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Abstract

This paper aims to investigate the actual nature of the interest rate pass-through to Turkish cash, automobile, housing and corporate loan rates. Focusing on the possibility of nonlinearity in the adjustment of lending rates due to financial market conditions and monetary policies, we adopt the threshold autoregressive (TAR) and momentum threshold autoregressive (MTAR) models of Enders and Siklos (2001). Empirical results suggest substantial asymmetries (nonlinearities) in all lending rates. More specifically, banks adjust their lending rates faster in response to increases in negative discrepancies from the long-run equilibrium arising from an increase in the money market rate, while they act slowly following money market rate decreases. Furthermore, the degree of reluctance of banks to follow money market rate decreases appears to vary across lending rates, suggesting the existence of sectoral heterogeneities besides asymmetries.

Key Words: Interest Rate Transmission, Lending Rates, Threshold Cointegration

JEL classification numbers: C22, C51, G21

1. Introduction

For a long time, official short-term interest rates have been the principal tool of conducting monetary policy for many central banks under the inflation targeting framework. When the central bank changes its official rate, it aims to affect first the money market rate, marginal cost of funds faced by banks, and then the retail (loan and deposit) rates offered by banks to non-financial institutions and households, in order to achieve its aim for inflation and output. Allowing some degree of price stickiness, an effective monetary policy with official rate changes being influential over the real economy depends on how complete and fast the pass through is.

However, in practise, although the first step is assumed to be complete, there are many factors decreasing the completeness and the speed of the pass-through from the money market rate or the official rate to retail loan rates and breeding an asymmetric, state-dependent, structure. The first factor is the adjustment costs, namely costs incurred to banks as a result of changing loan rates. Due to these costs, banks may not adjust their lending rates following very small official rate changes and/or changes that are expected to be temporary, but wait for large changes and/or a sequence of small changes to accumulate. This might produce lending rate smoothing as well as asymmetry, with faster adjustment following large and/or anticipated official rate changes (Hofmann and Mizen, 2004). Likewise, highly volatile official rates and uncertainty of banks about the future market conditions may encourage banks to stick with the same rate to protect themselves from adjustment costs and fluctuations[1].

Switching costs, namely costs incurred by changing lender or switching to a new loan with an existing lender, is the other reason why loan rates are sticky. Costs of obtaining information on different loan rates, filling out new application forms and acquiring the necessary documentation may discourage the existing borrowers to switch the lender or the loan. With these costs, banks may prefer to smooth loan rates in accordance with the principle of adjustment cost minimization, as the risk of losing existing borrowers would be lower. Besides, they might reduce the elasticity of loan demand and lead to a reluctance of banks to decrease loan rates in response to a decrease in the official rate, which breed faster adjustment to official rate

[1] See Lowe and Rohling (1992) for a more detailed discussion of the effects of adjustment costs.

increases[2]. Even small switching costs might cause market segmentation and a decline in the demand elasticity as indicated by Klemperer (1987).

There is no doubt that the degree to which adjustment and switching costs delay the adjustment depends on the cost of keeping loan rates out of equilibrium. As discussed by Corvoisier and Gropp (2001), a competitive market increases this cost, lessens the degree of asymmetry in the responses of loan rates and increases the degree of the pass-through. An imperfectly competitive market, however, leads to a more incomplete and asymmetric pass-through by decreasing the cost of not adjusting.

Although many studies, including Bredin, Fitzpatrick and Reilly (2002), de Bondt (2005) and Marotta (2007), examine the interest rate pass-through mechanism within a linear context, there appears to be a growing literature that considers the possibility of asymmetry arising from financial market conditions and monetary policies discussed above. Empirical studies investigating asymmetries in the interest rate pass-through employ generally nonlinear threshold error-correction models (ECMs), with the longrun equilibrium being defined in terms of cointegration between official rate or its proxy and the retail loan rate. Within this framework, the pass-through is explored for a number of countries in studies by Heffernan (1997), Hofmann and Mizen (2004), Fuertes, Heffernan and Kalotychou (2010), Becker, Osborn and Yildirim (2012) for the United Kingdom; Payne (2006a, 2006b, 2007) Payne and Waters (2008) for the USA; Burgstaller (2005), de Bondt, Mojon and Valla (2005) for Austria; Sander and Kleimeier (2004a) and Kleimeier and Sander (2006) for the Euro area and Rocha (2012) for Portugual. Many of these studies provide strong evidence of nonlinearities, with retail loan rates responding asymmetrically to disequilibrium in relation to the official rate (or the money market rate), the disequilibrium or the change in disequilibrium term. However, only Payne (2006a, 2006b, 2007), Payne and Waters (2008), Sander and Kleimeier (2004a) and Kleimeier and Sander (2006) employ the testing methodology of Enders and Siklos (2001), which allows for an endogenously determined threshold value through the approach of Chan (1993)[3]. The rest of the studies rely on an exogenously determined threshold value, zero, and aim to observe heterogeneities in the pass-through process due to negative/positive deviations from the equilibrium.

