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The Role of Macroprudential Policies on Controlling Credit Growth: The Case of Turkey[1]

Makro İhtiyati Politikaların Kredi Büyümesini Sınırlamadaki Rolü: Türkiye Örneği

Ali ILHAN, Tekirdağ Namık Kemal University, Turkey, ailhan@nku.edu.tr

Orcid No: 0000-0001-6201-5353

Metin OZDEMIR, Bursa Uludağ University, Turkey, mozdemir@uludag.edu.tr

Orcid No: 0000-0002-3944-4018

Kadir Yasin ERYIGIT, Bursa Uludağ University, Turkey, kyeryigit@uludag.edu.tr

Orcid No:0000-0001-6857-7402

Abstract: Following the global financial crisis, the quantitative easing policies implemented by developed countries to recover from the crisis led to large capital inflows into developing countries. In the face of macro-financial risks associated with capital flows, policy authorities had to deal with various policy dilemmas between price stability and financial stability. The need to support monetary policy with additional tools to ensure price stability and financial stability simultaneously has led many developing countries to increase the use of the macroprudential policy. Turkey is also among the emerging market economies exposed to the macro-financial risks caused by large capital inflows. Unable to control the risks that accumulated due to the divergence between domestic demand and external demand, the Central Bank of the Republic of Turkey began to implement a new policy mix from November 2010. To this end, the conventional inflation targeting was modified by incorporating financial stability as a supplementary objective without prejudice to price stability and monetary policy was conducted together with macroprudential policy. This study investigates the effectiveness of macroprudential policies to control excesses in credit growth under the new policy mix in Turkey. Different from the literature on Turkish experience, an index is constructed to analyze macroprudential policy. By employing cointegration approach with structural breaks of Johansen et al. (2000) the relationship between macroprudential policy index and real total credit growth was estimated covering the period from November 2010 to December 2017. Our empirical findings indicated that macroprudential policy implementations in Turkey have had a limiting effect on credit growth. However, this effect emerged after the tightening of the macroprudential policy stance was increased.

Keywords: Cointegration Analysis with Structural Breaks, Financial Stability, Macroprudential Policy, Turkish Economy

JEL Classification: C32, E52, E58, G18

Öz: Küresel finansal kriz sonrası dönemde, gelişmiş ülkelerin krizden çıkış için uyguladıkları niceliksel genişleme politikaları, gelişmekte olan ülkelere yönelik yoğun sermaye girişlerine neden olmuştur. Sermaye girişlerinin beraberinde getirdiği makro-finansal riskler karşısında politika otoriteleri, fiyat istikrarı ve finansal istikrar arasında çeşitli politika açmazları ile karşı karşıya kalmıştır. Fiyat istikrarı ve finansal istikrarın eş anlı sağlanmasında para politikasının ilave araçlarla desteklenme ihtiyacı, birçok gelişmekte olan ülkenin makro ihtiyati politika kullanımını arttırmalarına neden olmuştur. Türkiye de yoğun sermaye girişlerinin yol açtığı makro-finansal risklere maruz kalan yükselen piyasa ekonomileri arasındadır. Ekonominin iç ve dış dengesinin farklılaşmasıyla biriken riskleri mevcut politika çerçevesi ile kontrol altına alamayan Türkiye, yeni politika bileşimini Kasım 2010'dan itibaren uygulamaya başlamıştır. Bu doğrultuda geleneksel enflasyon hedeflemesi, fiyat istikrarına zarar vermeyecek şekilde finansal istikrarın tamamlayıcı bir araç olarak dahil edilmesiyle değiştirilmiş ve para politikası ile makro ihtiyati politika birlikte yürütülmüştür. Bu çalışma, Türkiye'de yeni politika bileşimi çerçevesinde uygulanan makro ihtiyati politikaların kredi büyümesindeki aşırılıkları kontrol altına almadaki etkinliği incelemektedir. Türkiye deneyimine ait literatürden farklı olarak, makro ihtiyati politikanın analizinde bir endeks oluşturulmuştur. Makro ihtiyati politika endeksi ile reel toplam kredi büyümesi

[1] This study is based on the PhD thesis of Ali İLHAN entitled "Finansal İstikrarı Sağlamaya Yönelik Makro İhtiyati Politikalar: Türkiye Örneği" ("Macroprudential Policies for Financial Stability: Evidence from Turkey") supervised by Assoc. Prof. Dr. Metin ÖZDEMİR at Bursa Uludağ University Institute of Social Sciences, Department of Economics.

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arasındaki ilişki, 2010:11-2017:12 dönemini kapsayacak şekilde Johansen vd. (2000) yapısal kırılmalı koentegrasyon yaklaşımı kullanılarak tahmin edilmiştir. Ampirik bulgular, Türkiye'de makro ihtiyati politika uygulamalarının kredi büyümesini sınırlayıcı etkisinin bulunduğunu göstermektedir. Bununla birlikte, söz konusu etkinin makro ihtiyati politika duruşunun sıkılaştırma derecesinin arttırılmasının ardından ortaya çıktığı görülmüştür.

Anahtar Kelimeler: Yapısal Kırılmalı Koentegrasyon Analizi, Finansal İstikrar, Makro İhtiyati Politika, Türkiye Ekonomisi

JEL Sınıflandırması: C32, E52, E58, G18

1. Introduction

According to Minsky (1977) and Kindleberger (1978), the financial system tends to become unstable following long periods of prosperity (Klingelhöfer and Sun, 2019). The most accurate indicator of financial instability is an increase in the volume of credit (Jorda et al. 2011). Excessive credit growth poses various threats to macro-financial stability through expansion in financial cycles -resulting in contraction. Acceleration of credit growth may cause overheating of the economy by increasing aggregate demand beyond its potential. Credit demand fueled by consumption and import demand leads to disruptions in macroeconomic indicators such as current account balance, inflation, and exchange rate (Hilbers et al. 2007). While credit grows excessively, the use of short-term external financing sources increases liquidity risk. Rising liquidity risk increases the vulnerability to sudden stops and sensitivity to global financial conditions (Seidler and Gersl, 2012).

