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Asymmetric effects of central bank funding on commercial banking sector behaviour

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ABSTRACT

In this paper, we assess the effects of Central Bank Funding (C.B.F.) on commercial bank lending behaviour by using weekly Turkish data from 7 January 2011 to 5 June 2015. To be specific, using the Nonlinear Autoregressive Distributed Lag Error Correction Model, we assess the effects of C.B.F. provided daily by the Central Bank of the Republic of Turkey through Open Market Operations to financial markets. Our empirical evidence reveals that for all types of lending, an increase in C.B.F. (which has a higher cost for commercial banks relative to alternatives) forces commercial banks to borrow from higher-cost channels, i.e., we find that increasing C.B.F. discourages commercial bank lending. We also find that decreases in C.B.F. that proxy what commercial banks can borrow more cheaply from alternative sources increase commercial bank lending. However, increasing C.B.F. is more effective than decreasing C.B.F. for Total Bank Loans, Total Credit Cards and Automobile Loans, and decreasing C.B.F. is more effective in the short run for Consumption Loans, Housing Loans and Commercial Loans: *short-run asymmetry*. Therefore, we can report only limited support for *long-run asymmetry*, and consequently, claim that there is *magnitude* (an increase versus decrease in C.B.F.) and *category asymmetry* (across different lending categories).

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1. Introduction

After the 2008 financial crises, central banks faced challenges in stabilising their economies in addition to addressing price stability and excessive capital flows. Thus, central banks, including the Central Bank of the Republic of Turkey (C.B.R.T.), developed and used new monetary policy tools (in addition to traditional tools such as short-term interest rate) to address these issues, such as multiple short-term interest rates, buying and selling foreign currency, macroprudential tools and the Reserve Option Mechanism (R.O.M.; see Varlik and Berument, 2016 and 2017 for a review of relevant tools)¹.

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With its new financial architecture, the C.B.R.T. provides various types of liquidity to financial markets through various types of costs and restrictions (i.e., tools). One such tool is Central Bank Funding (C.B.F.), and the logic behind it is as follows: as the C.B.R.T. cuts types of liquidity with lower costs to financial markets and thus forces market participants to borrow at a higher cost within the limits of commercial banks' positions at the central bank, the funding costs of commercial banks will increase and thus banks will alter their lending behaviour. Therefore, an increase in C.B.F. associated with a higher cost for commercial banks results in a decrease in commercial bank lending. In other words, the C.B.R.T. may increase C.B.F. to tighten monetary policy (see C.B.R.T., 2015, pp. 2–3), and this paper assesses how changes in C.B.F. affect various types of commercial bank lending and whether an increase versus decrease in C.B.F. affects commercial bank lending differently.

Post-2008, central banks have been using multiple tools to set up their monetary policies. Sometimes, however, they use policy tools in a 'wrong way' (in Brainard's (1967) sense), such that an adverse effect of one policy tool is decreased by using another policy tool that moves in the opposite direction.² This paper assesses the effect of one policy tool on commercial bank lending (a central bank transmission channel on economic performance) rather than the effect on total economic performance. There are various reasons for this approach. First, the C.B.R.T. argues that different monetary policy tools affect different variables to a different degree. For example, Kara³ (2015a) argues that a lower band of interest rate is important for international capital inflows, and that the cost of funding to all commercial banks is important for banks' deposit interest rates. Er and Guney (2016) and Guler et al. (2014) argue that C.B.F. affects the banking sector's credit cost and its credit quantity dynamics. Thus, because the C.B.R.T. might be using C.B.F. in a 'wrong way', we directly look at the effects of C.B.F. on the bank's intended intermediate targets rather than at the effect of C.B.F. on economic performance. Second, commercial banks obtain various short- and long-term funding from various sources. Increasing the latter might be a desired aim, but the former is more dominant in financing banking sector loans. Therefore, determining the cost composition of these funds is essential (Deans and Stewart, 2012; Fabbro and Hack, 2011; Wong, 2012; Beau et al., 2014). Commercial banks also use short- and long-term funds for their credits. Different credits have different characteristics: maturity, likelihood or expectations of refinancing, liquidity and interest rate elasticities. Note that different types of lending will be affected differently as the stance of monetary policy changes. Commercial banks will choose less-risky projects and begin to exhibit flight-to-quality behaviour, as mentioned by Lang and Nakamura (1995) and Gambacorta and Rossi (2010). Commercial credits are given only to those with more solid collateral, and the term structure of the funding cost is usually longer. Therefore, with a tighter monetary policy stance, banking sector credits, especially consumer credits, are affected more than commercial loans are because short-term sources are deviated to short-term credits. Cash-restricted consumers are also prone to purchase on credit, despite its cost, because they usually do not like to postpone their wants and needs (see Wickens, 2012, p. 202).

Third, it is important to understand how different types of lending are affected by monetary policy tools because the C.B.R.T. argues that not all types of lending have the same effect on economic performance. For example, the C.B.R.T. (2015, p. 10) notes that commercial lending from commercial banks has a smaller effect on the current account than consumer credit lending does. Aliogullari, Baskaya, Bulut and Kilinc (2015), also from the C.B.R.T., support the increasing effect of consumer credits on the current account but do not find a significant effect for commercial loans. The C.B.R.T. argues that it uses the funding mechanism to affect these credits as well (see, for example, C.B.R.T., 2014).

As liquidity decreases, commercial banks may need to wait for credit maturity to recall their credits. Further, refinancing credits or increasing interest rates may not be possible, therefore it is not easy for commercial banks to call in these credits.⁴ However, because the C.B.R.T. provides liquidity, it is easier for commercial banks to open new credit lines. Thus, there might be an asymmetry for the different effects of liquidity on different types of credits. The potential motives for this asymmetry have been studied within the literature, and Gambacorta and Rossi (2010) provide a good review of this issue. One channel the above authors suggest is capital regulation, under which it is necessary for commercial banks to keep the ratio between lending and bank capital at a certain minimum level. A looser monetary policy stance (which may also be associated with lower C.B.F.) may further limit commercial banks from extending credits, but a similar effect may not be observed under a tighter monetary stance. Alternatively, Friedman et al. (1993) note the differential cost effect of internal and external funds; a tighter monetary policy is associated with more internal funds (less demand on commercial bank lending) but a looser monetary policy stance may encourage more external financing for corporates, and thus higher lending.

The C.B.R.T. provides liquidity to markets in various channels, each of which has a different cost and availability. One such channel is C.B.F., and the cost of using this channel is high: as the C.B.R.T. tightens market liquidity through channels with a lower cost, commercial banks must borrow higher-cost funding (i.e., C.B.F.), which we take as an indicator of tighter monetary policy. Thus, higher usage of C.B.F. means a tighter monetary policy stance.

Total Banks (Commercial banks (34) + Development and Investment Banks (13) + Participation Banks (5)) constitute 81% of the financial system in Turkey as of the year 2016. The remaining are: Portfolio management companies (4%), Unemployment insurance fund (4%), Insurance companies (3%), Real estate investment trusts (2%), Pension investment funds (2%), Individual pension funds (2%), Financial leasing companies (1%), Factoring companies (1%), Financial companies (1%), Intermediary institutions (1%), and negligibly, each of Reinsurance companies, Venture capital funds, and Securities investment trusts (see The Banks Association of Turkey, 2017, pp. 15–16 for details of the banking structure in Turkey). Given the above information, banks are one of the basic and most important financial institutions in Turkey (and elsewhere).