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[2] See Scholnick (1999) and Miles (2004) for a detailed explanation of switching costs.

[3] In order to account for the discrete nature of changes in the official rate, Becker, Osborn and Yildirim (2012) develop a new bootstrap testing procedure for cointegration.

Despite the key role it plays in determining the effectiveness of monetary policy, the pass-through from official to retail loan rates in Turkey is surprisingly under-studied. The only papers (of which we are aware) are Aydin (2007) and Ozdemir (2009). Using bank level (micro) data, Aydin (2007) analyzes the interest rate pass-through from the money market rate to corporate, housing, cash and vehicle loan rates in a linear panel data setting, where the money market rate is taken as a proxy for the official rate. According to the estimation results, the highest interest rate pass-through is observed for housing loans while the lowest one is observed for commercial loans. Ozdemir (2009), on the other hand, employs aggregate data with all loan types being aggregated to one lending rate series, and finds out that the pass-through from the money market rate to loan rates is complete only in the long-run. He also examines whether the loan rates respond differently to positive and negative disequilibrium deviations through the ECM, however no statistically significant asymmetry is observed in loan rate responses.

This paper aims to analyze the interest rate pass-through mechanism in Turkey, with the focus being on the nonlinearity in the responses of corporate, housing, cash and automobile loan rates following money market rate changes. In this sense, unlike Aydin (2007) and Ozdemir (2009), we employ the threshold autoregressive (TAR) and momentum threshold autoregressive (MTAR) models of Enders and Siklos (2001) and allow for endogenously determined threshold values. Besides utilizing a more appropriate methodology to analyze nonlinearity, we examine the credit rates seperately rather than using an aggregated data as in Ozdemir (2009), which may not reveal the real nature of the pass through since different credit rates will have different dynamics.

Overall, empirical results reveal substantial asymmetries in all lending rates. More specifically, the pass-through from the money market rate to lending rates exhibits an MTAR type asymmetry, where lending rates adjust faster to rising money market rates while they act slowly to follow money market rate increases. Furthermore, it is revealed that downward rigidity of lending rates vary across loan types as well, with the most prominent rigidity being observed for corporate loans.

The rest of the paper is organised as follows. The next section presents our data with preliminary analysis, while Section 3 describes the TAR and M-TAR models within the context of pass-through. Substantive empirical results are discussed in Section 4 and the final section concludes the paper.

2. The Data and Preliminary Unit Root Analysis

We employ interest rate series measured at the end-of-month from November 2002 to October 2011.[4]Our data set comprises the overnight money market rate as a proxy for the monetary policy stance, as in Aydin (2007), and lending rates for consumer, vehicle, housing and corporate loans. Loan rates are average of individual banks' interest rates, weighted by their relative share of total loans. The overnight repo rate, calculated from the repo transactions in Istanbul Stock Exchange, is converted into the monthly frequency by taking simple averages.

The start date of our sample coincides with the credit expansion experienced after the 2001 crisis in Turkey. The year of 2001 could well be named as a milestone for the Turkish banking sector. In that year, banking sector faced with a very deep and devastating crisis and a substantial increase in the non-performing loans due to the skyrocketed interest and exchange rates. In order to overcome the crisis in the financial sector Turkish authorities implement many reforms. In this respect, as of January 2002, the banking law, which is also known as "Istanbul Approach" is put into effect, the Banking Regulation and Supervision Agency was established in search of a way out of the crisis and restoration of stability. In the same year, the Central Bank of the Republic of Turkey gained its independency and adopted inflation targeting regime, with the aim of decreasing the inflation rate at a persistent and low level. Towards the end of 2002, the reforms started to show their effects with a decrease in inflation and interest rates and development of a relatively stable environment. Accordingly, the demand for credits and the weight of the credit portfolios in the total assets' portfolios of banks increased.

Figure 1 illustrates lending rates, along with the money market rate and the spread (mark-up) between each lending rate and the market rate. Overall, Figure 1 suggests that despite a significant spread, Turkish lending rates are linked with the money market rate over the long-run. Moreover, as it may be expected, consumer lending rates, which inherent the highest credit risk have the highest mark-up of all loan rates, while mark-up pricing is approximately similar for automobile, housing and commercial loans.

[4] All data are from the Central Bank of the Republic of Turkey database, at http://evds.tcmb.gov.tr.