The global financial crisis has demonstrated the devastating effects of the endogenous risks accumulated due to excesses in credit growth and brought about a new expansion in the financial cycle. The quantitative easing policies implemented by developed countries to recover from the crisis caused large capital inflows to emerging countries. Increasing capital inflows, easing of credit conditions, the appreciation of local currencies, and the rising asset prices exposed policy authorities to various policy dilemmas between price stability and financial stability. The expansion of credit volume and the tightening of monetary policies aimed at securing price stability accelerated capital inflows further, while the lowering of interest rates intended to slow down capital inflows caused expansion of credit and overheating of the economy by stimulating domestic demand (Pereira da Silva, 2016). The difference between the interest rates that ensures price and financial stability has led to the need to support monetary policy with additional tools (Başçı and Kara, 2011). Accordingly, many developing countries have turned to policy frameworks in which monetary policy and macroprudential policy are conducted together.

Macroprudential policy is a policy area in which uses primarily prudential instruments to control systemic risks[2] and to strengthen the resilience of the overall financial system against possible shocks and to increase the effectiveness of other economic policies (FSB et al. 2011). Utilizing regulatory and supervisory instruments, it is aimed to reduce procyclical bias in the financial system and to limit the risks that may occur during periods of boom and bust of the financial cycle. The fact that macroprudential instruments can be used to moderate asset and credit cycles has led to an increase in practices of macroprudential policy, especially in developing countries, following the global financial crisis.[3]

Turkey is one of the emerging market economies exposed to the macro-financial risks caused by large capital inflows. Due to the global liquidity conditions, which were loosened in the post-crisis period, credit growth accelerated, the Turkish Lira (TL) was overvalued and the current account balance deteriorated. The policy dilemmas experienced by the current policy framework in controlling the accumulation of risks due to differentiation in the domestic and external demand have necessitated a new policy framework that considers macro-financial stability. In this direction, the Central Bank of the Republic of Turkey (CBRT) began to implement a new policy mix from November 2010 (Başçı and Kara, 2011).

Slowing short-term capital inflows and controlling credit growth are adopted as intermediate targets in the new policy mix. The conventional inflation targeting was modified by adopting financial stability as a supplementary objective without prejudice to price stability. Therefore, macroprudential policy and monetary policy were conducted together. While price stability remains the ultimate goal of monetary policy, the scope of the new policy mix has been expanded to take into account the macro-financial risks that may be stemmed from global liquidity conditions. Accordingly, the CBRT's toolkit was diversified with new tools such as the reserve option mechanism (ROM)[4] and asymmetric interest rate corridor[5], and traditional tools such as required reserves used for macroprudential targets. Furthermore, regulatory and supervisory agencies responsible for ensuring financial stability, notably the Banking Regulation and Supervision Agency (BRSA), also played an active role in the new policy mix.

[2] Although there is no universally agreed definition of systemic risk, the definition given in the FSB et al.'s (2009: 5-6) G20 report is regarded as a reference. According to this, systemic risk is defined as "*the risk of disruption to financial services that is caused by an impairment of all or parts of the financial system and has the potential to have serious negative consequences for the real economy*".

[3] Cerutti et al. (2018) developed an index for the use of macroprudential tools in 119 countries. Accordingly, while the index value for developing countries was 2 in the year 2008, this had risen by 50% to 3 by the year 2015.

[4] The ROM is a new countercyclical macroprudential instrument developed by the CBRT on reserve requirements which allow banks to hold a certain percentage of TL required reserves in the form of gold or foreign exchange. The aim of ROM is to soften the effects of fluctuations in capital flows on the financial system and the exchange rate, to allow more flexibility for banks' liquidity management, and to strengthen foreign exchange reserves (Ermişoğlu et al. 2013: 2).

[5] The interest rate corridor, which is used to ensure that market interest rates are set close to policy interest rates in the orthodox form of inflation targeting, was transformed into an active policy instrument in the new policy mix with the uncertainty created based on the predictability of short-term interest rates and width of the corridor (Kara, 2012: 8-9).

Under the guidance and coordination of the Financial Stability Committee (FSC), these institutions have been the designers and implementers of macroprudential measures to support the CBRT's individual efforts (Kara, 2016).

The first pillar of the new policy mix, built on two intermediate targets, focused on slowing short-term capital inflows. Thus, it was aimed to deter speculative capital inflows, to bring exchange rate movements closer to macroeconomic fundamentals, and to limit the macro-financial risks that may arise from the sudden stop in external financing. To this end, the CBRT has used a wide interest rate corridor and low policy rate with the contribution of the inflation rate below the targeted level. The interest rate corridor was enlarged downwards, allowing interest rates in the overnight market to be lower than the policy rate and to follow a fluctuating course. The CBRT tried to reduce speculative capital inflows by lowering the average yields and increasing the volatility of overnight market rates (CBRT, 2011: 3; Başçı and Kara, 2011: 5).

The second pillar of the policy mix aimed to limit the expansion in credit. Accordingly, required reserves were used as a macroprudential tool. The scope of required reserves was expanded and required reserve ratios were gradually differentiated as maturity and currency (CBRT, 2010). However, banks reacted to reduce the effect of rising reserve requirements on the supply of credit. Banks' reduction in profit margins and borrowing from CBRT through open market transactions caused an increase in credit growth (IMF, 2017: 69).

Inadequate measures taken by the CBRT to slow down the credit growth caused other institutions responsible for financial stability to get involved in the new policy mix. Accordingly, a series of macroprudential tightening measures were introduced by BRSA in June 2011. During this period, which can be called the first macroprudential tightening period, various regulations were made to control the growth in consumer loans and to reduce the indebtedness levels of households. Against the renewed acceleration of credit growth, which declined to 15% in the last quarter of 2012, more comprehensive and stricter measures were introduced in the last quarter of 2013. In the second macroprudential tightening period, new regulations were implemented in addition to the tightening of existing regulations for consumer loans and consumer credit cards (CBRT, 2014: 51-60).

The tight macroprudential policy stance was not followed throughout the new policy mix. In the second half of 2016, the significant slowdown in loan growth due to the series of negative domestic and external shocks has become a major threat to weakening economic growth. Since the CBRT's efforts to support credit growth through interest rate cuts and required reserves did not yield the expected results, several macroprudential regulations were loosened or abolished from September 2016 (BRSA, 2017: 45-51).