In Turkey, other types of banks (such as participation banks) follow and consider a non-interest-rate policy of Islamic rules. For example, they do not pay interest on deposits but offer profit shares in the bank. Their share and role in the country's

banking system is smaller; as of 2016, there are only five participation banks in Turkey, and these have a 5% share in total banking sector assets (commercial banks have a 90% share) (The Banks Association of Turkey, 2017, p.17). Development and investment banks also exist, which do not accept deposits from customers and mostly lend money to government-sponsored projects that have virtually no default risk, thus the interest rates charged are not representative of the market.

In other words, commercial banks constitute the biggest and most important component of Turkey's financial sector. Commercial banks can extend their credit lines in foreign currency only to companies with revenue in foreign currency, such as export firms. Moreover, due to a tax code that does not account for volatile and high inflation, loan transactions are conducted mostly in fixed-rate domestic currency rather than inflation index contracts or foreign currency contracts. Due to relatively thin volatile government bond markets, loan contracts indexed to government securities are also non-existent. Thus, loans extended by commercial banks constitute the biggest loan share of Turkey's banking system.

We analysed the effects of increases versus decreases in C.B.F. on different types of lending and differentiated banking sector credits into Credit Cards, Automobile Loans, Consumption Loans, Housing Loans and Commercial Loans to see whether there was any heterogeneity among the responses. For Turkey, Guler et al. (2014) study the effect of C.B.F. on credits⁵ and argue that increasing C.B.F. financed by short-term borrowing will increase the maturity mismatch of bank balance sheets, which in turn will increase interest rate risk and affect credits and their compositions. We extend the Guler et al. (2014) exercise and analyse the effects of C.B.F. on banking sector credits by using the Nonlinear Autoregressive Distributed Lag model (N.A.R.D.L.), which also allows for the asymmetric response of loans to changes in C.B.F. Our model also assesses this effect for short- and long-term asymmetry.

Our paper contributes to the literature in several ways: (i) Using N.A.R.D.L., we provide empirical evidence on the effect of C.B.F. on various types of commercial bank lending. (ii) We allow asymmetry to show that increases and decreases in C.B.F. affect lending differently. (iii) Our methodology allows us to assess long- versus short-run asymmetry. (iv) Our methodology also allows us to compare the effects of C.B.F. on various types of lending.

We assess the effectiveness of C.B.F. in Turkey on commercial bank lending. The empirical evidence provided here reveals that for all types of lending, an increase in C.B.F. decreases commercial bank lending, and shows that decreases in C.B.F. increase commercial bank lending. However, increasing C.B.F. is more effective than decreasing it for Total Bank Loans, Total Credit Cards and Automobile Loans, and decreasing C.B.F. is more effective for Consumption Loans, Housing Loans and Commercial Loans in the short-run: *short-run asymmetry*. The supporting evidence on the *long-run asymmetry* is limited.

The next section (Section 2) discusses the development of Turkey's monetary policy since the 2000s. Section 3 introduces the data and methodology. Section 4 provides the empirical evidence concerning the estimates of the N.A.R.D.L.-Error Correction Model (E.C.M.). Section 5 discusses the results and Section 6 elaborates on further research and concludes the paper.

2. Development of Turkey's monetary policy

With high and volatile foreign capital inflows mostly stemming from portfolio investment occurring in the 2000s, the C.B.R.T. implemented a more flexible tool than short-term interest rates to affect economic performance. The C.B.R.T. began an inflation-targeting regime in 2006, and the new tool was developed around an interest rate rather than an exchange rate (see, for instance, Basci,⁶ Ozel and Sarikaya, 2007 and Basci and Kara, 2011). The C.B.R.T. also designed a new set of policy tools through the banking sector's credit channel (see C.B.R.T., 2015 and 2014).⁷ The C.B.R.T. focused on this channel because the banking sector is the single most important conduit through which to implement monetary policy, and commercial banks (C.B.s) are the most dominant players in the banking sector for Turkey. As of 2011, 90.44% of total banking sector domestic loans were from C.B.s, whereas only 3.60% and 5.95% were from investment and development banks and participation banks, respectively.⁸⁹

The C.B.R.T. provides daily liquidity to financial markets in various forms and through various channels, such as Open Market Operations (O.M.O.) with different maturities¹⁰ (overnight, over-week and over-month), discount windows and additions to short-term interest rates through a set of strict limits on their usage and costs. The weighted average cost of the C.B.R.T.'s lending at different frequencies is higher than the lower bound of the corridor, and more important, higher than the C.B.R.T.'s official monetary policy tool the over-week interest rate. The over-week rate fluctuates between the lower and upper bands, as shown in Figure 1a. There is a limit for over-week borrowing but clients can engage in unlimited overnight borrowing using Repurchase Agreements (repo) transactions as long as C.B.s provide pre-defined qualified government bonds in exchange. Thus, as the C.B.R.T. makes commercial banks borrow at overnight rates, this higher borrowing cost means a tighter liquidity condition (C.B.R.T., 2015, pp. 2-3).



Figure 1a. Interest rate behaviour in Turkey from 7 January 2011 to 10 June 2015. Source: C.B.R.T.'s interactive graphing tool. Upper limit of the shaded corridor: O/N lending interest rate; Lower part of the shaded area: O/N borrowing interest rate; Purple: One-week repo rate; Blue: B.I.S.T. overnight repo rates (five-day moving average); Red: C.B.R.T. average fund rate (five-day moving average).

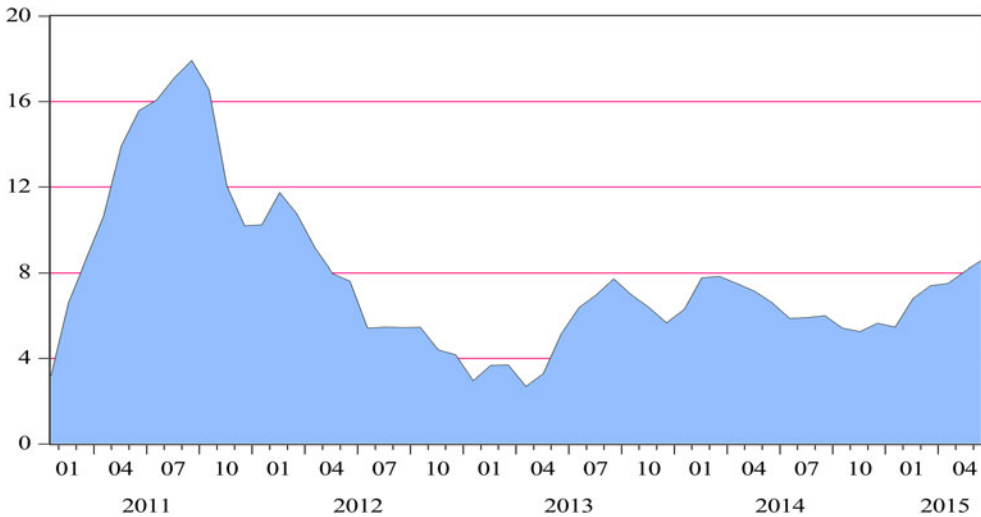


Figure 1b. Ratio of C.B.F. to commercial and retail loans from January 2011 to June 2015 (%). Source: C.B.R.T., E.D.D.S. Note: The y axis is the percentage ratio of C.B.F. to loans.