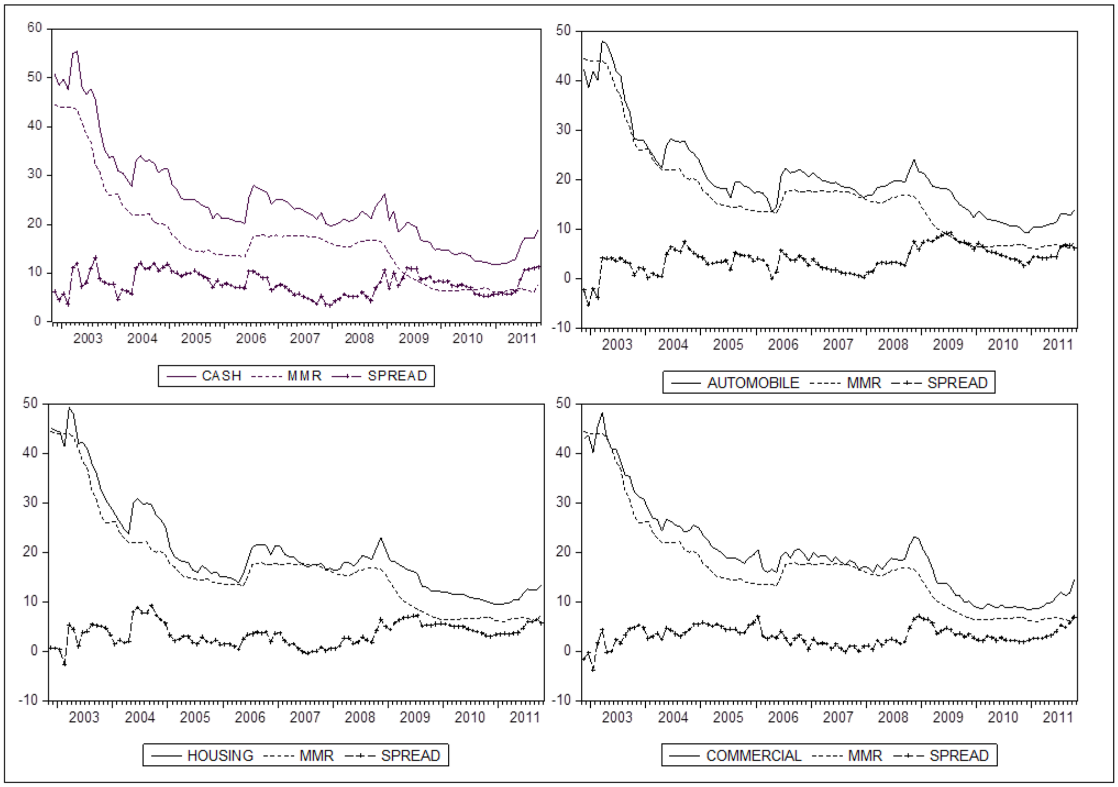

Figure 1: The money market rate and lending rates, together with the difference between each lending rate and the money market rate (SPREAD), are shown over the sample from November 2002 to October 2011.

As a preliminary analysis, we employ the Ng and Perron (2001) unit root tests, which are modified versions of the existing unit root tests with better performance in terms of power and size distortions.[5] Table 1 presents unit root test results together with the corresponding critical values. Being in line with the other pass-through studies, the unit root analysis does not reject the null hypothesis of a unit root in each of five series at the 5% significance level. Given the nonstationary, *I(1)*, structures of the interest rates, we continue with a cointegration analysis of the pass-through.

[5] See Ng and Perron (2001) for further details.

Table 1: Ng and Perron (2001) Unit Root Test Results

	MZ_{α}^{GLS}	MZ_{t}^{GLS}	MSB^{GLS}	MP_{T}^{GLS}
mmr	-2.693	-1.040	0.386	30.003
cash	-3.473	-1.109	0.319	22.764
automobile	-7.476	-1.850	0.247	12.373
housing	-5.800	-1.595	0.275	15.548
commercial	-2.356	-0.847	0.359	29.166

Notes: The lag order for all unit root tests has been chosen using the modified AIC (MAIC) suggested by Ng and Perron (2001). The critical values for the above tests have been taken from Ng and Perron (2001):

Model with constant and linear trend				
	MZ_{α}^{GLS}	MZ_{t}^{GLS}	MSB^{GLS}	MP_{T}^{GLS}
1%	-23.80	-3.42	0.14	4.03
5%	-17.30	-2.91	0.16	5.48
10%	-14.20	-2.62	0.18	6.67

3. Methodology

Taking the standard Engle-Granger approach as a benchmark, this section describes the TAR and M-TAR type cointegration tests of Enders and Siklos (2001) along with the nonlinear ECMs within the context of the interest rate pass-through. A univariate approach is adopted to reveal short run and long run dynamics of the pass through process under the assumption of weak exogeneity of the money market rate to lending rates.