Frequent use of macroprudential tools under the new policy mix has led to the need for an investigation of the effectiveness of macroprudential policies.[6] Many cross-country studies were analyzing the effectiveness of macroprudential policies of emerging market economies including Turkey. But, the number of studies dealing with the relationship between macroprudential policy and credit growth related to the Turkish experience is very limited. Furthermore, these studies have focused on the effects of a single/several tools rather than the macroprudential policy stance. This study explores the effectiveness of macroprudential policies to control excessive credit growth in Turkey. Different from the literature on Turkish experience, an index is constructed to analyze macroprudential policy. By employing cointegration approach with structural breaks of Johansen et al. (2000) the relationship between macroprudential policy index and real total credit growth was estimated covering the period from November 2010 to December 2017. Our empirical findings revealed that macroprudential policy implementations in Turkey have had a limiting effect on credit growth.

The remainder of the paper is organized as follows. Section 2 reviews the literature on the relationship between macroprudential policy and credit growth. Section 3 introduces the data and methodology and the construction of the macroprudential policy index. Section 4 provides the empirical findings. Section 5 concludes the paper.

2. Literature Review

Frequent use of macroprudential instruments in the post-crisis period has also increased the attention in empirical studies to address the effectiveness of these instruments in limiting excessive credit growth. Data constraints due to the short history of macroprudential policy implementation have led to the formation of literature where cross-country studies are predominant.

The relationship between macroprudential policy and credit growth has been analyzed with large data sets including many countries and many instruments, in the literature. Lim et al. (2011) found that macroprudential instruments limited the procyclical bias in credit growth in their study covering 49 countries from 2000 to 2010. They also indicated that there is no relationship between the effectiveness of macroprudential tools and exchange rate regimes and the size of financial systems. Dell'Ariccia et al. (2012) concluded that macroprudential tools were effective for bringing excessive credit growth under control and reducing the possibility of credit bubbles bursting. However, they emphasized the difficulty of restraining credit bubbles in financially open economies by using macroprudential instruments alone.

[6] Göver and Oğuz (2017) stated that 93 macroprudential regulations were put into practice in Turkey between 2010 and 2015.

Akinci and Olmstead-Rumsey (2015) investigated the effectiveness of macroprudential policies in 57 developing and developed countries between 2000 and 2013 with a policy index consisting of 7 instruments. Their empirical results revealed that there is a significant relationship between the tightening of macroprudential instruments and the slowdown in the growth rate of bank and housing loans. In the study by Cerutti et al. (2015) dealing with 119 countries between 2000 and 2013, it was found that macroprudential policies had strong effects on limiting credit growth. Also, these policies were more effective during expansions rather than the contraction periods. By analyzing 30 developing countries for the period of 2000-2013, Erdem Küçükbıçakçı et al. (2020) also found that the restrictive effects of macroprudential instruments were greater, particularly in the expansion phase of the credit cycle.

Zhang and Zoli (2016) analyzed 46 countries, including 13 Asian countries, from 2000 to 2013. They concluded that housing-related tools, especially debt-to-income (DTI) and loan-to-value (LTV) caps, were effective in restricting credit growth in Asian countries, while this limiting effect was quite low for other countries. Analyzing 57 countries for the period 1980-2011, Kuttner and Shim (2016) found that tightening the DTI cap reduced housing loans by 4-7% in the following year. Fendoğlu (2017), showed that borrower-based instruments and required reserves are effective in moderating credit cycles. Dumicic (2018), which studied 11 Eastern and Central European countries in the period 2000-2013, demonstrated that macroprudential policies were successful in reducing the credits for households. By using panel data analysis covering 136 countries between 1990 and 2016, Alam et al. (2019) concluded that LTV restrictions significantly reduced household loans. Moreover, they found that macroprudential policy also had side effects restricting household consumption, but this effect was less than the impact on credit growth.

It is possible to state that there is a consensus in the literature that macroprudential policy has limiting effects on credit growth. However, some studies emphasize the policy dilemmas caused by the interaction between macroprudential policy and monetary policy. Analyzing 4 Asian countries for the period 2000-2012, Kim and Mehrotra (2017) indicated that since the macroprudential policy had negative effects on prices and real GDP -similar to the monetary policy- the simultaneous effects of monetary policy and macroprudential policy need to be carefully managed. Kim (2019) found a significant negative relationship between credit conditions and macroprudential policy in the period 2000-2014 in 11 Asian countries. He also suggested that policy conflicts might arise in case of credit expansion while the economy is in recession due to the similar relationship between macroprudential policy and output. Contrary, Klingelhöfer, and Sun (2019), which examined China for the period 2000-2015, concluded that while the restrictive effects of macroprudential policy on credit growth, there are no effects on

output. Therefore, it is possible to use macroprudential tools alone to achieve financial stability without compromising growth or as a complement for balancing the effects of monetary policy that create financial instability.

As a result of the expansion of the data set on macroprudential policy, the number of studies analyzing the effectiveness of macroprudential policy stance has increased gradually through country-specific indices. Epure et al. (2018) found a significant relationship between the tightening of macroprudential instruments and the decrease in household loan growth in their studies covering the period 2004-2012 for Romania. Moreover, they indicated that the quantitative effect of macroprudential policies on borrowers was higher than that of lenders. Analyzing the 2000-2017 period for India, Verma (2018) concluded that the tightening in macroprudential policies reduced credit growth with a one-year delay. Focusing on 60 banks in Malaysia from 2006 to 2017, Rauf (2018) found a negative and significant relationship between macroprudential policies and credit growth. Anh et al. (2018) suggested that macroprudential instruments aimed at tightening credit conditions in Vietnam for the period 2000-2016 were effective in controlling the excesses in credit growth.

The empirical findings in the literature concerning the negative and significant effects of macroprudential policy on credit growth have also been found in studies on Turkey. Binici et al. (2013) indicated that the asymmetric interest rate corridor is a macroprudential instrument that can be used to control credit growth by affecting credit spreads. Similarly, Bulut (2015) demonstrated that the uncertainty created by the interest rate corridor on the number of funds and fund costs had a limiting effect on loans. Bumin and Taşkın (2016) found a negative and significant relationship between macroprudential measures taken by BRSA and consumer loans. Yüceyılmaz et al. (2017) showed that the BRSA's regulations related to the limitation of maturities and general provisions had restraining effects on consumer loans. Alper et al. (2018) concluded that the reserve requirement policy affects credit growth through lending behaviors.[7]

3. Data and Methodology

In the study, monthly data covering the period from November 2010 to December 2017 were used. The starting date of the data set was based on the date on which the CBRT's new policy mix was begun.[8] As of May 2018, CBRT completed the normalization of its monetary policy and abandoned the new policy mix. Therefore, the data set was ended 2017:12 (CBRT, 2018).

