

The Effects of Macroprudential Policy Actions on Non-Bank Credit Growth: Evidence from Turkey

Emrah AKKOÇ¹
Mehmet Oğuz KARAHAN²

Received: 14.02.2026, Accepted: 30.04.2026
DOI Number: 10.5281/zenodo.20800525

Abstract

This paper examines the relationship between macroprudential policy actions and quarterly borrower-side NBFi credit growth in Turkey from 2005Q1 to 2021Q4. We use BIS credit statistics to construct NBFi credit and IMF iMaPP action-count indices to measure both the net stance and its tightening/loosening components. We estimate static and dynamic distributed-lag models, controlling domestic macro-financial conditions and global risk. We observe a significant negative relationship between loosening policy actions and NBFi credit growth in the same quarter and after four quarters. In the dynamic model, the contemporaneous net stance estimate is positive, while the within-year cumulative effect is small and shifts in a more negative direction after 2013Q4. Overall, the relationship between macroprudential actions and NBFi credit growth appears to vary over time and can be interpreted as conditional rather than as a fully identified causal effect.

Key words: Macroprudential policy; non-bank financial intermediation; NBFi credit growth; Turkey.

JEL Code: E44; G28; F36

1. Introduction

The use of macroprudential policy tools has increased since the 2008-2009 Global Financial Crisis (GFC). They have become central for managing systemic risk and restraining procyclical credit growth (Galati & Moessner, 2013, 2018; Cerutti, Claessens, & Laeven, 2017). When credit booms are driven by leverage, short-term funding, and increased risk-taking, macroprudential tools intervene in areas that

¹ Yasar University, Graduate School, Turkey, emrah.akkoc@stu.yasar.edu.tr, <https://orcid.org/0000-0002-1403-2076>

² Yasar University, Department of International Trade and Finance, Turkey, oguz.karahan@yasar.edu.tr, <https://orcid.org/0000-0003-0959-5824>

monetary policy cannot target directly. Policymakers generally use these tools to focus on vulnerable areas of the financial system and to strengthen resilience.

It may be difficult to evaluate how these strategies worked in the post-crisis era. Policymakers do not simply establish macroprudential actions and leave them unchanged. They continually adjust these tools due to both domestic and global events. Meanwhile, the financial system is changing. Non-bank financial intermediaries (NBFIs) have expanded their share of lending, raising concerns about regulatory arbitrage and the potential for credit activity to migrate outside the banking sector (Financial Stability Board, 2023). When regulators tighten restrictions on banks, lending can migrate to these non-bank entities, especially if borrowing demand remains strong (Aiyar, Calomiris, & Wieladek, 2014).

We explore these issues by examining Turkey, a major emerging market economy that has experienced numerous financial shocks and has actively used macroprudential policy. Turkey's macro-financial environment is rapidly changing due to volatile capital flows and sudden shifts in global risk appetite. These fluctuations often require quick responses from policymakers. Also, Turkey's macroprudential strategy has typically been part of a wider policy package, often combined with liquidity, FX, and supervisory actions. Therefore, timing and cross-sector substitution risks are particularly important. In this context, macroprudential tightening that focuses on banks can change the composition of credit supply rather than reducing total credit, so it may become critical to track NBFI credit from the borrower's side.

Various institutional reports documented the evolution of macroprudential coordination and the use of both borrower- and bank-based tools in Turkey after 2010 (Binici et al., 2013; Kara, 2016a; Kara, 2016b; Uysal, 2017; Financial Stability Board, 2015). However, Turkey-specific empirical studies on the relationship between macroprudential policy actions and borrower-side NBFI credit dynamics remain limited.

In this paper, we focus on the following question: How do macroprudential policy actions relate to quarterly borrower-side NBFI credit growth in Turkey? We address this question in three steps. First, following the borrower-based framework in Dembiermont et al. (2013), we construct a quarterly series for Turkish borrower-side NBFI credit based on BIS data, decomposing aggregate credit to a measure that better proxies domestic non-bank lending. Second, using IMF iMaPP action-count indices, we distinguish the net macroprudential stance from its tightening and loosening components (Alam et al., 2019). This allows us to examine how relationships differ across the policy cycle, rather than relying on a single composite measure. Third, in distributed-lag specifications, we split the full sample at 2013Q4 when the cross-border

lending series becomes directly observed in the BIS data to examine subsample sensitivity.

We estimate static specifications as benchmarks and provide dynamic distributed-lag models that incorporate lagged adjustment, since macroprudential actions may affect credit growth with delays. In these models, a significant negative effect of loosening actions is observed in the same quarter and after four quarter-lags. In subsample analysis, cumulative tests indicate that the net-stance relationship shifts in a more negative direction after 2013Q4, reflected in a negative and statistically significant post–pre difference.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the data and variables used in the study. Section 4 presents our empirical analysis and discusses the main findings. Section 5 concludes.