The standard two-step Engle and Granger (1987) procedure developed for linear time series models requires OLS estimation of the long-run equilibrium relationship in the form:

$$lrate_t = \alpha + \beta mmr_t + u_t \quad (1)$$

where mmr_t and $lrate_t$ refer to the money market and lending rates, respectively, and u_t is the stochastic disturbance term measuring the deviation of the lending rate from its equilibrium path. While the coefficient α measures the mark-up (or down), β represents the degree of the pass-through in the long-run, with complete pass-through indicated by $\beta = 1$ and incomplete pass-through by $\beta < 1$. The second step of the Engle-Granger approach involves testing for the presence of cointegration, i.e. stationarity of the $\hat{u}_t$ sequence, through the OLS estimation of the equation:

$$\Delta\hat{u}_t = \rho\hat{u}_{t-1} + \sum_{j=1}^{p}\gamma_j\Delta\hat{u}_{t-j} + v_t \tag{2}$$

where p is the required number of lagged changes of $\Delta\hat{u}_t$ that ensures an iid structure for the disturbance term, v_t. Rejecting the null hypothesis of $\rho = 0$ implies stationarityof $\hat{u}_t$, namely existence of a longrun equilibrium between the money market and lending rates.

Equation (2) is constructed under the assumption that adjustment towards longrun equilibrium is symmetric. However, previous studies, including Sander and Kleimeier (2004a) and Payne (2007), find that the symmetric speed of adjustment may not adequately capture the actual nature of the interest rate pass-through mechanism. Indeed, Enders and Siklos (2001) note that equation (2) is misspecified if the adjustment process is asymmetric. Hence, extending the two-step Engle-Granger procedure, they develop a cointegration test that allows for a threshold autoregressive (TAR) type adjustment under the alternative of cointegration. They test for the presence of cointegration by re-specifying equation (2) as

$$\Delta\hat{u}_t = \rho_1 I_t\hat{u}_{t-1} + \rho_2\left(1 - I_t\right)\hat{u}_{t-1} + \sum_{j=1}^{p}\gamma_j\Delta\hat{u}_{t-j} + v_t \tag{3}$$

where I_t is the Heaviside indicator function such that,

$$I_t = \begin{cases} 1 & \hat{u}_{t-1} \geq \tau \\ 0 & \hat{u}_{t-1} < \tau \end{cases} \tag{4}$$

andstationarity of $\hat{u}_t$ requires $\rho_1 < 0,\ \rho_2 < 0$ and $\left(1+\rho_1\right)\left(1+\rho_2\right) < 1,$ as shown by Petrucelli and Woolford (1984) and Chan, Petrucelli and Woolford (1985). In this TAR setting, speed of adjustments of the lending rate differs with regard to the position of the lagged disequilibrium term, $\hat{u}_{t-1}$ relative to an unknown threshold value τ. Specifically, if $\hat{u}_{t-1}$ is above the threshold, the adjustment is captured by $\rho_1\hat{u}_{t-1}$, however, if $\hat{u}_{t-1}$ is below the threshold, the adjustment is measured by $\rho_2\hat{u}_{t-1}$. Thus, for a threshold value close to zero, $|\rho_2| > |\rho_1|$ implies that discrepancies from the equilibrium are more persistent when the money market rate is decreasing relative to the lending rate, suggesting a sluggish downward adjustment in the lending rate. For the cases where the threshold value is substantially different from zero, on the other hand, this form of asymmetric adjustment might reflect that interest rates adjust differently to disequilibrium once a certain minimum deviation is exceeded.

While the Heaviside indicator function in (4) depends on the disequilibrium, $\hat{u}_{t-1}$, it is also possible to allow the adjustment to depend on changes in this disequilibrium, where the indicator function becomes:

$$I_t = \begin{cases} 1 & \Delta\hat{u}_{t-1} \geq \tau \\ 0 & \Delta\hat{u}_{t-1} < \tau \end{cases} \quad (5)$$

Equation (3) with the Heaviside function (5) is referred to as M-TAR (momentum threshold autoregressive) adjustment by Enders and Siklos (2001). This model is especially valuable when the adjustment is believed to exhibit more momentum in one direction than the other. For example, for a threshold value close to zero, if $|\rho_2| > |\rho_1|$, increases in negative discrepancies from the equilibrium simply due to an increase in the money market rate will be less persistent than increases in positive discrepancies arising from money market rate decreases. It may also reflect that large market rate changes (negative discrepancies) are smoothed out more quickly compared to small changes, as stated by Sander and Kleimeirer (2004a). This form of asymmetric adjustment may be more appropriate for our case since banks may follow money market rate changes more closely when the gap between the money market and lending rates gains more momentum in favour of the money market rate, in line with the principle of adjustment cost minimization.