Although commercial bank funding from the C.B.R.T. is small, it is important in these banks' decision-making processes. At the end of our sample period, the ratio of C.B.F. to Total TL-denominated Commercial and Retail Loans is 9% (Figure 1b). A higher funding cost affects commercial bank lending preferences.¹¹ As the cost of borrowing from the C.B.R.T. increases, commercial banks will need to pass on that increase to borrowers.¹² Usually, the C.B.R.T. aims for banks to lend or borrow from each other within a pre-defined interest rate corridor; it is not profitable for commercial banks to lend or borrow from the C.B.R.T. using a high lending interest rate and a low borrowing rate. However, the C.B.R.T. is the net funder for financial markets (see Figure 1a), and thus a bank's net liquidity position affects its lending level on the asset side of the balance sheet due to the C.B.R.T.'s actions, particularly with C.B.F.

3. Data and methodology

We gathered weekly data from the C.B.R.T.'s E.D.D.S. from 7 January 2011 to 5 June 2015; details are provided in Table 1. All series are deflated (normalised) with a sixth lag of Total Bank Loans times 100 to avoid simultaneity.¹³ Total Bank Loans consists of the sum of the total loans of C.B.s, investment and development banks,¹⁴ participation banks and finance companies. Following Enders (2010, p. 303) and the references cited therein, we did not difference the data, although there is a case of unit root. The unit root tests and a set of robustness analyses are not reported here but are available from the authors upon request.

To capture the asymmetric effect of C.B.F. on credit, we employ Shin et al.'s (2014) N.A.R.D.L. method. This approach allows us to assess the short- and long-run responses of credit-to-C.B.F. increases versus decreases. The method also allows us to gather inferences regardless of the variables' integration orders. The method decomposes C.B.F. into its positive and negative partial sums as:

Table 1. Details of the data.

<i>Variables</i>	<i>Explanation</i>	<i>Codes</i>
Central Bank Funding (CBF)	Weekly average of the daily Funding Needs data, and the exact dates matched with the lending data	C.B.R.T. Net Funding Data
Total Bank Loans	Commercial Bank Loans + Investment and Development Bank Loans + Participation Bank Loans + Finance Companies' Loans	TP.BFTUKKRE.L001: I + TP.BFTUKKRE.L192: II + TP.BFTUKKRE.L233: III + TP.BFTUKKRE.L290: IV
Total Credit Cards	Public Deposit Money Bank Credit Cards + Private Deposit Money Bank Credit Cards + Foreign Deposit Money Bank Credit Cards	TF.BF.TUKKRE.L064:I.I.2.a.TRY
Automobile Loans	Deposit Money Bank Automobile Loans + Participation Bank Automobile Loans	TP.BFTUKKRE.L007:I.C.2 + TP.BFTUKKRE.L237.III.A.2
Consumption Loans	Public Deposit Money Bank Consumption Loans + Private Deposit Money Bank Consumption Loans + Foreign Deposit Money Bank Consumer Loans	TF.BF.TUKKRE.L014:I.E
Housing Loans	Deposit Money Bank Housing Loans + Participation Bank Housing Loans	TP.BFTUKKRE.L005:I.C.1 + TP.BFTUKKRE.L235:III.A.1
Commercial Loans	Public Deposit Money Bank Commercial Instalment Loans + Private Deposit Money Bank Commercial Instalment Loans + Foreign Deposit Money Bank Commercial Instalment Loans	TF.BFTUKKRE.L039:I.H.1

$$CBF^+ = \sum_{i=1}^t \Delta CBF_i^+ = \sum_{i=1}^t \text{Max}(\Delta CBF_i, 0) \tag{1}$$

and

$$CBF^- = \sum_{i=1}^t \Delta CBF_i^- = \sum_{i=1}^t \text{Min}(\Delta CBF_i, 0). \tag{2}$$

The asymmetric long-run relationship without a constant term can be represented as

$$CR_t = \beta^+ CBF_t^+ + \beta^- CBF_t^- + u_t,$$

where Credits (CR_t) and CBF are scalar I(1) variables. Granger and Yoon (2002) extend the model, where cointegration may exist for their positive and negative components. Schorderet (2003) generates the above specification for asymmetric cointegration such that there may be a stationary variable z_t , which may be written as:

$$z_t = \beta_0^+ CR_t^+ + \beta_0^- CR_t^- + \beta_1^+ CBF_t^+ + \beta_1^- CBF_t^-, \tag{3}$$

where CR_t and CBF_t are asymptotically cointegrated. If $\beta_0^+ = \beta_0^-$ and $\beta_1^+ = \beta_1^-$, then the system reduces to (symmetric) cointegration. Following Shin et al. (2014), we extend the Linear E.C.M. to a general N.A.R.D.L.-E.C.M. as follows:

$$\Delta CR_t = \alpha_0 + \rho CR_{t-1} + \theta^+ CBF_{t-1}^+ + \theta^- CBF_{t-1}^- + \sum_{j=1}^{p-1} \gamma_j \Delta CR_{t-j} + \sum_{j=0}^{q-1} \left(\varphi_j^+ \Delta CBF_{t-j}^+ + \varphi_j^- \Delta CBF_{t-j}^- \right) + \varepsilon_t. \quad (4)$$

$$\Delta CR_t = \alpha_0 + \rho \zeta_{t-1} + \sum_{j=1}^{p-1} \gamma_j \Delta CR_{t-j} + \sum_{j=0}^{q-1} \left(\varphi_j^+ \Delta CBF_{t-j}^+ + \varphi_j^- \Delta CBF_{t-j}^- \right) + \varepsilon_t.$$

where $\zeta_t = CR_t - \beta^+ CBF_t^+ - \beta^- CBF_t^-$; $\beta^+ = -\theta^+ / \rho$; and $\beta^- = -\theta^- / \rho$

(5)

This is the basic model that we will be estimating for the main inference of this paper. The lag orders (p and q) are determined by following the general-to-specific approach¹⁵ within the Stepwise Regression method internally, where the nonsignificant coefficients are dropped. To test for the existence of an asymmetric long-run relationship (cointegration), we benefit from the model based on the N.A.R.D.L.-E.C.M. approach described above.¹⁶

In this study, we employ the N.A.R.D.L.-E.C.M. methodology rather than a value at risk (V.A.R.) methodology, the latter of which allows a feedback mechanism from different types of lending to assess the effect of C.B.F. on these lending types. Using impulse response functions gathered from V.A.R. for inferences requires the assumption that shocks to C.B.F. capture monetary policy stance. After 2010, the C.B.R.T. adopted multiple tools to conduct its monetary policy framework, as also stressed by Turkey's Financial Stability Board (2015). One should note that the European Commission (2014, p. 39 and 2015, p. 30) criticises Turkish monetary policy for its complexity and recommends that the C.B.R.T. solely focus on an inflation-targeting regime. The International Monetary Fund (2014, p. 17) also stresses the *hampering effect* of multiple tools on financial markets and claims that they disturb the inflation-targeting process. Thus, there is no single variable that can be used as a monetary policy tool. For this reason, we could not use V.A.R. to gather inferences. Further, introducing an asymmetry to V.A.R. requires a set of arbitrary assumptions, which may produce different types of impulse responses. Studying the effect of monetary policy within a multiple-tool framework and considering various specifications that introduce asymmetry within a V.A.R. framework are beyond the scope of this study.