2. Literature Review

Cross-country research has documented how macroprudential policy (MaPP) is used and how it relates to systemic risk and procyclical credit dynamics. Due to their ability to restrain leverage cycles, early studies positioned macroprudential tools at the center of financial stability discussions (Borio, 2003; Claessens, 2015). Empirical analyses using broad MaPP indices indicate a systematic relationship between policy actions and credit conditions across countries. These studies find that tighter policy actions can slow bank credit growth and improve resilience. The impact of the results varies across countries and specifications (Cerutti et al., 2017; Akinci & Olmstead-Rumsey, 2018).

These relationships also vary with the policy toolkit, financial structure, and the monetary and capital-flow environment. Studies show that the most significant effects appear when examining borrower-based and housing-related tools (Kuttner & Shim, 2016). Policy guidance highlights the importance of instrument choice and country context (Lim et al., 2011). IMF's iMaPP database enables researchers to monitor tightening and loosening policies consistently across countries and over time (Alam et al., 2019).

Analyses of the effects of macroprudential tools are also performed at the micro-level. Using loan-level and credit registry data, researchers analyze the dynamics of how tighter macroprudential policy shapes lending behavior, such as who receives credit, how loans are priced, which intermediaries participate or withdraw, and how risk-taking changes (Jiménez et al., 2017; Altavilla et al., 2020).

The growth of non-bank financial intermediaries (NBFIs) added new dimensions to the issue. Most regulations target banks, but some financial activity migrates outside the regulatory perimeter. Early research on shadow banking

documented the growth of market-based intermediation, supported by wholesale funding and collateralized finance (Adrian & Shin, 2010; Pozsar et al., 2010). When banking regulations are tightened, lending may move toward non-banks or shift through cross-border channels.

Recent research discusses these movements as "leakages", while also emphasizing cross-sector substitution between bank and non-bank credit channels (Aiyar et al., 2014; Reinhardt & Sowerbutts, 2015; Cizel et al., 2019; Claessens et al., 2021; Hodula & Ngo, 2024). There is also evidence that the interaction between macroprudential and monetary policy affects the shift of corporate lending from banks to non-banks (Albuquerque et al., 2025). These patterns do not always unfold in the same way; they depend on global financial conditions and investor risk appetite, which influence domestic funding and can amplify booms and busts (Rey, 2015; Drehmann et al., 2012; Jordà et al., 2013).

Most studies for Turkey focus on banks and the effects of the policy mix on credit supply and funding after 2010. A distinctive feature is Turkey's use of "unconventional" instruments, such as the interest-rate corridor and the Reserve Option Mechanism (ROM). Policymakers adopted these instruments to buffer the economy from fluctuations in capital flows and changes in global risk sentiment. The interest-rate corridor, for example, operates as a macroprudential tool by affecting credit pricing and spreads (Binici et al., 2013). Research on the ROM shows that it helps stabilize exchange rates and guide market expectations (Oduncu et al., 2013; Değerli & Fendoğlu, 2015).

There is also evidence that Turkey's broader macroprudential policies, once implemented, reduce the sensitivity of cross-border flows to global shocks. These measures can act as a shield against the global financial cycle (Aysan et al., 2015). Studies of reserve requirements and liquidity measures indicate that they affect banks' lending and risk management (Mimir et al., 2012; Alper et al., 2018). Other research highlights the relationship between capital flows and domestic credit in Turkey's open financial system (Varlık & Berument, 2016). Borrower-based tools, such as loan-to-value (LTV) limits, are also significant; they can change the composition of lending and generate spillovers across loan segments (Baziki & Çapacıoğlu, 2021).

Overall, macroprudential actions can be related to the reallocation of credit across intermediaries when regulation is tightened for banks. The net relationship with non-bank credit growth is therefore an empirical question, as it depends on the instrument mix and broader funding conditions, including shifts in risk sentiment that can also compress non-bank credit. Turkey-specific empirical analysis of macroprudential policy actions on borrower-side non-bank credit growth is limited. We provide new time-series evidence to examine this relationship.

3. Data

3.1. NBF1 Credit Construction

We employ the BIS “credit to the private non-financial sector” statistics and follow the borrower-based framework in Dembiermont et al. (2013) and Cizel et al. (2019) to measure borrower-side NBF1 credit. Total credit can be decomposed into domestic bank credit, credit provided by non-bank lenders, and direct cross-border credit from non-resident banks. To approximate domestic non-bank intermediation, we net out direct cross-border credit from non-resident banks and define:

$$NBF1\ Credit_t = C_t^{Total} - C_t^{Bank} - C_t^{XB} \quad (1)$$

where C_t^{Total} denotes total credit to the private non-financial sector, C_t^{Bank} denotes bank credit from resident banks, and C_t^{XB} denotes direct cross-border credit provided by non-resident banks. Netting out C_t^{XB} removes direct foreign-bank cross-border lending from total borrower-side credit so that it closely tracks domestic non-bank intermediation.

