Siklos, P. L. “Cointegration and Threshold Adjustment”, *Journal of Business & Economic Statistics,*19 (2) [online], pp.166-176, 2001

[13] Matemilola, B. T., Bany-Ariffin, A. N., & Muhtar, F. E. “The impact of monetary policy on bank lending rate in South Africa”, *Borsa Istanbul Review*, 15 (1), pp.53-59, 2015

[14] King S.R. “Monetary transmission: Through Bank Loan or Bank Liabilities?”, *Journal of Money, Credit, and Banking,* 18(3) pp.290-303, 1986

[15] Bernanke, B.S. and Blinder, A. S. “The Federal Funds Rate and Channels of Monetary Transmission”, *American Economic Review*, 82(4), pp.901-921, September 1992

[16] Bacchetta, P. and Ballabriga, F. ‘The Impact of Monetary Policy and Banks Balance Sheets: Some International Evidence’, *Applied Financial Economics*, 10(1), pp.15-26, 2000

[17] Bernanke, B. “Non-Monetary aspects of the Financial Crisis in the Propagation of Great Depression”, *American Economic Review*, June 73, pp.257-76, 1983

[18] Romer, C.D. and Romer, H. “New Evidence on the Monetary Transmission Mechanism’, *Brookings Papers on Economic Activity*, (1), pp.149-213, 1990

[19] Kashyap, A.K. and Stein, J. C. and Wilcox, D. W. “Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance1993”, *American Economic Review*, 83(1), pp.78-98, 1993

[20] Bernanke, B.S. and A.S. Blinder, A. S. “Is It Money or Credit, or Both, or Neither? Credit, Money and Aggregate Demand”, *AEA Papers and Proceedings*, 78(2), pp. 435-439, 1988

[21] Adam, R. M. and Amel, D. F. ‘The Effects of Local Banking Market Structure on the Bank-Lending Channel of Monetary Policy’ [Online], https://www.federalreserve.gov/pubs/feds/2005/200516/200516pap.pdf, 2005

[22] Yildirim, D. “Interest Rate Pass-Through to Turkish Lending Rates: A Threshold Cointegration Analysis”, [online], ERC Working Papers, http://www.erc.metu.edu.tr, 2012

[23] Yüksel, E., & Özcan, K. M. “Interest rate pass-through in Turkey and impact of global financial crisis: asymmetric threshold cointegration analysis”, *Journal of Business Economics and Management*, 14(1) [Online], pp.98-113 https://doi.org/10.3846/16111699.2012.671189, 2013

[24] Aliyu, A. J. & Ismail, N. W. ‘Threshold cointegration and interest rate pass-through during the pre- and post-banking consolidation in Nigeria: are there asymmetries? *International Journal of Banking, Accounting and Finance*, *7*(2) [Online], pp.172–193, https://doi.org/10.1504/IJBAAF.2016.10001416, 2016

[25] Ansari, J. ‘A Theoretical and Empirical Analysis of Interest rate pass-through in India with Regulatory Requirements’, *Beykent University Journal of Social Sciences-BUJSS*, 6 [Online], www.ssbfnet.com/ojs, 2013

[26] Banerjee, S. Basu, P. Ghate, C. Gopala K. P. & Gupta, S. “*A Monetary Business Cycle Model for India”,* Retrieved from https://rbi.org.in/scripts/BS_PressReleaseDisplay.aspx?prid=30446, 2018

[27] Kumar, A. V. & Sarkar, K. "*Interest Rate Pass-Through from the Weighted Average Call Rate to the Primary Commercial Paper Market in India using daily data: An empirical analysis",* [online] http://www.cafral.org.in/sfControl/content/Speech/1312018112113AMArunKumarKaustavSarkar.pdf, 2018

[28] Raj, J., *Report of the Internal Study Group to Review the Working of the Marginal Cost of Funds Based Lending Rate System, RBI [online], https://rbi.org.in/scripts/PublicationReportDetails.aspx?ID=878,* 2017

[29] Das, S. "Monetary Policy in India: Transmission to Bank Interest Rates", Working Papers- *International Monetary Fund*, 15/129 [Online] , pp.1-33, 2015

[30] Mishra, P., Montiel, P., & Pedroni, P. "*Monetary Policy and Bank Lending Rates in Low-Income Countries: Heterogeneous Panel Estimates", [Online], https://www.isid.ac.in/~pu/conference/dec_12_conf/Papers/PrachiMishra.pdf*, 2012

[33] Narasimham, M., *Report of Committee on Financial Sector Reforms*, Nabhi Publication, New Delhi, 1991

[32] Pal, J., *Financial Sector Reforms and Monetary Policy in India*, Regal Publishers, New Delhi, 2008.

[33] Reserve Bank of India, *Annual Report*, Mumbai, 2002

[34] Reserve Bank of India, *Annual Report*, Mumbai, 2003

[36] Reserve Bank of India, *Annual Report*, Mumbai, 2012

[37] Reserve Bank of India, *Annual Report*, Mumbai, 2016

[38] Goyal, A. "Banks, Policy and Risks: How Emerging Markets Differ", *International Journal of Public Policy,* Inderscience Enterprises Ltd, vol. 10(1/2/3) [online], https://www.researchgate.net/publication/264818839_Banks_policy_and_risks_How_emerging_markets_differ, pp.4-26, 2014

[39] Sengupta, N. "Macroeconomics and Finance in Emerging Market Economies Interest rate pass-through in India Interest rate pass-through in India", [Online] http://dx.doi.org/10.1080/17520843.2013.771692, 2013

[40] Reserve Bank of India, *Handbook of Statistics on Indian Economy, 2018.*

[41] Engle, R.F. and Granger, C. W. J. "Co-integration and Error Correction: Representation, Estimation and Testing", *Econometrica,* 55(2), pp. 251-276, 1987

[42] Johansen S. "Statistical Analysis of Co-integrating Vectors", *Journal of Economic Dynamics and Control*, *12*, 1988, pp. 231-254.

[43] Osborne, D.R. "A Survey of Seasonality in U.K. Macroeconomic Variables, *International Journal of Forecasting*, 6, pp.327-336, 1990

[44] Thornton, D.L. and Batten, D. S. "Lag-Length Selection and Tests of Granger Causality between Money and Income', *Journal of Money, Credit and Banking*, 17(2), pp.164-178, 1985

[45] Hsiao, C. "Autoregressive Modeling and Money-Income Causality Detection', *Journal of Monetary Economics*, 7, pp.85-106, 1981

Notes

[1] Since Bank Rate and repo rate are official interest rates, but they are controlled by RBI and discrete in nature.

[2] The study utilized the critical value developed by Wane et al (2004) for varying lag length, sample sizes and number of time series for equations like equation 3.1. They generated critical values for threshold autoregressive co-integration through 50000 random walk processes.

[3] KPSS test utilizes the null hypothesis that a particular variable is free from unit roots and alternative hypothesis that the variable is suffering from unit roots.