[7] In addition to studies analyzing the effects of macroprudential tools on credit growth, there are also studies in which their effects on the exchange rate are examined. These include Ermişoğlu et al. (2013), Değerli and Fendoğlu (2015), Doğan et al. (2016), and Gök (2017).

[8] The announcements made by the CBRT officials indicate that the new policy mix began in November 2010 (Özatay, 2011: 31).

In this study, the vector of the endogenous variables can be specified as follows:

$$Y_t' = [crdt_t \quad mpr_t \quad r_t \quad cds_t] \tag{1}$$

Where ($crdt_t$) represents real total credit growth, (mpr_t) stands for macroprudential policy index. The real rate of return (r_t) reflecting monetary policy stance, and the credit default swap (CDS) premium (cds_t) reflecting external conditions are included in the analysis as control variables.

3.1. Macroprudential Policy Index

During the macroprudential policy process, many tools can be used at the same time and the frequency of implementation/changing of the tools can be high. This makes it difficult to analyze the effectiveness of each tool on the targeted variable independently from the other tools. Furthermore, it is not possible to ascertain a policy stance by separately analyzing the effectiveness of the macroprudential tools on the targeted variable. Accordingly, an aggregated index was constructed to achieve the macroprudential policy stance in Turkey based on the method used in the studies by Kuttner and Shim (2016), Cerutti et al. (2017), Fendoğlu (2017), and Epure et al. (2018).

In an aggregated index reflecting the macroprudential policy stance, it is not possible to display the instruments with continuous variables. Therefore, macroprudential instruments are represented as, 0, -1, +1 in the index. The index was based on the monthly frequency and the direction of macroprudential instruments. Accordingly, the months in which an instrument to restrict credit growth was implemented/changed were coded as "+1", while the months in which an instrument to support credit growth was implemented/changed were coded as "-1". Months, when no macroprudential instrument was implemented/changed, were given the value "0".

In cases where more than one instrument was implemented/changed within the same month, the value of that month may be higher or lower. For example, a month in which three new regulations aimed at tightening were put into practice, and in which the degree of tightening was increased for two regulations already in force, was coded as "+5". On the other hand, if the two regulations aimed at loosening in a month were implemented/changed whereas five regulations for tightening were implemented/changed, the relevant month was coded as "+3". In other words, the coding was made by considering the "net tightening/loosening" situations in the given month. In this context, the preferred coding mode allows measuring the timing, intensity, and direction of the policy change. The macroprudential policy index obtained in the framework of the coding method described above is shown in Figure 1.

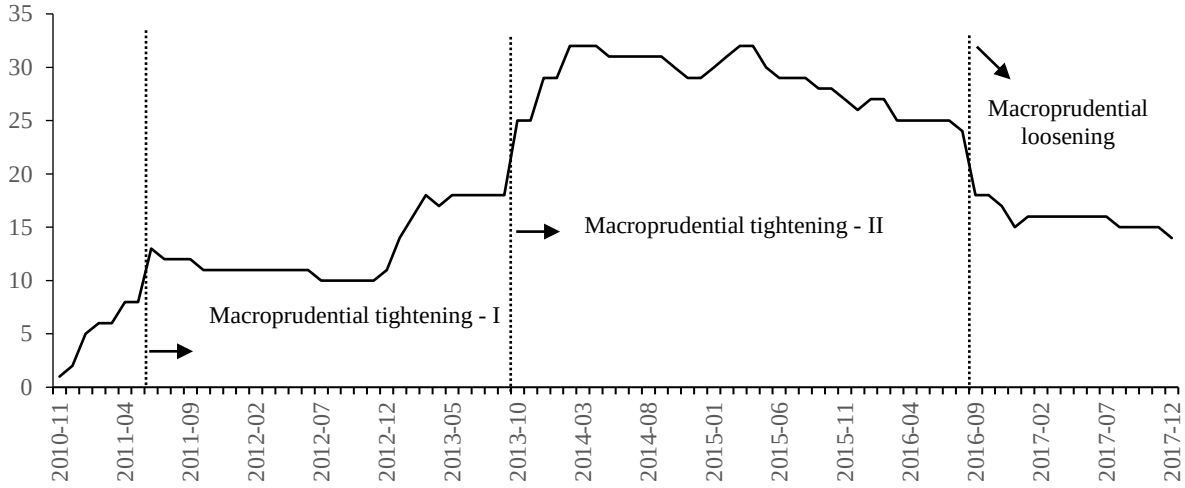

Figure 1. Macroprudential Policy Index
Source: Authors' calculations based on the CBRT, BRSA, Republic of Turkey Ministry of Treasury and Finance, the Savings Deposit Insurance Fund

The cumulative sum of the coded values for the instruments was taken into account while constructing the macroprudential policy index. The index created for the period from November 2010 to December 2017 and having values ranging from 1-32 reached its highest value in February 2014, and decreased to 14 in December 2017. In this respect, the index allows the measurement of both the direction and the level of macroprudential policy stance in a given period (Cerutti et al. 2017: 483-484).

The macroprudential policy index was comprised of the instruments used to limit credit growth in the banking sector. These include measures such as credit and credit card regulations (maturity restrictions, LTV caps, and DTI ceilings e.g.), capital adequacy ratios, general provisions, and reserve requirements. However, not all macroprudential instruments used under the new policy mix to ensure financial stability are included in the index. Despite their indirect effects on credit growth, ROM and interest rate corridor have been used in the new policy mix to moderate the effects of fluctuations in short-term capital movements on financial markets and exchange rates. Both instruments were excluded from the index as the index was formed for the analysis of the effects of macroprudential instruments on credit growth.

3.2. Description of Variables

Various processes were performed to make the variables usable in the analysis. To derive the real total credit growth, the total credit volume series in the banking sector was seasonally adjusted using the Census X-13 method. Then, the related series were adjusted for inflation and the annual percentage change was calculated. The macroprudential policy index was included in the analysis in logarithmic form. For calculating the real rate of return, the one-week repo

rate, which has been the policy interest rate of the CBRT from May 2010, was used as the interest rate.[9] The CDS premium was converted into logarithmic form.