The BIS quarterly series on direct cross-border credit from non-resident banks begins in 2013Q4. We back-cast the cross-border component for 2005Q1–2013Q3 using its average share in total credit over 2013Q4–2021Q4 to extend the quarterly NBF1 credit series back to 2005Q1. Specifically, for each quarter in 2013Q4–2021Q4, we compute the ratio C_t^{XB}/C_t^{Total} and use its sample-average, 7.76%, to impute pre-2013 cross-border credit as $\widehat{C}_t^{XB} = 0.0776 \times C_t^{Total}$. We then construct NBF1 Credit_t using Eq. (1), C_t^{XB} replaced by \widehat{C}_t^{XB} in the pre-2013 period.

This procedure is necessarily approximate, since the pre-2013 direct cross-border component must be inferred from the later BIS sample. In the baseline series, we use Turkey’s post-2013 average direct cross-border share as a practical country-specific benchmark. At the same time, this assumption may be less accurate during stress periods. Cross-border lending weakened during the global financial crisis, and Turkey faced tighter external borrowing conditions in 2008–2009 (Özen et al., 2013; Çapacıoğlu, 2018). To address this concern, we also conduct a conservative sensitivity check. For the GFC window (2007Q3–2009Q2), we recalculate the series using Turkey’s minimum post-2013 observed share, 5.49%, instead of the post-2013 average. This serves as a lower-bound robust exercise rather than a replacement for the baseline series.

The dependent variable is borrower-side NBFi Credit Growth, measured as the first difference of the log level of NBFi Credit:

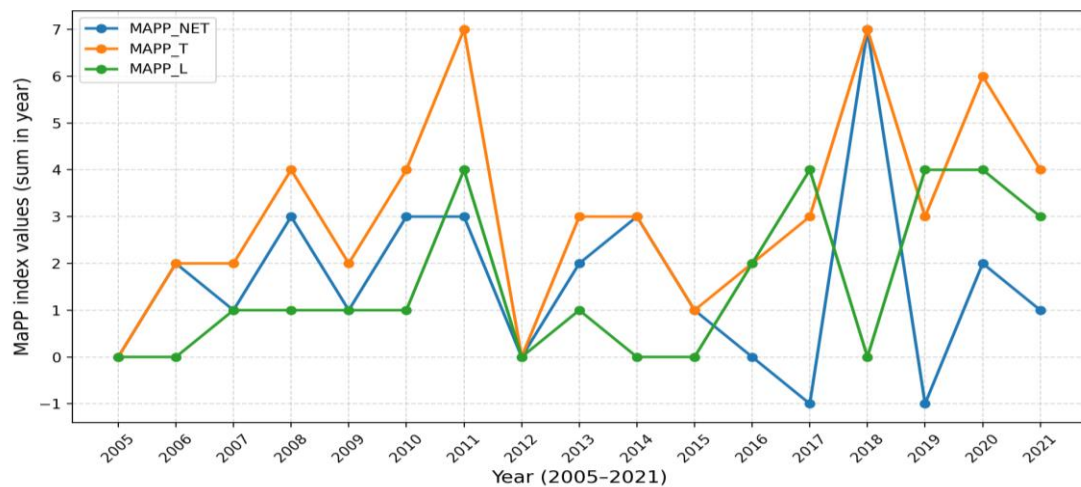
$$y_t = \Delta \ln(\text{NBFi Credit}_t) = \ln(\text{NBFi Credit}_t) - \ln(\text{NBFi Credit}_{t-1}) \quad (2)$$

3.2. Macroprudential Policy Variables

Macroprudential policy variables are obtained from the IMF’s Integrated Macroprudential Policy (iMaPP) database (Alam et al., 2019). We use three quarterly iMaPP-based action-count indices: (i) MAPP_NET, which is net tightening (tightening actions minus loosening actions), (ii) MAPP_T, the total number of tightening actions, and (iii) MAPP_L, the total number of loosening actions. In the iMaPP database, 17 instruments are coded at a monthly frequency. The indicator equals one if a measure is tightened or loosened, and zero otherwise. We aggregate monthly dummies within each quarter for each instrument and then sum across instruments to obtain quarterly counts of tightening, loosening, and the net stance. A one-unit change in any of these indices means that one macroprudential action was recorded in that quarter.

Figure 1 highlights the cyclical nature of Turkey’s macroprudential activity. Policy actions are relatively limited in the mid-2000s, but they rise sharply around global and domestic stress periods. The number of tightening actions peaks in 2011 with an annual total of 7 separate actions during the euro-area crisis, while loosening becomes more important during the COVID-19 period, as authorities loosen policy, releasing buffers and relaxing constraints.