4. Empirical results and discussion

Table 2 reports the estimated parameters of the N.A.R.D.L.-E.C.M. model and the set of statistics across different lending categories when Required Reserves are excluded from C.B.F. Both long-run coefficients for CBF_{t-1}^+ and CBF_{t-1}^- across all types of lending are negative. These coefficients are statistically significant at the 5% level for both positive and negative C.B.F. coefficients for Total Bank Loans, Total Credit Cards and Housing Loans. They are not statistically significant at the 5% level for the other three lending types. Estimating these coefficients as negative is parallel to the expectations of the error correction specification: an excessive increase (or decrease)


Table 2. Dynamic asymmetric estimation with central bank funding – required reserves.

Variable	Total Bank Loans			Total Credit Cards			Automobile Loans			Consumption Loans			Housing Loans			Commercial Loans		
	Coefficient	p-value		Coefficient	p-value		Coefficient	p-value		Coefficient	p-value		Coefficient	p-value		Coefficient	p-value	
Constant	4.1319*	0.0626		0.4859**	0.0308		0.0239	0.2172		1.2875	0.2418		0.5051*	0.0699		-0.0675	0.7596	
CR_{t-1}	-0.0382*	0.0721		-0.0126	0.1305		-0.0075	0.1696		-0.0238	0.2246		-0.0191*	0.0806		0.0012	0.9091	
CBF_{t-1}	-0.1454**	0.0182		-0.0970***	0.0079		-0.0037	0.1479		-0.0551*	0.0536		-0.0371**	0.0156		-0.0049	0.8621	
CBF_{t-1}	-0.1302**	0.0158		-0.0677**	0.0229		-0.0014	0.4025		-0.0427	0.1432		-0.0337**	0.0292		-0.0123	0.6014	
ΔCR_{t-1}				-0.2384***	0.0000		0.1385**	0.0126										
ΔCR_{t-2}	0.2109***	0.0000		0.1587***	0.0076		0.1656**	0.0044		0.1656**	0.0044		0.1869***	0.0015				
ΔCR_{t-3}																		
ΔCR_{t-4}	0.3451***	0.0000		0.3026***	0.0000		0.3233***	0.0000		0.2479***	0.0000		0.3223***	0.0000		0.2706***	0.0000	
ΔCR_{t-5}				-0.2578***	0.0000		-0.2390***	0.0002		-0.4465***	0.0000		-0.3615***	0.0000		-0.2556***	0.0000	
ΔCR_{t-6}	-0.5698***	0.0000		-0.1769***	0.0007		-0.4372***	0.0000		-0.1341**	0.0111		-0.1471***	0.0055				
ΔCR_{t-7}	-0.1921***	0.0000																
ΔCR_{t-8}																		
ΔCR_{t-9}	0.1752***	0.0004		0.2992***	0.0000		0.2898***	0.0000		0.1815***	0.0013		0.2294***	0.0000		0.2134***	0.0005	
ΔCR_{t-10}																		
ΔCR_{t-11}	-0.3077***	0.0000		-0.2910***	0.0000		-0.1153**	0.0346		-0.1794***	0.0012		-0.1616***	0.0024				
ΔCR_{t-12}	-0.7830**	0.0125		-0.3262**	0.0108		-0.0248***	0.0020										
ΔCBF_{t-2}																		
ΔCBF_{t-5}																		
ΔCBF_{t-7}																		
ΔCBF_{t-1}																		
ΔCBF_{t-2}																		
ΔCBF_{t-6}																		
ΔCBF_{t-12}																		
L^1_{CBF}	-3.8070	0.1183		-7.6713**	0.0392		-0.4925**	0.0318		0.2836*	0.0530		0.2144***	0.0021		3.9378	0.8905	
L^2_{CBF}	-3.4094	0.1300		-5.3551**	0.0470		-0.1854	0.3059		-2.3140	0.3095		-1.9475	0.2109		9.9353	0.9001	
R^2	0.7341			0.7077			0.5937			0.5617			0.5148			0.3938		
Adj.R ²	0.7200			0.6921			0.5657			0.5337			0.4889			0.3650		
LM ⁽¹⁾	2.8842***	0.0011		2.5953***	0.0032		2.1956**	0.0134		1.9217**	0.0339		1.6927	0.1244		1.3902	0.1729	
ARCH ⁽²⁾	1.1974	0.1781		0.9451	0.6027		2.4563***	0.0000		1.5011**	0.0174		0.5830	0.7437		1.2243	0.1569	
RESET ⁽³⁾	1.4124	0.2360		0.0527	0.8186		0.9943	0.3199		0.1198	0.7296		0.0155	0.9010		0.1105	0.7399	
JB ⁽⁴⁾	10.4546***	0.0056		10.1252	0.9394		7.2101**	0.0271		4.7474*	0.0932		4.9083*	0.0859		8.1677**	0.0168	
t_{BDM} ⁽⁵⁾	-1.8078			-1.5183			-1.3782			-1.2180			-1.7556			0.1143		
F_{PSS} ⁽⁶⁾	3.0578			5.6884***			3.4526			4.4398*			7.5506***			1.9860		
W_{LR} ⁽⁷⁾	1.6455	0.2010		4.0960**	0.0443		10.3464***	0.0015		3.4167*	0.0660		1.4642	0.2277		0.0115	0.9146	
W_{SR} ⁽⁸⁾	7.1987***	0.0010		6.1554***	0.0025		11.7451***	0.0000		5.4814***	0.0003		7.8963***	0.0005		3.9741***	0.0088	

Notes: LM and ARCH tests use six lags. RESET Test uses one lag. c indicates cointegration between two variables. (1) LM Test for Serial Correlation, F-stat. (2) ARCH Test for Heteroscedasticity, F-stat. (3) Functional Form, RESET Test, F-stat. (4) Jarque-Bera Test for Normality. (5) BDM Test. (6) PSS Test. (7) Wald Test for Long Run. (8) Wald Test for Short Run.

in C.B.F. relative to credits that long-run equilibrium requires, decreases (or increases) C.B.F. in the next period.