In both TAR and MTAR models, the null hypothesis of no cointegration, $\rho_1 = \rho_2 = 0$, is tested using an F-test which has a non-standard distribution due to τ being unidentified under the null (the well-known Davies (1987) problem), and the test statistic is denoted as Φ. Once the interest rate pairs are found to be cointegrated and stationarity conditions are satisfied, the next step is to test the null hypothesis of symmetric adjustment, namely $\rho_1 = \rho_2$. As such, Enders and Siklos (2001) employ a standard *F*-test, which requires a consistent estimate of the threshold value, τ, and this is achieved by following the approach of Chan (1993). That is, for each potential threshold value τ, which is typically in the middle 70% of the ordered values of the threshold variable $\hat{u}_{t-1}$ $(\Delta\hat{u}_{t-1})$, the TAR (MTAR) model is estimated through OLS. The estimate $\hat{\tau}$ is then determined by minimizing the sum of squared residuals over these estimations.

Once threshold cointegration is established, one can fit a nonlinear threshold ECM to uncover the short-run and long-run dynamics between money market and lending rates.The nonlinear ECM is formed as:

$$\Delta lrate_t = \varphi_0 + \sum_{i=1}^{p} \varphi_i \Delta lrate_{t-i} + \sum_{i=1}^{p} \delta_i \Delta mmr_{t-i} + \gamma_1 I_t \hat{u}_{t-1} + \gamma_2 \left(1 - I_t\right) \hat{u}_{t-1} + v_{1t} \quad (6)$$

where v_{1t} is the iid disturbance term with zero mean and constant variance, $\hat{u}_{t-1} = lrate_{t-1} - \hat{\alpha} - \hat{\beta} mmr_{t-1}$, γ_1 and γ_2 are the error correction terms or speed of adjustments to the long-run equilibrium, I_t is the Heaviside indicator function which has the form of (4) and (5) for TAR and MTAR type ECMs, respectively. The parameters φ_i and δ_i indicate short-run dynamics, with rejection of the null of $\delta_i = 0$ suggesting Granger-causality from the money market rate to the lending rate. As mentioned before, in this single equation modelling approach, we assume that the money market rate is weakly exogenous to the lending rate. To test for the validity of this assumption we re-form the nonlinear ECM in (6) by setting the money market rate as the dependent variable:

$$\Delta mmr_t = \varphi_0 + \sum_{i=1}^{p} \varphi_i \Delta lrate_{t-i} + \sum_{i=1}^{p} \delta_i \Delta mmr_{t-i} + \gamma_1 I_t \hat{u}_{t-1} + \gamma_2 \left(1 - I_t\right) \hat{u}_{t-1} + v_{1t} \quad (7)$$

In this context, the weak exogeneity assumption is supported when the money market rate does not respond to the disequilibrium error terms, with insignificant γ_1 and γ_2 coefficients, but may still be influenced by lagged changes in the lending rate (see Engle, Hendry and Richard, 1983).

4. Empirical Results

We initially estimate the long-run equilibrium relationship in (1) in order to derive information about the mark-up (down) and the degree of the pass through for each lending rate. According to the results presented in Table 2, a substantial mark-up pricing policy is implemented for all loan types with the highest mark-up being observed for cash loans, followed by automobile, housing and commercial loans. Horvath and Podpiera (2012) infers the mark-up value as a signal for the riskiness of the loan, so that the higher the risk the higher the mark-up set for the lending rate. Following Horvath and Podpiera (2012), our results might suggest that the highest level of risk is associated with cash loans. Although, corporate loans should be riskier than consumer loans in nature, this finding may arise from the fact that Turkish banks extend loans only to firms with good credit records and this naturally declines the risk of corporate loans. Regarding the extendt or the degree of pass through, a complete pass through is observed for cash and housing loan rates, while automobile and commercial loans appear to respond to money market rate changes incompletely even in the long run. Being the most competitive credit markets in Turkey could be at the basis of the observed complete pass-through for these lending rates (Aydin, 2007).

Table 2: Estimated Long-run Equilibrium Relationships

	α	β	$\beta = 1$
cash	7.732	1.007	Yes
	(0.723)	(0.037)	
automobile	6.247	0.856	No
	(0.815)	(0.046)	
housing	4.464	0.944	Yes
	(0.595)	(0.029)	
commercial	4.151	0.936	No
	(0.560)	(0.028)	

Notes: α and β are estimated long-run parameters of (1) with the Newey-West heteroscedasticity and autocorrelation consistentstandard errors given in parentheses.

Next, the results of the Engle-Granger cointegration test along with the TAR and MTAR type cointegration tests of Enders and Siklos (2001) are presented in Table 3. The results of the Engle-Granger cointegration test (2) are reported for each lending rate in the first column of Table 3. The null hypothesis of no cointegration is rejected at the 5% significance level for only the automobile loan rate, while existence of the long run relationship is supported for cash, housing and commercial loans only if the significance level is extended to10 percent. However, not only with respect to the structure of monetary transmission mechanism, but also with regard to Figure 1, which indicate common movements between the lending rates and the money market rate, a strong evidence of cointegration is anticipated for each lending rate. In this sense, the incompatible conclusions drawn from the application of the Engle-Granger test might be caused by the underlying assumption of symmetric adjustment. It is known that this cointegration test and its extensions are misspecified and have low power if adjustment to the equilibrium is asymmetric.