Figure 1. Annual macroprudential actions in Turkey, 2005–2021



Notes: Figure 1 shows annual sums of quarterly macroprudential tightening, loosening, and net policy actions (MAPP_T, MAPP_L, MAPP_NET) for Turkey over 2005Q1–2021Q4. The total number of

actions over the sample is 53 (tightening), 26 (loosening), and 27 (net). Source: Authors' calculations based on the IMF iMaPP database (Alam et al., 2019).

3.3. Control Variables, Transformations, and Summary Statistics

Macro-financial control variables include real GDP growth (GDP GROWTH), the real interest rate (RIR), the credit-to-GDP ratio (CREDIT/GDP), the share of NBFi credit in total credit (NBFi/CREDIT), the banking-sector Z-score (Z-SCORE), and an interaction term capturing global risk and financial openness (VIX x KAOPEN). Table 1 reports variable definitions, sources, and the transformations used in the regression analysis.

Table 1. Variable Definitions and Sources

Variables	Definitions/Calculations	Source
NBFi Credit Growth	First difference of log credit to the private non-financial sector provided by non-banks constructed as: total credit – bank credit – direct cross-border lending by foreign banks (see Section 3.1)	BIS, authors' calculations
MAPP_NET	Quarterly sum of net policy actions (tightening minus loosening)	Alam et al. (2019), iMaPP database
MAPP_T	Quarterly sum of tightening actions	Alam et al. (2019), iMaPP database
MAPP_L	Quarterly sum of loosening actions	Alam et al. (2019), iMaPP database
Real GDP Growth (GDP GROWTH)	Year-on-year log change in real GDP	OECD
Real Interest Rate (RIR)	Policy rate (end-of-quarter) minus CPI year-on-year inflation (entered in first differences)	BIS, IMF
Credit-to-GDP (CREDIT/GDP)	Total credit to the private non-financial sector (PNFS) as a percentage of GDP (entered in first differences)	BIS
NBFi Credit -to-Total Credit (NBFi/CREDIT)	The percentage of NBFi credit in total credit to the PNFS (entered in first differences)	BIS, authors' calculations
Bank Z-Score (Z-SCORE)	$Z\text{-Score} = ROA + ((\text{equity}/\text{assets})/\text{sd}(ROA))$ (entered in first differences)	World Bank
Chinn-Ito (KAOPEN)	Index Openness Index: to measure a country's degree of capital account openness	Chinn–Ito dataset (Chinn & Ito, 2006).

VIX	Quarterly average of the daily CBOE Volatility Index (VIX). Mean of daily closing values by each quarter.	CBOE; FRED series VIXCLS (St. Louis Fed).
VIX x KAOPEN	VIX × Chinn–Ito KAOPEN Index. (both series mean-centered and aligned at quarterly frequency)	Authors' calculations

Notes: Authors' compilation based on the stated sources. Chinn-Ito Index available at (web.pdx.edu/~ito/Chinn-Ito_website.htm).

Appendix Table A.1 reports Augmented Dickey–Fuller (ADF) unit root tests (Dickey & Fuller, 1979) with an intercept, where the lag length is selected by SIC/BIC. In line with these results, we take first differences for any macro-financial controls that show unit-root behavior in levels. These are: RIR, CREDIT/GDP, NBF1/CREDIT, and Z-SCORE. Meanwhile, the dependent variable (NBF1 CREDIT GROWTH), macroprudential action indices (MAPP_NET, MAPP_T, MAPP_L), and the other controls (GDP GROWTH, VIX x KAOPEN) are stationary and enter regressions in levels. To reduce the impact of outliers, we winsorize all non-policy variables at the 1st and 99th percentiles, while policy indices are discrete quarterly action counts and are not winsorized. Table 2 reports descriptive statistics for the final dataset.

Table 2. Descriptive Statistics

Variable	N	Mean	Median	Std. Dev.	Min	Max
NBF1 CREDIT GROWTH	68	0.019968	0.008887	0.075297	-0.128881	0.398443
MAPP_NET	68	0.397059	0.000000	1.294532	-3.000000	4.000000
MAPP_T	68	0.779412	0.000000	1.130917	0.000000	4.000000
MAPP_L	68	0.382353	0.000000	0.733615	0.000000	3.000000
GDP GROWTH	68	1.243499	1.543471	2.380412	-7.787220	7.786138
RIR	67	-0.268638	-0.457574	2.304019	-9.476665	6.855209
CREDIT/GDP	67	0.010556	0.010000	0.024494	-0.047000	0.070640
NBF1/CREDIT	67	-0.000669	-0.001882	0.011063	-0.025580	0.034630
Z-SCORE	67	-0.103335	0.000000	0.739336	-3.325164	2.018740
VIX x KAOPEN	68	0.159490	0.092504	0.910130	-1.902952	3.327166

Source: Authors' calculations

4. Empirical Analysis and Results

This section discusses the static and dynamic specifications that we use to estimate the relationships between macroprudential policy actions and quarterly borrower-side NBF credit growth in Turkey.