Table 1. Descriptive Statistics

Variables	Source	Mean	Std. Dev.	Min.	Max.	Jarque-Bera	Prob.
$crdt_t$	BRSA	0.141	0.077	0.010	0.310	8.436	0.015
mpr_t	Authors	19.244	8.596	1.000	32.000	5.397	0.067
r_t	CBRT	-0.012	0.018	-0.048	0.022	2.575	0.276
cds_t	Datastream	209.765	46.998	118.728	303.781	3.294	0.193

In the period under consideration, real total credit growth fluctuated in a wide band. The real credit growth rate, which fluctuated between 1% and 31%, received its lowest value in August 2016, when loosening policies aimed at encouraging credit growth began. It reached its highest value in September 2011 at the beginning of the first macroprudential tightening period. Moreover, it is possible to state that the average period of real total credit growth is in line with the reasonable credit growth expressed by CBRT officials.[10]

The macroprudential policy index followed an upward trend until September 2016, when the policy stance was changed, and a declining course from that date. The macroprudential policy index, which had the lowest value at the beginning of the period, reached its highest value in February 2014 with the start of the second macroprudential tightening period. The average of the index, where high values reflect the tightening in macroprudential policy stance, was 19.24 indicates that a relatively tight macroprudential policy stance was pursued to limit credit growth in this period.

It is possible to explain the negative mean of the real rate of return in the period under consideration with the intermediate objective of slowing short-term capital inflows. The CBRT, which tries to control credit growth through credit supply, seems to exhibit a policy behavior towards negative real interest rates in the period under consideration. Moreover, the CDS premium, which was 251.91 on average in November 2008-October 2010, was 209.76 on average. Also, the CDS premium, which started to rise with the European debt crisis, reached its highest value in January 2012 and recorded its lowest value in May 2013.[11]

Jarque-Bera values were calculated to test whether the error terms of the series were normally distributed. Accordingly, all series except the real total credit growth with a marginal significance level (probability value) of less than 5% to exhibit a normal distribution.

[9] For converting the policy interest rate into the real rate of return, the formula $[(1+i)/(1+\pi)]-1$ is used.
[10] Kara et al. (2013), found that 15% reference value for the credit growth rate is reasonable and healthy for Turkey.
[11] The CDS premium increased from 118.72 in May to 177.49 in June following the announcement of the "*taper talk"* by Federal Reserve (FED) governor B. Bernanke on 22 May 2013.

3.3. Econometric Methodology

For analyzing the relationship between macroprudential policy and credit growth, Johansen et al.'s (2000) cointegration approach was used. This approach, which enables estimation of long-run relationships between time series, also takes into account the possible structural breaks that may appear in time series.

Cointegration analysis is a method used for investigating long-run relationships between non-stationary time series. Johansen et al.'s (2000) cointegration test with structural breaks is a method that can be used in cases where time series for which long-run relationships are sought contain one or two structural breaks for the period examined. This approach is the version, revised with small changes, of the cointegration test based on the vector error correction model (VECM) developed by Johansen (1988) and Johansen and Juselius (1990).

If Y_t given in Equation (1) is defined as first-order integrated, *p*-dimensional and in the form of an endogenous variable vector which includes an *r* number of cointegrating vectors, then the model suggested by Johansen et al. (2000) can be expressed in VECM form as follows:

$$\Delta Y_t = \alpha \begin{pmatrix} \beta \\ \gamma \end{pmatrix}' \begin{pmatrix} Y_{t-1} \\ tE_t \end{pmatrix} + \mu E_t + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \sum_{i=1}^{k} \sum_{j=2}^{q} \psi_{j,i} D_{j,t-1} + \sum_{m=1}^{d} \phi_m W_{m,t} + \varepsilon_t \quad (2)$$

Here, Δ is the first difference operator, while k represents the lag length. For $T_{j-1} + k \leq t \leq T_j \ (j = 1, \ldots, q)$, $E_{j,t} = 1$, and in other cases for zero, a q number of dummy variable vectors is expressed as $E_t = [E_{1t} \quad E_{2t} \quad \ldots \quad E_{qt}]'$. The first *k* observation in the subsample of the effect shown by $E_{j,t}$ is equated to zero. $D_{j,t-1}$ is an indicator function for the *i*th observation in the *j*th period, and if $t = T_{j-1+i} \ (j = 1, \ldots, q)$, then $D_{j,t-i} = 1$ and the others are "impulse" dummy variables that are zero. As suggested by Hendry and Mizon (1993), to normalizing the residuals, the "intervention" dummy variable shown by $W_{m,t} (m = 1, \ldots, d)$ is added to the model. β is the $(p \times r)$-dimensional coefficient matrix expressing the speed of adjustment to long-run equilibrium, while $\gamma = [\gamma_1 \quad \gamma_2 \quad \cdots \quad \gamma_q]'$ is the$(q \times r)$-dimensional matrix of the long-run trend coefficients. For $i = 1, \ldots, k-1$, Γ_i with $(p \times r)$ dimension; for$j = 2, \ldots, q$, $i = 1, \ldots, k$ and $m = 1, \ldots, d$, $\mu = [\mu_1 \quad \mu_2 \quad \cdots \quad \mu_q]$ with $(p \times r)$ dimension; $\psi_{j,i}$ with $(q \times 1)$ dimension; and ϕ_m with $(q \times 1)$ dimension are short-run parameter matrices and vectors. $\beta' Y_t + \gamma' t E_t$ expresses stationarity around the level and trend breaks for each subsample period.

Equation (2) above is the linear trend model in which the trend and level of the cointegration relationships vary between periods, and is named $H_l(r)$. It can be seen here that for $\alpha\beta' = \Pi_{pxp}$ and $\alpha\gamma' = \alpha[\gamma_1, \ldots, \gamma_q] = [\Pi_1, \ldots, \Pi_q]_{pxq}$, if the rank is $(\Pi, \Pi_1, \Pi_2, \ldots, \Pi_q) \leq r$, the deterministic component of each subsample is linear both for the cointegration relationship and

for non-stationarity. In the presence of an r number of cointegrating vectors in the linear trend model, the tested hypothesis is in the form of $H_l(r)$: rank $(\Pi, \Pi_1, \Pi_2, \ldots, \Pi_q) \leq r$. By using canonical correlation and estimating the $1 \geq \tilde{\lambda} \geq \ldots \geq \tilde{\lambda}_p \geq 0$ squared sample canonical correlation values, the trace test for the r cointegration relationship $H_l(r)$ hypothesis against the $H_l(p)$ the alternative is as follows:

$$LR\{H_l(r) \parallel H_l(p)\} = -T \sum_{i=r+1}^{p} ln(1 - \tilde{\lambda}_i) \quad (3)$$

If there is only a break instead of a linear trend in the cointegration relationship, then Equation (2) is transformed into the $H_c(r)$ model. As suggested by Johansen et al. (2000), the critical values of both the $H_l(r)$ and the $H_c(r)$ models are derived from Gamma distribution.