For this reason, we rely on the TAR and MTAR type cointegration tests that account for the potential nonlinear nature of the long run relationship between the lending rates and the money market rate. TAR and MTAR type cointegration tests are carried out by estimating the equation (3) with the Heaviside indicator functions (4) and (5), respectively, and the results are reported in the second and third columns of Table 3. Regarding the TAR type cointegration, at the 5% significance level, the null hypothesis of no cointegration, $\rho_1 = \rho_2 = 0,$ is rejected for automobile, housing and commercial loan rates based on the F test, Φ, and corresponding simulated p-values[6]. Given the estimates of ρ_1 and ρ_2 satisfy the necessary and sufficient conditions for stationarity (convergence), the null hypothesis of symmetric adjustment $\rho_1 = \rho_2$ can be tested by a standard F-test. The results provide empirical support for asymmetric adjustment (at the 5% level) for all loan rates found to be cointegrated with the money market rate.

Turning to the MTAR cointegration test based on the equations (3) and (5), the null of $\rho_1 = \rho_2 = 0$ is strongly rejected at the 1% significance level for all loan rates except the cash loan rate, where the empirical evidence of cointegration is supported at the 5% level. Furthermore, the estimatesof ρ_1 and ρ_2 appear to suggest convergence and substantially asymmetric adjustment for all loan rates, with the null hypothesis of symmetric adjustment $\rho_1 = \rho_2$ being rejected at 5% and 1% significance levels in the case of cash and automobile, housing and commercial loans, respectively. Moreover, as may be expected, the MTAR model appears to be most appropriate model for all cases based on Akaike Information Criterion (AIC).

Inferences gained from the MTAR model are important to explore the actual nature of the asymmetry in the process. It is observed from Table 3 that all lending rates exhibit MTAR asymmetry in the form of $|\rho_2| > |\rho_1|$ with estimated consistent threshold values being close to zero. This finding suggests that increases in divergence from the long-run equilibrium originating from an increase in the money market rate die out more quickly than other changes. More specifically, lending rates follow money market rate increases more closely while they act slowly following decreases, which implies that more time is required in order expansionary

[6] A set of critical values changing with the sample size and the augmentation order of (3) are provided by Enders and Siklos (2001). However, in order to employ the critical values corresponding exactly to our case we perform a Monte Carlo simulation following the procedure described in Enders and Siklos (2001) and simulate the p-values.

monetary policy to produce its final effects on aggregate demand and eventually inflation. This also clearly reveals that Turkish lending rates exhibit downward rigidity, probably due to low competition in the banking sector, existence of switching and adjustment costs, as mentioned previously. A concentrated banking sector being subject to adjustment and switching costs provides a noticeable market power to banks and enables them to adjust to money market rate increases more quickly compared to the declines. The bank concentration ratio, the ratio of the three largest banks' assets to total banking sector assets, is 0.626 for Turkey between the years 2002 and 2009, as given in Beck and Demirguc-Kunt (2009) [7]. Compared to developed countries such as Canada, Japan and the United States with bank concentration ratios of 0.553, 0.443 and 0.302, respectively, it can be deduced that Turkish banking system still has scope to be competitive.

Having established the MTAR type cointegration between the lending rates and the money market rate, we proceed with estimation of MTAR type nonlinear ECMs given in (6) and (7) with the indicator function (5) and the consistent estimate of the threshold value τ observed from Table 2. Estimation results for each lending rate are reported in Table 4, with the first columns representing lending rate equations (6) and the second ones money market equations (7). Being in line with MTAR cointegration test results in Table 2, it appears from the lending rate equations that all loan rates show slower convergence for positive discrepancies from the long-run equilibrium arising from a decrease in the money market rate, supporting downward rigidity.

Indeed, this behaviour is much more prominent for commercial loan rates, which adjust to money market rate decreases at the lowest speed with the speed of adjustment parameter being -0.142. Moreover, it exhibits the highest speed of adjustment (-0.869) following money market rate increases. As indicated by Aydin (2007), the lack of deep financial system[8] and limited funding options lead Turkish firms to depend mainly on bank credits and result in inelastic demand for corporate loans. These could explain the observed substantial rigidity of the corporate loan rates. Automobile loan rates, on the other hand, appears to be less rigid compared

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[7]Beck and Demirguc-Kunt (2009) provides bank concentration ratios on a yearly basis. In order to obtain a general measure representing the period of 2002 and 2009 we take the simple average of the given ratios.