4.1. Static and Dynamic Models

Let y_t denote the quarterly NBF credit growth, defined as $y_t = \Delta \ln(\text{NBF Credit}_t)$. The net stance (NET) model relates y_t to the net macroprudential policy index $MAPP_NET_t$, controlling for macro-financial conditions.

Static NET model:

$$y_t = \alpha + \beta MAPP_NET_t + \gamma' X_t + \varepsilon_t \quad (3)$$

Dynamic NET model (distributed lags):

$$y_t = \alpha + \rho y_{t-1} + \sum_{h=0}^Q \beta_h MAPP_NET_{t-h} + \gamma' X_t + \delta' X_{t-1} + \varepsilon_t \quad (4)$$

To allow for potential asymmetries between tightening and loosening actions, we also estimate specifications that decompose the policy stance into $MAPP_T_t$ (tightening actions) and $MAPP_L_t$ (loosening actions). The specifications become:

Static model with decomposition:

$$y_t = \alpha + \beta_T MAPP_T_t + \beta_L MAPP_L_t + \gamma' X_t + \varepsilon_t \quad (5)$$

Dynamic model with decomposition:

$$y_t = \alpha + \rho y_{t-1} + \sum_{h=0}^Q \beta_{T,h} MAPP_T_{t-h} + \sum_{h=0}^Q \beta_{L,h} MAPP_L_{t-h} + \gamma' X_t + \delta' X_{t-1} + \varepsilon_t \quad (6)$$

In these models, h indexes quarterly policy lags, and Q denotes the maximum lag length. The control vector X_t enters both contemporaneously and with one lag, implying an ARDL(1,4,1) structure with one lag of the dependent variable, policy lags up to $Q = 4$, and controls at t and $t - 1$. Throughout, ε_t denotes the regression error term.

Appendix Table A.2 compares candidate ARDL(p,q,r) specifications using AIC and BIC, where p denotes lags of the dependent variable, q the maximum lag on policy variables (including lag 0), and r denotes the number of lags on each control in addition to contemporaneous controls. For the NET model, AIC prefers ARDL(2,4,1) while BIC selects the more parsimonious ARDL(1,4,1). For the T/L model, both AIC and BIC select ARDL(1,4,1). We therefore use ARDL(1,4,1) to analyze policy effects over a one-year window ($Q = 4$). The results under ARDL(2,4,1) are similar but are not reported in the main text for brevity.

Table 3 reports OLS estimates for the baseline specifications using Newey–West HAC standard errors. Panel A summarizes the lagged dependent variable and macroprudential policy coefficients under the net stance model (NET) and the tightening/loosening split (T/L). Panel B reports control-variable estimates and model fit statistics.

In the static NET model (NET-S), the coefficient on the net stance ($MAPP_NET_t$) is small and statistically insignificant. In contrast, in the decomposed static model (T/L-S), the contemporaneous coefficient on loosening actions ($MAPP_L_t$) is negative and statistically significant, implying roughly a 2.9 percentage-point decline in quarterly NBFBI credit growth. This finding is better interpreted as a timing-related conditional relationship than as an isolated causal effect. Loosening actions are likely to be introduced when credit conditions are already weakening, and policymakers are responding to system-wide macro-financial stress. In Turkey, such measures have often formed part of a wider policy package that may also include monetary easing, liquidity support, fiscal stimulus, exchange-rate-related measures, and supervisory adjustments (Rawdanowicz, 2010; Central Bank of the Republic of Turkey, 2020).

In the dynamic NET model (NET-D), the contemporaneous net stance coefficient is positive and statistically significant, while lagged net-stance terms are economically small and not statistically significant. In the dynamic decomposed model (T/L-D), tightening coefficients are not statistically significant at individual horizons. In contrast, loosening actions are negatively related to NBFBI credit growth contemporaneously (-0.0118 , $p < 0.05$) and at longer horizons, with the largest and most significant effect at the four-quarter lag (-0.0222 , $p < 0.01$).

Regression diagnostics for static and dynamic specifications are summarized in Table 4. The static models present several diagnostic concerns: the Breusch–Pagan and White tests reject homoskedasticity, the Jarque–Bera test rejects normality, the Ramsey RESET test points to possible misspecification, and the Breusch–Godfrey LM test indicates residual autocorrelation in the static NET model and borderline autocorrelation in the static T/L model.