On the long-term relationship between C.B.F. and each lending type, we provide various long-run (cointegration) test statistics. L_{CBF}^+ and L_{CBF}^- are the test statistics for the long-run coefficients associated with positive and negative changes in C.B.F. These coefficients and their statistics suggest that we reject the null of no-cointegration only for Total Credit Cards for both positive and negative cointegrations, and for Automobile Loans only for negative autocorrelation. Alternatively, if $\rho = 0$, then the equation suggests that there is no long-run relationship among CR , CBF^+ and CBF^- . Second, following Banerjee et al. (1998), we test $H_0 : \rho = 0$ versus $H_A : \rho < 0$ [t_{BDM} test]; we cannot reject the null of no-cointegration for any lending category that we consider at the 5% level. Third, in order to test the long-term relationship, by following Pesaran, Shin and Smith (2001), we test the null of $H_0 : \rho = \theta^+ = \theta^- = 0$ [F_{PSS} test]; we can reject the null of no-cointegration for Total Credit Cards and Housing Loans at the 5% level. The results are also parallel with the long-run asymmetry test, where the test statistics are reported by W_{LR} ($H_0 : -\theta^+/\rho = -\theta^-/\rho$). We can reject the long-run asymmetry at the 5% level only for Total Credit Cards and Automotive Loans. Thus, overall we find limited support for an asymmetric cointegration or for a long-run relationship between C.B.F. and each of the credit categories.

One of the advantages of the A.R.D.L. or bounds-testing approach à la Pesaran, Shin and Smith (2001) is that we can still use our basic modelling scheme for inferences, regardless of whether the series are I(0) and I(1) or mutually cointegrated.

Next, we test the short-run asymmetry with $H_0 : \sum_{j=0}^{q-1} \phi_j^+ = \sum_{j=0}^{q-1} \phi_j^-$ and report the statistics as W_{SR} . We clearly reject the null of no-short-run asymmetry for all credit groups at the 1% level. Thus, regardless of whether there is long-run symmetry, we find statistically significant evidence for the presence of short-run asymmetry.

One of the aims of this paper is to analyse how increases and decreases in C.B.F. affect Total Loans and its sub-components. In order to capture that effect, we calculate the dynamic asymmetric (or nonlinear) multipliers (see Delatte and Lopez-Villavicencio 2012; Shin et al., 2014 and Hoang et al., 2016 for the details of the methodology). The multipliers are basically captured by:

$$m_h^+ = \sum_{j=0}^h \frac{\partial CR_{t+j}}{\partial CBF_t^+} \text{ and } m_h^- = \sum_{j=0}^h \frac{\partial CR_{t+j}}{\partial CBF_t^-}, \text{ where } h = 0, 1, 2, 3, \dots \quad (6)$$

The multipliers given in Equation (6) converge to the long-run coefficients of funding to credits, calculated by $-\theta^+/\rho$ and $-\theta^-/\rho$.¹⁷

Figure 2 reports the dynamic multiplier of C.B.F. for Total Bank Loans and a set of loan components for 26 periods. The solid black line reports the dynamic multiplier when there is an increase in C.B.F. The broken black line is for the effect of lowering C.B.F. The grey lines represent the differences of the solid and broken black lines. The middle grey line stands for the differences and the other two lines stand for the confidence intervals of the differences. The bandwidths for the 90%

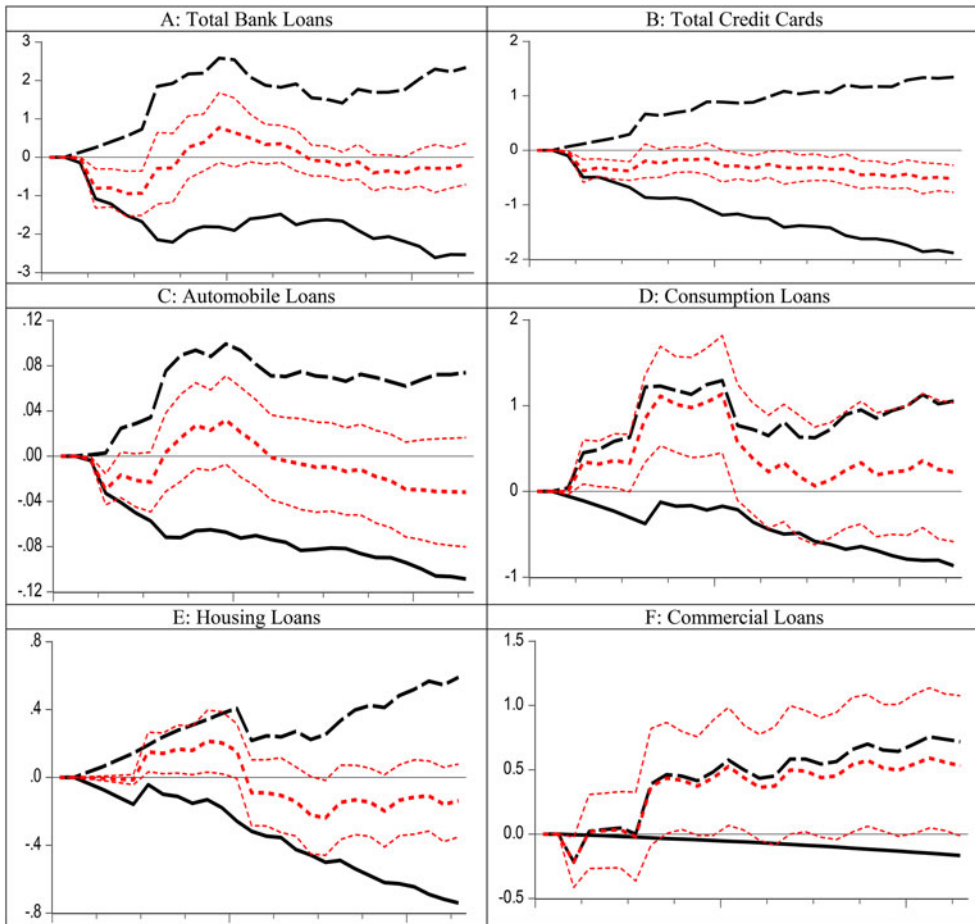


Figure 2. Central bank funding (C.B.F.) multipliers when required reserves are not excluded. Notes: The solid black line reports the dynamic multiplier for an increase in F.N.; the dashed black line is for a decrease in F.N.; the middle red line is for the difference in the absolute value of dynamic multipliers; the other two red lines are for the confidence bands for the differences.

confidence bands are calculated by the bootstrap method, with 40,000 replications. If we cannot reject that the grey line is different from zero, then we can conclude that there is no asymmetry for the corresponding period. Panel A in Figure 2 suggests that as C.B.F. increases, Total Bank Loans decreases, and as C.B.F. decreases, Total Bank Loans increases. However, the grey line suggests that an increase in C.B.F. decreases Total Bank Loans, which is more than the increasing effect of C.B.F. for Total Bank Loans for nine periods. This finding implies that an increase in C.B.F. is more effective for Total Bank Loans than a decrease in C.B.F. initially. This effect is statistically significant for six periods.