[8]The ratio of private credit to Gross Domestic Product (GDP), one of the most comprehensive measure for financial development and deepening according to Sander and Kleimeier (2004b), is 0.217 for Turkey over the period of 2002 and 2009, as provided by Beck and Demirguc-Kunt (2009). This low ratio clearly reveals that despite its distinguishing upward trend, Turkey still has a long way to go to reach advanced countries levels of financial deepening.

to other loan rates with the speed of adjustment of -0.289 following money market rate decreases. Given that at the end of 2011 automobile loans constituted only around 2% of all banks loans with substantial amount of loans being supplied by private non-banking companies, this finding is not surprising[9]. Turning to the lending rates for cash and housing loans, the most competitive credit markets, we observe approximately same degree of rigidity with similar speed of adjustment in both regimes. These findings clearly uncover the existence of sectoral heterogenities in the pass-through structure and the effects of the monetary policy.

Finally, as mentioned before, our single equation modelling relies on the weak exogenity assumption of the money market rate to lending rates. The ECM results support the validty of this assumption with the p-values for the error correction terms in all money market rate equations being insignificant at the 5% significance level. Estimated threshold error correction models permits us further to test for short run dynamics between the lending and money market rates. In this sense, rejection of the null hypothesis of $\delta_i = 0 \ (\varphi_i = 0)$ suggests Granger-causality from the money market rate (lending rate) to the lending rate (money market rate). At the 5% significance level, it is obseved that money market rate Granger causes cash and commercial loan rates in the short-run, whereas the only lending rate Granger causes the market rate is the automobile loan rate.

[9]The ratio of cash, housing and commercial loans to total bank loans were around 18%, 15% and 65%, respectively, at the end of 2011according to the Banking Regulation and Supervision Agency of Turkey.

Table 3: Cointegration Test Results

	cash			*automobile*		
	EG	*TAR*	*MTAR*	*EG*	*TAR*	*MTAR*
ρ_1	-0.226[c]	-0.182	-0.167	-0.229[b]	-0.063	-0.148
	(-3.272)	(-2.213)	(-2.234)	(-3.737)	(-0.897)	(-2.307)
ρ_2	NA	-0.313	-0.453	NA	-0.555	-0.624
		(-2.723)	(-3.792)		(-5.620)	(-4.944)
p	1	1	0	0	0	0
τ	NA	-2.490	-0.485	NA	-2.185	-0.957
Φ	NA	5.749	9.684[b]	NA	16.039[a]	14.882[a]
		[0.105]	[0.020]		[0.000]	[0.000]
$\rho_1 = \rho_2$	NA	NA	4.136[b]	NA	16.391[a]	11.349[a]
			[0.045]		[0.000]	[0.001]
$Q(8)$	11.852	10.697	12.952	8.205	12.728	5.903
	[0.158]	[0.219]	[0.113]	[0.414]	[0.122]	[0.658]
AIC	0.883	0.893	0.851	0.647	0.521	0.504
housing				*commercial*		
	EG	*TAR*	*MTAR*	*EG*	*TAR*	*MTAR*
ρ_1	-0.211[c]	-0.128	-0.115	-0.231[c]	-0.143	-0.138
	(-3.277)	(-1.581)	(-1.704)	(-3.264)	(-1.750)	(-1.972)
ρ_2	NA	-0.314	-0.541	NA	-0.436	-0.692
		(-3.492)	(-4.617)		(-3.616)	(-4.915)
p	3	3	3	1	1	0
τ	NA	-0.994	-0.778	NA	-1.624	-0.852
Φ	NA	6.721[b]	11.374[a]	NA	7.594[b]	14.023[a]
		[0.048]	[0.006]		[0.027]	[0.000]
$\rho_1 = \rho_2$	NA	2.633	10.829[a]	NA	4.300[b]	12.391[a]
		[0.108]	[0.001]		[0.041]	[0.001]
$Q(8)$	10.938	12.679	11.388	9.533	13.018	11.192
	[0.205]	[0.132]	[0.181]	[0.229]	[0.111]	[0.191]
AIC	0.522	0.515	0.437	0.403	0.381	0.295

Notes: ρ_1 and ρ_2 are estimated values with t-statistics given in parentheses. p indicates the required number of lagged changes to ensure *iid* residuals in (2) and (3). τ is the estimated threshold value and Φ refers to the sample value for threshold cointegration test with simulated p-values (50,000 replications) given below in brackets. NA indicates that asymmetry test, $\rho_1 = \rho_2$, is not reported due to lack of evidence for cointegration. $Q(8)$ is the Ljung-Box Q statistic for serial correlation of order 8 and *AIC* is the Akaike Information Criterion. Significance levels are denoted as a, b and c for 1, 5 and 10 %, respectively.