Table 3. OLS Estimates under Different Model Specifications - Turkey, 2005Q1-2021Q4

The table reports OLS regressions of quarterly NBFi CREDIT GROWTH on iMaPP-based macroprudential policy indices. Static specifications include contemporaneous policy indices only. Dynamic specifications include the lagged dependent variable (LDV), and policy lags $h = 0 \dots 4$ (one-year window), and controls enter both contemporaneously and with one lag (ARDL(1,4,1) control structure). Row definitions: NET-S (static NET model), NET-D (dynamic NET model), T/L-S (static tightening & loosening model), T/L-D (dynamic tightening & loosening model).

PANEL A: Lagged Dependent and Macroprudential Policy Action Variables																
Spec.	NBFI CREDIT GROWTH(t-1)	MAPP_NETt	MAPP_Tt	MAPP_Lt	MAPP_NET(t-1)	MAPP_NET(t-2)	MAPP_NET(t-3)	MAPP_NET(t-4)	MAPP_T(t-1)	MAPP_T(t-2)	MAPP_T(t-3)	MAPP_T(t-4)	MAPP_L(t-1)	MAPP_L(t-2)	MAPP_L(t-3)	MAPP_L(t-4)
NET-S		0.0036 (0.0069)														
NET-D	0.4505*** (0.1195)	0.0089** (0.0041)			-0.0080 (0.0052)	0.0000 (0.0042)	-0.0004 (0.0040)	-0.0027 (0.0040)								
T/L-S			-0.0064 (0.0063)	-0.0290*** (0.0092)												
T/L-D	0.3559*** (0.0999)		0.0064 (0.0042)	-0.0118** (0.0050)					-0.0059 (0.0058)	-0.0028 (0.0046)	-0.0034 (0.0036)	-0.0037 (0.0056)	0.0040 (0.0053)	-0.0050 (0.0066)	-0.0085 (0.0062)	-0.0222*** (0.0069)

PANEL B: Control Variables and Model Statistics																	
Spec.	GDP GROWTHt	ΔRIRt	Δ(CREDIT/GDP)t	Δ(NBFI/CRE DIT)t	ΔZ-SCOREt	(VIX×KA OPEN)t	GDP GROWTH(t-1)	ΔRIR (t-1)	Δ(CREDIT /GDP)(t-1)	Δ(NBFI/CRE DIT)(t-1)	ΔZ-SCORE (t-1)	(VIX×KA OPEN)(t-1)	Constant	R ²	Adj. R ²	Prob (F-stat)	N
NET-S	0.0006 (0.0040)	0.0033 (0.0060)	-0.2934 (0.3238)	2.7760* (1.4712)	-0.0093 (0.0084)	-0.0044 (0.0119)							0.0243** (0.0099)	0.193	0.097	0.0683	67
NET-D	-0.0044* (0.0023)	0.0029 (0.0024)	-1.0493*** (0.2408)	2.6555*** (0.8285)	-0.0087 (0.0066)	-0.0368*** (0.0123)	0.0002 (0.0018)	0.0003 (0.0032)	0.5725*** (0.1803)	-3.3700*** (0.7461)	-0.0136* (0.0075)	0.0415*** (0.0106)	0.0111 (0.0068)	0.556	0.379	0.0010	64
T/L-S	0.0022 (0.0041)	0.0028 (0.0050)	-0.3275 (0.3060)	2.7155* (1.3787)	-0.0128 (0.0081)	-0.0061 (0.0097)							0.0402*** (0.0109)	0.278	0.178	0.0110	67
T/L-D	-0.0050* (0.0019)	0.0021 (0.0025)	-1.1722*** (0.2098)	2.5192*** (0.6616)	-0.0159* (0.0083)	-0.0406*** (0.0096)	-0.0004 (0.0019)	-0.0002 (0.0030)	0.3268* (0.1764)	-2.9923*** (0.6933)	-0.0118* (0.0064)	0.0410*** (0.0079)	0.0428*** (0.0102)	0.639	0.432	0.0009	64

Notes: The dependent variable is quarterly NBFi credit growth, $MAPP_NET_t$ is the net macroprudential stance (tightenings minus loosening) at time t ; $MAPP_T_t$ and $MAPP_L_t$ denote iMaPP-based indices for tightening and loosening actions, respectively. Controls are: real GDP growth (GDP_GROWTH_t), the real interest rate (RIR_t), the credit-to-GDP ratio ($CREDIT/GDP_t$), the share of NBFi credit in total credit ($NBFI/CREDIT_t$), the banking-sector Z-score (Z_SCORE_t), and the interaction between the VIX index and the Chinn–Ito capital account openness index ($VIX \times KAOPEN_t$). Based on Augmented Dickey–Fuller (ADF) unit-root tests; RIR_t , $(CREDIT/GDP)_t$, $(NBFI/CREDIT)_t$, and Z_SCORE_t enter in first differences (Δ); remaining variables enter in levels. All non-policy variables are winsorized at the 1st and 99th percentiles; the policy indices ($MAPP_NET$, $MAPP_T$, $MAPP_L$) are discrete quarterly action counts and are not winsorized. Standard errors are Newey–West HAC (Bartlett kernel; maxlags = 4) and are reported in parentheses (Newey & West, 1987). ***, **, and * denote significance at the 1%, 5%, and 10% levels (two-sided). Panel B reports R^2 , adjusted R^2 , and the p-value of the overall F-test, and N denotes the number of observations.