When the data are the number of cointegrating vectors, to test for weak exogeneity of the variables in the system, the recommended approach is that discussed by Harris and Solis (2003) in a standard framework. These tests are expanded in this study as in that of Dawson and Sanjuan (2006) for the models suggested by Johansen et al. (2000).

4. Empirical Findings

Prior to conducting cointegration analyses, it is first necessary to determine whether or not the process that creates series in the system is stationary. Accordingly, in the study, Lee and Strazicich's (2003) Lagrange multiplier (LM) unit root test, which enables examination of single-variable time series characteristics of series when there are structural breaks, was used. Table 2 represents the results of the unit root test.

Table 2. Unit Root Test Results

Variables	Model	Lag	Break Times	λ	t-statistics	Critical Value
$crdt_t$	C	2	2011:09 2013:07	0.2 0.4	-3.95	-5.59
mpr_t	C	5	2013:02 2016:08	0.4 0.8	-3.90	-5.65
r_t	C	6	2013:11 2017:02	0.4 0.8	-4.72	-5.65
cds_t	C	5	2012:07 2015:10	0.2 0.8	-5.22	-5.71

Notes: Critical values at the 5% significance level were obtained from Lee and Strazicich (2003, 2004).

It can be understood from the results of the unit root test that the series were non-stationary at the level value and where I(1). The absolute values of the *t*-statistics calculated for all series were below the critical values obtained according to the break periods. The fact that all series contained a unit root at level value meant that there would be no equilibrium problem that might be encountered in terms of the degree of integration during the cointegration analysis process.

Another finding that can be obtained from the results of a unit root test is whether or not the series contain significant structural breaks. Accordingly, all series included in the study had significant structural breaks. The structural breaks in real credit growth are shown in Figure 2.

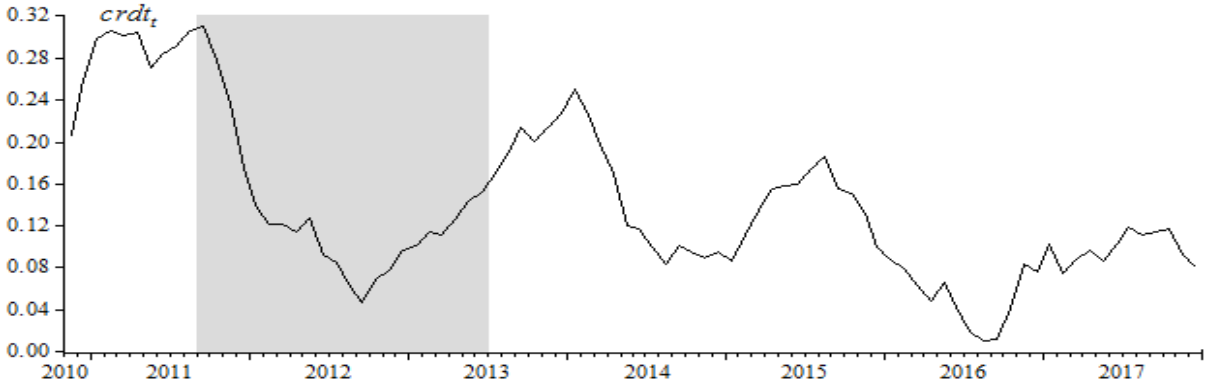

Figure 2. Structural Breaks in Real Credit Growth

Figure 2 indicates that the structural breaks in real credit growth coincide with periods of macroprudential tightening. The first break points to June 2011, when the BRSA implemented several measures to limit credit growth, and the second break points to October 2013, when existing measures were further tightened or new tightening regulations were introduced. Between the two break periods, real credit growth tended to decline after the beginning of the first macroprudential tightening period. It is possible to state that the improvement in global financial conditions and the gradual decrease in the effect of macroprudential measures were effective in the real credit growth to rise again since the second half of the related period.

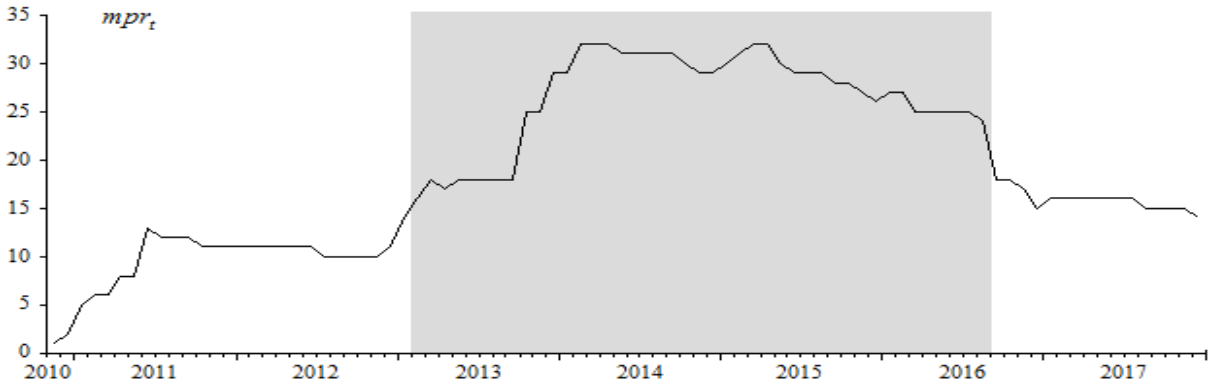

Figure 3. Structural Breaks in Macroprudential Policy Index

As expected, the structural breaks in the macroprudential policy index coincide with the periods in which the macroprudential policy stance changed. Consequently, the first break occurred before the beginning of the second tightening period. The second break points to September 2016, when the macroprudential policy stance began to be loosened. At the beginning of the period between the two breaks, the level of tightening was increased for a certain time. Partial easing towards the end of the period signaled the change in macroprudential policy stance.