Table 4: Estimated Threshold Error-Correction Models

	cash	*mmr*	*automobile*	*mmr*	*housing*	*mmr*	*commercial*	*mmr*
φ_0	-0.078	-0.083	-0.102	-0.081	-0.160	-0.114	-0.238[c]	-0.118
	[0.679]	[0.293]	[0.555]	[0.312]	[0.246]	[0.182]	[0.080]	[0.152]
φ_1	-0.103	0.029	0.186	0.106	0.225[b]	0.106	0.114	0.122[c]
	[0.385]	[0.552]	[0.131]	[0.064]	[0.024]	[0.085]	[0.279]	[0.057]
φ_2	-0.211[c]	-0.072	0.031	-0.099[c]	-0.167[c]	-0.071	-0.344[a]	0.270[b]
	[0.065]	[0.132]	[0.799]	[0.089]	[0.092]	[0.243]	[0.001]	[0.019]
φ_3	NA	NA	-0.071	-0.118[b]	0.328[a]	-0.043	NA	NA
			[0.542]	[0.041]	[0.001]	[0.458]		
φ_4	NA	NA	NA	NA	-0.029	-0.076	NA	NA
					[0.758]	[0.201]		
δ_1	0.752[a]	0.395[a]	-0.038	0.267[b]	0.359	0.360[a]	0.056	0.342[a]
	[0.009]	[0.001]	[0.891]	[0.042]	[0.080]	[0.005]	[0.782]	[0.006]
δ_2	0.213	0.306[a]	0.382	0.404[a]	-0.036	0.232[c]	0.530[a]	0.270[b]
	[0.429]	[0.007]	[0.177]	[0.002]	[0.866]	[0.077]	[0.005]	[0.019]
δ_3	NA	NA	-0.031	0.067	-0.500[b]	-0.039	NA	NA
			[0.902]	[0.623]	[0.019]	[0.764]		
δ_4	NA	NA	NA	NA	-0.294	0.101	NA	NA
					[0.133]	[0.405]		
γ_1	-0.158	-0.061	-0.289[a]	-0.083[c]	-0.189[b]	-0.032	-0.142	-0.013
	[0.118]	[0.141]	[0.003]	[0.075]	[0.015]	[0.495]	[0.108]	[0.803]
γ_2	-0.381[b]	0.054	-0.607[a]	0.113	-0.314[b]	-0.021	-0.869[a]	-0.080
	[0.010]	[0.376]	[0.001]	[0.240]	[0.016]	[0.793]	[0.000]	[0.431]
$Q(8)$	7.132	8.949	12.286	12.656	3.599	11.572	9.823	8.575
	[0.522]	[0.347]	[0.139]	[0.124]	[0.881]	[0.171]	[0.278]	[0.379]
$\varphi_i = 0$	1.764	1.874	1.036	3.538[b]	5.827[a]	1.677	7.852[a]	3.053[c]
	[0.177]	[0.159]	[0.380]	[0.010]	[0.000]	[0.162]	[0.001]	[0.052]
$\delta_i = 0$	4.654[b]	12.526[a]	0.619	4.642[a]	2.335	3.570[a]	4.526[b]	8.798[a]
	[0.012]	[0.000]	[0.604]	[0.002]	[0.062]	[0.008]	[0.013]	[0.001]

Notes: For each lending rate, the first column represents the lending rate equation (6) and the second one the money market rate equation (7). In all equations the augmentation order is selected to ensure the absence of serial correlation of order 8 according to the Ljung-Box Q statistic, $Q(8)$. P-values are given in brackets and significance levels are denoted as a, b and c for 1, 5 and 10 %, respectively.

5. Conclusion

In this paper the nature of the pass-through of the money market rate to cash, housing, automobile and commercial loan rates in Turkey is analysed within the context of univariate threshold error-correction models. Our preliminary results suggest that a substantial mark-up pricing policy is implemented by Turkish banks for all loan types. As regards the extend or degree of the pass-through, it appears that money market rate changes are fully reflected to the lending rates in the long-run only for cash and housing loans, the most competitive credit markets in Turkey.

TAR and MTAR cointegration tests uncover importance of nonlinearities in the pass-through analysis. Our results justify the existence of asymmetric adjustment of all lending rates towards long-run equilibrium, with the MTAR type nonlinear adjustment being more appropriate than TAR type adjustment. Consequent MTAR type threshold error-correction models uncover further downward rigidity of the lending rates, implying a reduction in the money market rate, following a monetary policy expansion affect the economy differently from a monetary policy contraction. The finding of downward rigidity appears to be more substantial for commercial loan rates, probably due to the lack of a deep financial system and an inelastic demand for corporate loans arising from limited funding options of Turkish firms. Finally, the results support the validity of the weak exogenity assumption of the money market rate to loan rates, which is the basis of our univariate approach.

From the perspective of the effectiveness of monetary policy, the findings of incomplete and/or asymmetric pass-through and sectoral heterogeneities in the credit market might not indicate ineffectiveness of monetary policy actions, as long as the policy makers are aware of this structure. They may create challenging issues, however, if policy makers are incognizant of the actual structure of the mechanism but rely on the assumption of complete, symmetric and homogenous interest rate pass-through.

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