The ARDL(1,4,1) dynamic specifications perform more favorably, with improved heteroskedasticity, normality, and functional-form diagnostics, although the Breusch–Godfrey(4) test still suggests some remaining serial correlation. We therefore report Newey–West HAC standard errors in all specifications. Maximum VIF values remain moderate, indicating that multicollinearity is not a major concern. These results support placing greater weight on the dynamic distributed-lag models since macroprudential effects may operate with lags.

Table 4. Regression Diagnostics (Static and Dynamic OLS specifications)

Spec.	Model	N	Breusch-Pagan	White (LM)	Breusch-Godfrey(4)	Jarque-Bera	RESET	Max VIF
Static	NET	67	<0.0001	0.0044	0.0154	<0.0001	0.0372	1.456
Static	T/L	67	<0.0001	0.0258	0.0913	<0.0001	<0.0001	1.460
Dynamic	NET	64	0.8836	1.0000	0.0296	0.5164	0.1847	3.023
Dynamic	T/L	64	0.7164	1.0000	0.0203	0.9083	0.4481	3.219

Notes: The table reports regression diagnostics for static and dynamic OLS specifications. Entries report p-values (except Max VIF). Breusch–Pagan and White (LM) tests assess heteroskedasticity; Breusch–Godfrey(4) tests residual autocorrelation up to four lags; Jarque–Bera tests residual normality; Ramsey RESET tests functional-form misspecification. Max VIF summarizes multicollinearity. Dynamic models are estimated as distributed-lag OLS with LDV($t-1$), policy lags $h = 0 \dots 4$, and controls at t and $t - 1$.

4.2. Robustness and Sensitivity

We assess within-year distributed-lag effects by testing cumulative policy effects as the sum of policy-lag coefficients over horizons $h = 0 \dots 4$ ($Q = 4$), using HAC–Wald tests in the dynamic specifications. The results are reported in Table 5. Over the full sample, the cumulative net stance effect is economically small and statistically insignificant. In the decomposed model, the cumulative effect of loosening (MAPP_L) is negative and statistically significant, whereas cumulative tightening is negative but not significant at conventional levels.

We then allow cumulative policy effects to differ after 2013Q4 by including a post dummy (intercept shift) and post-period interaction terms. This allows us to assess sensitivity to the point at which cross-border bank credit becomes directly observed in BIS data. The post-2013 cumulative net-stance estimate is negative but not statistically significant on its own. However, the post–pre difference is negative and statistically significant ($p = 0.0249$), indicating a shift toward a more negative net-stance relationship after 2013Q4. For tightening and loosening, the post-2013 cumulative estimates are negative and significant at the 10% level, whereas the pre-2013 cumulative effects are not statistically significant.

Table 5. Cumulative policy effects and post-2013 sensitivity (Wald tests)

Cumulative ($\Sigma h=0..4$)	Effects	MAPP_NET	MAPP_T	MAPP_L
Full sample [p]		+0.0032 [0.6724]	-0.0095 [0.1828]	-0.0435*** [0.0055]
Pre-2013 [p]		+0.0163 [0.1604]	+0.0002 [0.9895]	-0.0584 [0.3057]
Post-2013 [p]		-0.0106 [0.1392]	-0.0205* [0.0743]	-0.0201* [0.0525]
Diff (Post–Pre) [p]		-0.0269** [0.0249]	-0.0207 [0.2264]	+0.0383 [0.4934]
N_pre		31	31	31
N_post		33	33	33

Notes: Within-year cumulative effects are the sum of policy coefficients over $h = 0 \dots 4$ ($Q = 4$) from the dynamic distributed-lag model with LDV($t-1$) and controls at t and $t - 1$ (ARDL(1,4,1) control structure). Pre-2013 and post-2013 estimates are obtained from a single interacted specification with a post dummy and post \times policy-lag interactions; “Diff (Post–Pre)” is the sum of the interaction terms. Inference uses Newey–West HAC (Bartlett; maxlags=4); p-values are Wald F-tests. *, **, *** denote 10%, 5%, 1% significance (two-sided).

It is also important to note that macroprudential actions became more frequent after 2013Q4. The total number of tightening actions increased from 21 to 32, while the total number of loosening actions increased from 9 to 17 between the pre-2013 and post-2013 periods (see Figure 1). The average NBFI share in total credit also declined from about 24.8% pre-2013 to 19.2% post-2013 (authors’ calculations based on BIS borrower-side credit statistics). Since 2013Q4 marks the start of the directly observed BIS cross-border lending series and coincides with shifts in policy intensity and credit composition, it provides a convenient breakpoint for sensitivity checks.