On the effect of C.B.F. on the sub-components of Total Bank Loans, Panel B assesses C.B.F. effect on Total Credit Cards and Panel C assesses its effect on Automobile Loans. Similar to Total Bank Loans, an increase in C.B.F. decreases these two variables, and a decrease in C.B.F. increases these two variables. Moreover,

similar to Total Bank Loans, initially, the effect of increasing C.B.F. is higher than the effect of decreasing C.B.F. on these two variables. These effects are statistically significant for the first seven periods for Total Credit Cards and for the first five periods for Automobile Loans. However, after 12 periods, an increase in C.B.F. is more effective than a decrease in C.B.F. for Credit Cards. Panels D, E and F report the effect of C.B.F. on Consumption Loans, Housing Loans and Commercial Loans. Initially, an increase in C.B.F. decreases all three loans and a decrease in C.B.F. increases all three loans. However, after three periods, we find an increase for Commercial Loans. In determining whether increasing versus decreasing C.B.F. is more effective, we find that for Consumption Loans and Housing Loans, decreasing C.B.F. is more effective than increasing C.B.F. Regarding the first 13 periods for Consumption Loans, between six and 12 periods of decreasing C.B.F. increases these two loans more than increasing C.B.F. decreases them in a statistically significant fashion. It seems that an increase in C.B.F. does not decrease Commercial Loans very much, but a decrease in C.B.F. increases Commercial Loans after three periods. If we look at the long-run effect, then an increase versus decrease in C.B.F. affects only two lending types differently: Total Credit Cards and Commercial Loans. Higher C.B.F. is more effective to decrease Total Credit Cards than lower C.B.F. is. On the other hand, lower C.B.F. (a looser monetary stance) is more effective to increase Commercial Loans than higher C.B.F. is after the eighth month.

Overall, the evidence suggests that increasing C.B.F. decreases loans for all categories and decreasing C.B.F. increases loans for all categories. However, increasing C.B.F. is more effective for changing loans for Total Bank Loans, Total Credit Cards and Automobile Loans; decreasing C.B.F. is more effective for Consumption Loans and Housing Loans. This finding is parallel to Lang and Nakamura (1995): banks have more incentive to finance less-risky projects during monetary tightness. We could not find a statistically significant effect for asymmetry on Commercial Loans.

When one looks at the magnitude of the changes, Figure 2 reveals that a one-unit change (increase or decrease) in C.B.F., not surprisingly, changes Total Bank Loans the most. When we look at the components, a one-unit decrease in C.B.F. increases Consumption Loans and Credit Cards the most. However, a one-unit increase in C.B.F. decreases Credit Cards the most. An increase in C.B.F. decreases Commercial Loans and Automobile Loans the least. One may interpret these findings as follows: if a central bank adopts a tighter monetary policy through C.B.F., this will be more effective for Total Bank Loans, mostly due to consumer (rather than corporate) credits. Note that if one considers that Credit Cards and Consumption Loans serve similar purposes, then loans on Credit Cards are riskier than on Consumption Loans and have a shorter maturity. Similarly, for C.B.s, Automobile Loans and Housing Loans may have similar risk exposures; the interest rates banks charge on Automobile Loans are higher than interest on Housing Loans, and the former usually have a shorter maturity. The evidence suggests that with tighter monetary policy, C.B.s cut credit lines on riskier loans and give them shorter maturities. On the other hand, C.B.s extend credit lines on loans with lower risk exposure and longer maturities. These findings support the proposition that C.B.s decrease their risk exposure the most with tight monetary propositions (Lang and Nakamura, 1995).

5. Robustness analyses

Within the previous analyses reported in Table 2 and Figure 2, we use C.B.F. where the Required Reserves are excluded (one may call it net C.B.F.). This approach requires that reserves be exogenous¹⁸ and might not change with commercial bank liquidity risk. Note that in August 2011, the C.B.R.T. introduced the R.O.M. to decrease the adverse effects of capital flows on economic performance (see Sahin, Dogan and Berument, 2015). This mechanism allows C.B.s to keep part of their domestic-currency-denominated required reserve obligations in foreign currency. Thus, due to the R.O.M., Required Reserves might be responding to deposits as well as C.B.s' foreign-currency-denominated obligations. Therefore, we repeat the exercise without subtracting Required Reserves from C.B.F. The relevant estimates are reported in Table 3 and the relevant dynamic multipliers are reported in Figure 3. Table 3 reveals a relatively lower level of support both for positive and negative cointegration and thus long-run asymmetry, but the results for the short-run relationship and its asymmetry are robust. Figure 3 reveals the same pattern for the dynamic multipliers even though the patterns for the differences are shorter for Consumer Loans, and the differences in the increasing and decreasing effects of C.B.F. on Housing Loans are higher.¹⁹ Thus, we claim that our results are robust to different ways of measuring C.B.F.

6. Conclusions and further research

In this paper, we analyse the dynamic asymmetric effects of C.B.F. changes on commercial bank lending practices. A *resilient* banking sector depends on efficient usage of external resources (see, for example, Basel, 2017; Dovern, Meier and Vilsmeier, 2010 and Briguglio, Cordina, Farrugia and Vella, 2009). To this end, central banks develop tools additional to their conventional tools (such as short-term interest rates) to conduct their policies. The present study provides empirical evidence from Turkey on the effectiveness of one of these tools: Central Bank Funding. Our evidence indicates that if the C.B.R.T. increases the cost of borrowing for short-term loans for commercial banks and thus decreases all types of lending, a lower cost of funding is associated with higher lending. When we examine the asymmetric effects of C.B.F. on lending choices, then:

- i. There is no *sign asymmetry* in terms of commercial lending.
- ii. However, with tight monetary policy, C.B.s choose lending that has higher risk exposure and lower maturity for consumers. On the other hand, with a loose monetary policy, C.B.s extend their credit lines on the types of lending that have lower risk exposure and longer maturities for consumers.
- iii. Therefore, we may claim that there is *magnitude* (an increase versus decrease in C.B.F.) and *category asymmetry* (across different lending categories).

This study can be extended in various directions as C.B.F. also affects the liability side of commercial banks' balance sheets. First, a further study could analyse how deposits and their compositions are affected by C.B.F. changes. Second, as

Table 3. Dynamic asymmetric estimation with central bank (gross) funding.