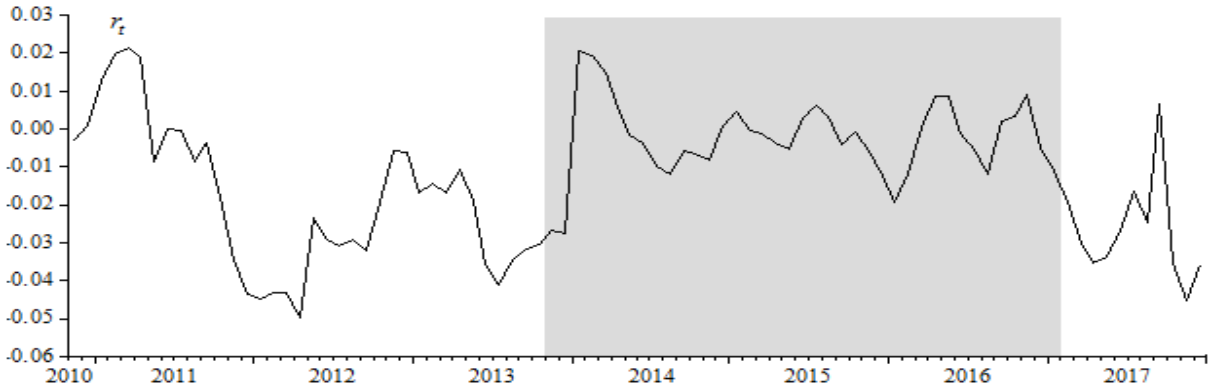

Figure 4. Structural Breaks in Real Rate of Return

As shown in Figure 4, the structural breaks in the real rate of return reflect the impact of the course of inflation as well as the monetary policy stance. The first break is strongly associated with the sharp increase in policy interest in January 2014. During this period, CBRT reacted to the tightening in global financial conditions due to the FED's signals for interest rate hikes, albeit with a delayed increase in policy rate from 4.5% to 10%. However, it is possible to state that inflation was more effective than interest rates in the second break. In this period, the policy rate, which has been kept constant for a long time against the rise in inflation, caused the real rate of return to fall into a downward trend.

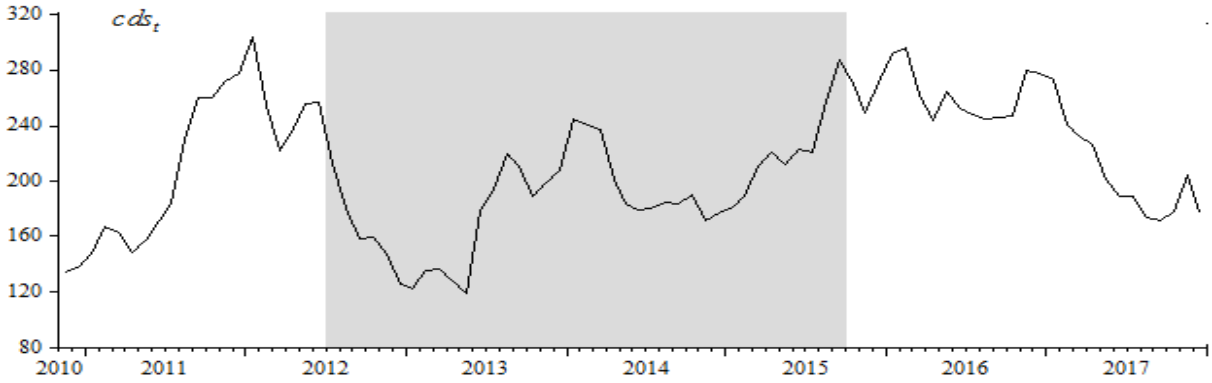

Figure 5. Structural Breaks in CDS Premium

The macroeconomic performance of the Turkish economy and changes in global liquidity conditions have an impact on the structural breaks of the CDS premium. The first break occurred in the second half of 2012 when inflation and credit growth were under control due to the tightening of monetary policy and macroprudential policy stance, and the tendency of balancing between domestic demand and external demand began. The second break came after the strengthening signals that the unconventional monetary policies of the developed countries would come to an end. In this period, which corresponded to the last quarter of 2015, the CDS premium increased and started to fluctuate due to the CBRT's relatively unresponsive monetary policy stance against these signals.

Following the examination of the stationarity characteristics of the series in the presence of structural breaks, to investigate the long-run relationship between real credit growth and the macroprudential policy index, a cointegration process which considered the dates of the breaks was begun. Firstly, trace test statistics and then the statistics related to VECM restriction tests were calculated.

For calculating the trace test statistics, the dates of September 2011 and July 2013, which were the significant breaks in the real credit growth variable, were used as the pair of endogenous breaks which we obtained from the unit root test with structural breaks. For the selection of suitable lag length, the Akaike Information Criteria (AIC) were utilized. Since the AIC minimum value is at the first lag, the lag length was taken as $k = 1$. Table 3 shows the trace test statistics for the September 2011-July 2013 pair of endogenous breaks.

Table 3. Trace Statistics for Endogenous Break Pair 2011:09-2013:07

Pair of Breaks	Model $H_0(H_1)$	Model $H_l(r)$
2011:09–2013:07	$r = 0$ $(r \geq 1)$	150.38 (97.79)
	$r = 1$ $(r \geq 2)$	67.82 (68.84)
	$r = 2$ $(r \geq 3)$	37.35 (43.87)
	$r = 3$ $(r \geq 4)$	11.37 (22.69)

According to the trace test results, one cointegrating vector, $r = 1$ was found for the $H_l(r)$ model which includes level and trend breaks in the long term. The existence of a cointegrating vector for the pair of breaks indicates that there may be a long-run relationship between real credit growth and the macroprudential policy index.

While there was one cointegrating vector, the significance of the weak exogeneity characteristics and the structural breaks of the series was tested with likelihood ratio (LR) statistics based on the restrictions on the VECM. Then, the long-run elasticity coefficients were calculated by normalization of the variables.