Variable	Total Bank Loans		Total Credit Cards		Automobile Loans		Consumption Loans		Housing Loans		Commercial Loans	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	4.2802*	0.0579	0.4054*	0.0748	0.0222	0.2500	2.6279**	0.0217	0.7429**	0.0115	-0.0364	0.8702
CR _{t-1}	-0.0395*	0.0667	-0.0109	0.1943	-0.0069	0.2047	-0.0472**	0.0203	-0.0287**	0.0126	0.0002	0.9861
CBF _{t-1}	-0.1489**	0.0183	-0.0821**	0.0254	-0.0033	0.1933	-0.0487*	0.0886	-0.0425***	0.0060	-0.0063	0.8278
CBF _{t-1}	-0.1319**	0.0163	-0.0550*	0.0641	-0.0010	0.5493	-0.0164	0.5842	-0.0369***	0.0177	-0.0137	0.5683
ΔCR _{t-1}			-0.2432***	0.0000	0.1264**	0.0199	0.1476***	0.0051	0.1862***	0.0013		
ΔCR _{t-2}	0.2153***	0.0000			0.1841***	0.0018	0.1197**	0.0421				
ΔCR _{t-3}												
ΔCR _{t-4}	0.3511***	0.0000	0.3085***	0.0000	0.3133***	0.0000	0.2991***	0.0000	0.3180***	0.0000	0.2763***	0.0000
ΔCR _{t-5}					-0.2700***	0.0000						
ΔCR _{t-6}	-0.5759***	0.0000	-0.2728***	0.0000	-0.4210***	0.0000	-0.4314***	0.0000	-0.3422***	0.0000	-0.2567***	0.0000
ΔCR _{t-7}	-0.1910***	0.0000	-0.1544***	0.0022					-0.1340***	0.0100	-0.1537**	0.0111
ΔCR _{t-8}												
ΔCR _{t-9}	0.1750***	0.0004	0.2916***	0.0000	0.3247***	0.0000	0.1757***	0.0017	0.2317***	0.0000	0.2322***	0.0002
ΔCR _{t-10}												
ΔCR _{t-11}	-0.3097***	0.0000	-0.2744***	0.0000	-0.1214**	0.0252	-0.1502***	0.0079	-0.1665***	0.0017		
ΔCR _{t-12}					-0.1984***	0.0001						
ΔCBF _t												
ΔCBF _{t-1}					-0.0191**	0.0264			0.1882**	0.0104		
ΔCBF _{t-2}	-0.8028**	0.0161	-0.2586*	0.0505	-0.0242***	0.0030			0.1496**	0.0258		
ΔCBF _{t-5}									0.1383**	0.0430		
ΔCBF _{t-7}												
ΔCBF _{t-8}												
ΔCBF _{t-1}												
ΔCBF _{t-2}												
ΔCBF _{t-3}												
ΔCBF _{t-6}	-0.9731***	0.0058	-0.4948***	0.0004	-0.0223**	0.0136	-0.4063	0.0105			0.2197*	0.1013
ΔCBF _{t-11}					-0.0462***	0.0000	-0.5268***	0.0010			-0.2553*	0.0619
ΔCBF _{t-12}												
L ⁺ _{CBF}	-3.7690	0.1088	-7.5570*	0.0718	-0.4802**	0.0524	0.4705***	0.0029	0.2481***	0.0008		
L ⁻ _{CBF}	-3.3372	0.1223	-5.0606*	0.0864	-0.1423	0.4771	-1.0326	0.1756	-1.4795*	0.0962	32.5026	0.9854
R ²	0.7329		0.7254		0.6143		-0.3479	0.6325	-1.2858	0.1543	70.8031	0.9859
Adj.R ²	0.7187		0.7079		0.5857		0.5766	0.5474	0.5387	0.3811	0.3516	
LM ⁽¹⁾	2.8468***	0.0013	1.9278**	0.0332	1.8808**	0.0389	1.5641*	0.1050	2.0124**	0.0251	1.6550*	0.0794
ARCH ⁽²⁾	1.1772	0.2014	1.0084	0.4816	2.1622***	0.0001	1.1435	0.2465	1.5334***	0.0132	1.2421	0.1405
RESET ⁽³⁾	1.8193	0.1789	0.0169	0.8968	0.7457	0.3889	0.1841	0.6683	0.0918	0.7622	0.3935	0.5312
JB ⁽⁴⁾	9.6180***	0.0081	0.1756	0.9159	4.7815*	0.0915	5.9126*	0.0520	6.3223**	0.0423	10.0632***	0.0065

(continued)



Table 3. Continued.

Variable	Total Bank Loans		Total Credit Cards		Automobile Loans		Consumption Loans		Housing Loans		Commercial Loans	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
⁽⁵⁾ t_{BDM}	-1.8437		-1.3021		-1.2723		-2.3393		-2.5185		0.0174	
⁽⁶⁾ F_{PSS}	3.0193		4.5593**		3.6584		4.6281**		10.3304***		1.7595	
⁽⁷⁾ W_{LR}	1.8393	0.1765	3.0678*	0.0814	8.0943***	0.0049	28.9803***	0.0000	3.4738*	0.0638	0.0003	0.9862
⁽⁸⁾ W_{SR}	6.5722***	0.0017	5.5222***	0.0012	12.3226***	0.0000	7.0916***	0.0000	6.7008***	0.0000	2.4544*	0.0642

Notes: LM and ARCH tests use six lags. RESET Test uses one lag. c indicates cointegration between two variables. (1) LM Test for Serial Correlation, F-stat. (2) ARCH Test for Heteroscedasticity, F-stat. (3) Functional Form, RESET Test, F-stat. (4) Jarque-Bera Test for Normality. (5) BDM Test. (6) PSS Test. (7) Wald Test for Long Run. (8) Wald Test for Short Run.

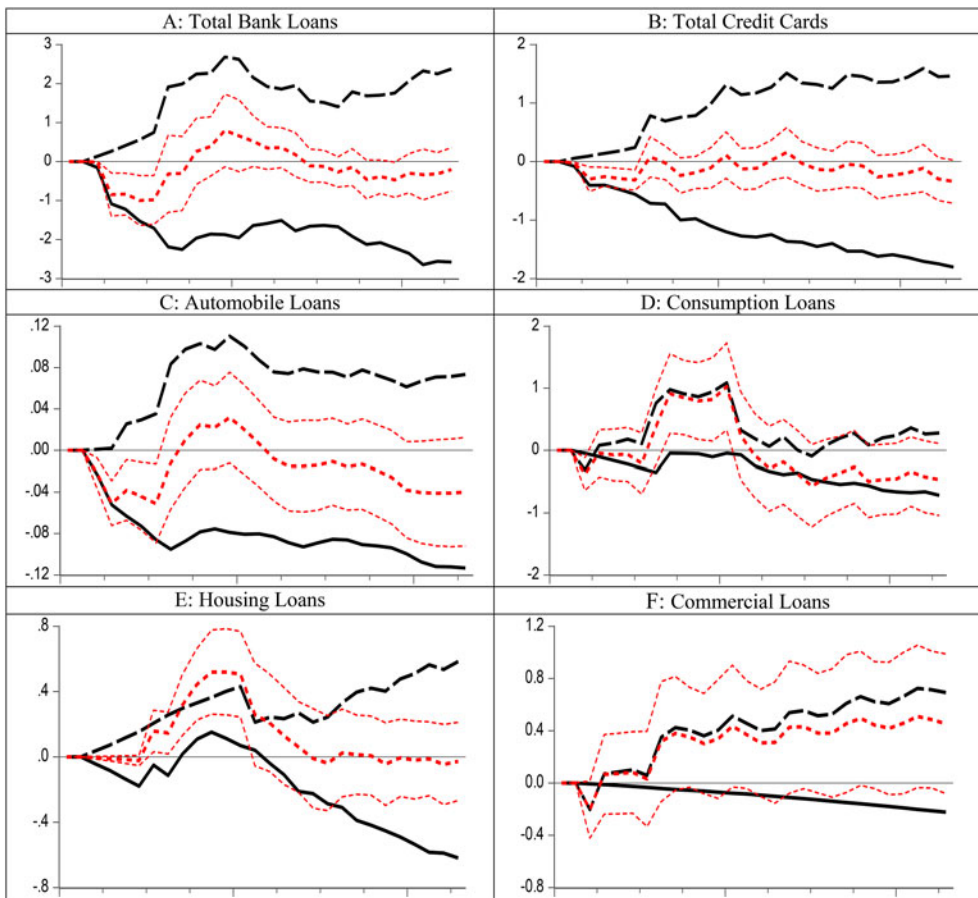


Figure 3. Central bank funding multipliers when required reserves are not excluded. Notes: The solid black line reports the dynamic multiplier for an increase in FN; the dashed black line is for a decrease in FN; the middle red line is for the difference in the absolute value of dynamic multipliers; the other two red lines are for the confidence bands for the differences.

commercial banks in developing countries tend to use their ability to borrow abroad to extend domestic credits, a study on how C.B.F. affects this borrowing mechanism through different channels, such as bond and swap markets, would be interesting. Third, as commercial banks have a high level of foreign exchange positions in their balance sheets, and may meet funding needs through these foreign exchange operations, the effect of C.B.F. on the foreign exchange market could be considered. And finally, one could conduct research on the effect of C.B.F. on small- and medium-sized businesses' liability dollarisation.

Notes

1. While these tools have been actively been used since the 2008 financial crises, the C.B.R.T. has been using multiple tools to conduct monetary policy (such as using overnight interest rates along with exchange rate) since 1986, though not independently (see Berument, 2007).

2. For example, the C.B.R.T. decreased its policy rate from 6.50 to 6.25 on 20 January 2011, and increased required reserve ratios on 24 January 2011.
3. Hakan Kara is the chief economist for the C.B.R.T.
4. Loan maturity may also affect C.B.F. effectiveness, as consumption loans generally have lower maturities than commercial loans do. Kara (2015b, p. 8) supports this proposition by suggesting that an increase in the average maturity of personal loans restricts monetary policy effectiveness; thus the C.B.R.T. may wish to restrict maturities on consumption loans.
5. We replicate Guler et al. (2014) by considering different types of banking sector credits that use a Vector Autoregressive (V.A.R.) framework with N.A.R.D.L.-E.C.M. We also perform the estimates with V.A.R., which are available upon request. The paper contributes to the V.A.R. versus A.R.D.L. debate in the empirical sense.
6. Erdem Başçı is a former governor of the C.B.R.T.; his tenure ended on 19 April 2016.
7. Central banks may also target credit growth rates, which are sensitive to interest rates, as argued by Fase (1995), and the C.B.R.T. does have a credit growth target rate of 15% (Varlik and Berument, 2016).
8. Further, the share of commercial and individual loans within C.B.s' Turkish Lira (T.L.)-denominated credit volume is 92% (source: C.B.R.T., Electronic Data Delivery System (E.D.D.S.)). Seventy percent of Turkey's banks are C.B.s, 96% of the total banking sector's assets consist of C.B.s and 95% of the sector's net profit belongs to C.B.s (source: Turkish Banking Association Statistical Database). Thus, the C.B.R.T. adopted a set of policies to affect this transmission mechanism (see, for example, Varlik and Berument, 2016).
9. For a more complete discussion of monetary policy developments, see also Varlik and Berument (2017).
10. The C.B.R.T. conducts O.M.O.s through eight channels, as provided in Chapter III, Article 52 of the Law on the Central Bank of the Republic of Turkey (Law No. 1211): liquidity bill issues, repo transactions through quotations, outright sales through auctions, outright purchases through auctions, repo auctions, outright purchases through quotations, reverse repo auctions and reverse repo transactions through quotations. The CBF is the sum of the repo and depo transactions, thus it is calculated by deducting the total sterilisation from the CBRT's total funding items. (Total funding is the sum of funding through auctions and funding through quotations, and total sterilisation is the sum of sterilisation through auctions and sterilisation through quotations.) These definitions and explanations are provided mostly based on information from the C.B.R.T.'s E.D.D.S. website: http://evds.tcmb.gov.tr/index_en.html.
11. One could look directly at the cost effects of C.B.R.T. lending on commercial bank lending. However, determining these effects is not an easy task. Note that the C.B.R.T. adopts a very complex structure for the liquidity it provides. For example, the overnight rate is not the same for all banks; market makers can get liquidity at a lower rate and the R.O.M. allows commercial banks to meet their required reserve obligations for T.L.-denominated deposits with foreign currency at a lower nominal interest rate (see Sahin et al., 2015).
12. Since interest rates in European countries and the United States are much lower compared with Turkey now and for the period we study, banks and big firms may choose to borrow in foreign currency (see Sahin and Sahin, 2014). The CBRT attempts to sterilise excess liquidity by automatic stabiliser tools such as the R.O.M.; however, in terms of T.L. borrowing, the C.B.R.T. is the lender of last resort in the financial market. Although foreign lending is dominant as a source of credit in terms of foreign currency, C.B.F. affects the credit allocation in the banking sector. That effect is beneficial in Stiglitz's (2015) sense, which claims that monetary policy affects credit availability through the banking sector.
13. Commercial banks must meet their obligations to the central bank within a two-week window; moreover, in order to guarantee the exogeneity of the denominator, we had to

deflate the variables with a month's worth of delay. Thus, the lag delay of the denominator was six.

14. One can claim that there is an omitted-variable bias because of not taking other control variables such as the central bank's open market operations into consideration while explaining the behaviour of banking sector lending. Papers such as Alper, Binici, Demiralp, Kara and Ozlu (2014) also include variables such as confidence index. However, our aim is to investigate the asymmetric behaviour in the dynamic specification and C.B.F. explains the credit growth sufficiently in econometric terms without an omitted variable bias.
15. In order to implement the general-to-specific approach, we set the lag order as 12 first, then drop the insignificant coefficients (starting from the least significant) until all included variables have individually statistically significant coefficients at the 5% level.
16. There are other types of E.C.M. in the literature. For instance, Sweiden (2011) benefits from asymmetric E.C.M. and explores a symmetric effect of policy rate on lending rate in the banking sector.
17. Here, the immediate effect of a one-unit increase in C.B.F. on CR is considered for h periods. If there is a case of low-level persistency, then it is assumed that the impact starts to diminish for longer horizons (see Verbeek, 2004, pp. 310–312).
18. One can assume that C.B.F. is an endogenous variable as in the V.A.R. analysis that we mentioned in the previous notes. However, in our specification and assumptions, C.B.F. that is keenly monitored by the C.B.R.T. is assumed to behave exogenously to the banking system.
19. Our specification in Equation (4) allows both long-run and short-run asymmetries. We also estimate a new set of multipliers under the restrictions with (i) no long-run asymmetry ($\theta^+ = \theta^-$), (ii) no short-run asymmetry ($\varphi_j^+ = \varphi_j^-$ for all j) and (iii) neither long-run nor short-run asymmetries ($\theta^+ = \theta^-$ and $\varphi_j^+ = \varphi_j^-$ for all j). Most of these dynamic multipliers are counter-intuitive. We did not include these figures to save space but they are available upon request.

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