As shown in Table 4, while the null hypotheses for weak exogeneity are rejected for real credit growth and the macroprudential policy index, they cannot be rejected for the real rate of return or CDS premium. In other words, while real credit growth and macroprudential policy index are endogenous, other variables are exogenous. These findings allow us to analyze the effectiveness of macroprudential policy in limiting credit growth. It also makes it possible to fix the direction and extent to which macroprudential policy usage may change in the face of changes in credit growth.

Table 4. Identified Long-run and Adjustment Coefficients Matrices and Identification Test Results for Endogenous Break Pair 2011:09 and 2013:07

Weak exogeneity	H_0	LR - statistics	Structural break	H_0	LR - statistics
$crdt_t$	α_{crdt}	14.753 (0.000)	2011:09	$\gamma_1 = \gamma_2$	0.082 (0.773)
mpr_t	α_{mpr}	40.612 (0.000)			
r_t	α_r	1.658 (0.197)	2013:07	$\gamma_2 = \gamma_3$	13.747 (0.000)
cds_t	α_{cds}	2.378 (0.122)			

Identified equations	β_{crdt}	β_{mpr}	β_r	β_{cds}	γ_1	γ_2	γ_3
$crdt_t$	1	-0.249	0.545	-0.071	0.044	0.018	-0.003
mpr_t	0.550	1	1.886	-0.172	-0.025	0.026	-0.017

In testing the significance of structural breaks in the long-run equilibrium relationship, the null hypothesis indicates that there is no statistically significant difference between the sub-periods separated by structural breaks in terms of level and trend behaviors. According to the test statistics in Table 4, while the null hypothesis is not rejected in the structural break that occurred in September 2011, the null hypothesis is rejected in the July 2013 break. In other words, only the 2013:07 break was found to have a statistically significant effect on long-run relationships between the variables.

The effectiveness of macroprudential measures implemented after 2013:07 on limiting credit growth may be explained by the tightening of the macroprudential policy stance. After October 2013, macroprudential measures to limit credit growth were increased and the scope of these measures was expanded. In addition to tightening regulations for consumer loans and credit cards, new macroprudential measures were introduced within the Basel III, to strengthen the soundness of the bank balance sheets and liquidity positions.

No identification problem is found in terms of the long-run relationships shown in Table 4. Furthermore, since all series used in the analysis are in logarithmic form, it is possible to interpret the estimated coefficients as long-run elasticity coefficients (Johansen, 2005).

Since real credit growth and the macroprudential policy index were determined to be endogenous according to the weak exogeneity test results, a normalization operation was carried out on these two variables. The normalization was first performed on real credit growth and then on the macroprudential policy index.

The normalization performed when real credit growth is endogenous made it possible to see the long-run effect of other variables on real credit growth. Accordingly, when the other variables were fixed, a 1% increase in the macroprudential policy index reduced real credit growth by about 0.25%. In this context, it is seen that the long-run elasticity coefficient of the macroprudential policy index is similar to the findings obtained in empirical studies in the literature and it is in line with the expectations.

In the case where the macroprudential policy index is endogenous, the normalization process shows the long-run effect of other variables on macroprudential policy use. Accordingly, while other variables are fixed, a 1% increase in real credit growth increases the macroprudential policy index by about 0.55%. In other words, macroprudential policy usage is increasing, as expected, in periods of accelerated credit growth.

5. Conclusion

Following the global financial crisis, quantitative easing policies implemented by developed countries led to rapid credit expansion in emerging market economies. Facing various policy dilemmas between price stability and financial stability, emerging market central banks added macroprudential instruments to their policy toolkits, to bring excessive credit growth under control. Similarly, the CBRT introduced a new policy mix to limit the risk of macroeconomic instability due to rapid credit growth. In this study, the effectiveness of the macroprudential policies implemented in Turkey to control excesses in credit growth under the new policy mix was investigated. In the new policy mix, the macroprudential policy stance, which changes depending on the state of the credit growth, points out that the effectiveness of macroprudential policies may also change over time. In this direction, Johansen et al.'s (2000) cointegration approach with structural breaks, which allows structural breaks to include in the model and test their significance as well as to estimate the long-run elasticity coefficients of non-stationary series, was used.

Our empirical results are consistent with a priori expectations and other empirical studies in the previous literature. Similar to the findings of Akinci and Olmstead-Rumsey (2015), Cerutti et al. (2015), Fendoğlu (2017), Anh et al. (2018), Epure et al. (2018), Verma (2018), Rauf (2018), Kim (2019), Klingelhöfer and Sun (2019) and Erdem Küçükbıçakçı et al. (2020), it is found that tight macroprudential policy stance has limiting effects on credit growth. Moreover, the test results on the significance of structural breaks show that measures implemented since the second macroprudential tightening period had a significant effect on curbing credit growth. As demonstrated in Erdem Küçükbıçakçı et al. (2020), the number of macroprudential instruments is important to manage credit growth. In the second macroprudential tightening

period, instruments to limit credit growth were increased and the scope of these measures expanded. This finding points to the need for a tight and comprehensive policy stance for affecting the targeted variable.

The tight macroprudential policy stance was not followed throughout the implementation of the new policy mix. Policymakers' prioritization of economic growth has led them not to take direct prudential measures for rising private sector indebtedness and corporate credit. The loosening of existing policy measures without controlling domestic demand indicates that macroprudential policy is used for growth. The macroprudential policy stance, which was not sufficiently tight, played a role in weakening the effect of restricting credit growth as well as reducing the effectiveness of the monetary policy. Under the new policy mix, the adjustment of interest rates for financial stability led to the de-anchoring of inflation expectations and the deterioration of the transmission mechanism. Thus, the objective of price stability has been undermined. The Turkish experience reveals that when the macroprudential policy is procyclical, monetary policy is constrained to focus on its ultimate goal. However, the effectiveness of the macroprudential policy requires a countercyclical policy stance.

The recent financial crisis has shown that there is a growing consensus among policymakers that the macroprudential approach to financial stability should be integrated into policy frameworks. In this context, our study presents empirical evidence for the effectiveness of macroprudential policy practices through a country-specific index in Turkey. However, there should be more studies that analyze the macroprudential policies in Turkey. Therefore, the empirical literature on macroprudential policy might be extended with future studies that analyzing different indices which is constructed from macroprudential instruments focusing on the supply and/or demand side of the financial system by using different econometric methods.

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