The lower post-2013 NBFI share is better viewed as part of a gradual rebalancing in Turkey’s credit composition rather than the result of one isolated regulatory change. Turkey’s financial system remains strongly bank-dominated. At the same time, selected macroprudential measures restrained some household credit segments, while tighter external financing conditions reduced the relative importance of cross-border and other non-bank funding channels.

When we re-estimate the analysis using the GFC-period cross-border component reconstructed as described in Section 3.1, the main findings remain similar. The dynamic results follow the same basic pattern: the full-sample cumulative loosening effect remains negative and statistically significant, and the post–pre net-stance difference also remains negative and statistically significant. Although the post-2013 tightening estimate weakens under this alternative reconstruction, the main conclusions are not driven by the baseline pre-2013 back-casting assumption.

A separate robustness check concerns the choice of lag window. Appendix Table A.3 reports cumulative Wald tests under alternative lag windows ($Q = 2$ and $Q = 6$). The results are similar: net stance and tightening remain insignificant, while loosening remains negative and strengthens as the lag window is extended. This suggests that the main conclusions are not sensitive to the baseline one-year window ($Q = 4$).

We run two additional checks to address timing-related endogeneity concerns. First, we re-estimate the dynamic models using only lagged policy terms over $h = 1 \dots 4$, excluding the same-quarter policy variable. The results remain close to the baseline; additional tables are available upon request. Second, we perform anticipation (lead) tests by adding one- and two-quarter leads to each policy variable. As shown in Appendix Table A.4, neither the individual lead coefficients nor their joint Wald tests are statistically significant. This suggests that future macroprudential actions do not predict current NBFi credit growth over up to two-quarter horizons.

These tests reduce, but do not eliminate, concerns about endogenous policy timing. More generally, macroprudential actions may be taken in response to the same macro-financial conditions that later influence NBFi credit dynamics. In the Turkish case, this issue is especially relevant during stress episodes, when macroprudential actions may overlap with broader monetary, liquidity, supervisory, exchange-rate-related, and fiscal responses. The results can be interpreted as conditional relationships rather than as fully isolated causal effects.

5. Conclusion

This paper examines the relationship between macroprudential policy actions and quarterly borrower-side NBFi credit growth in Turkey from 2005Q1 to 2021Q4. We use BIS credit statistics to construct a borrower-side measure of NBFi credit and IMF iMaPP-based action-count indices to capture the macroprudential stance and its tightening/loosening decomposition. We estimate static and dynamic distributed-lag specifications, controlling for domestic macro-financial conditions and global risk.

The static specifications indicate a significant negative relationship between macroprudential loosening actions and quarterly NBFi credit growth. By contrast, dynamic distributed-lag models that trace policy lags over a one-year window provide a more detailed picture than static regressions. The contemporaneous net-stance coefficient is positive, while lagged net-stance and tightening effects are generally modest. By contrast, loosening remains negatively related to NBFi credit growth on impact and at longer horizons, most clearly around the four-quarter lag. Given the timing of policy actions, this negative relationship more plausibly reflects loosening introduced when credit conditions are already weakening, rather than a contractionary effect of itself.

Cumulative tests indicate a significant negative effect for loosening, but not for net stance or tightening. Subsample analysis suggests that the net-stance relationship shifts in a more negative direction after 2013Q4. Post-2013 cumulative tightening and loosening estimates are both negative but only weakly significant, while pre-2013 cumulative effects are not statistically significant. The findings remain broadly similar under a conservative alternative reconstruction of the GFC-period cross-border component.

Overall, the findings indicate time-varying adjustment, while lag-only and lead (anticipation) tests help mitigate concerns about timing-related endogeneity. Future research could focus on incorporating stress episodes into the analyses and strengthening identification by using intensity-adjusted indices and instrument-level data to assess cross-sector substitution across bank and non-bank lenders.

REFERENCES

- Adrian, T., & Shin, H. S. (2010). The changing nature of financial intermediation and the financial crisis of 2007–2009. *Annual Review of Economics*, 2, 603–618. <https://doi.org/10.1146/annurev.economics.102308.124420>
- Aiyar, S., Calomiris, C. W., & Wieladek, T. (2014). Does macro-prudential regulation leak? Evidence from a UK policy experiment. *Journal of Money, Credit and Banking*, 46(S1), 181–214. <https://doi.org/10.1111/jmcb.12086>
- Akinci, O., & Olmstead-Rumsey, J. (2018). How effective are macroprudential policies? An empirical investigation. *Journal of Financial Intermediation*, 33, 33–57. <https://doi.org/10.1016/j.jfi.2017.04.001>
- Alam, Z., Alter, A., Eiseman, J., Gelos, G., Kang, H., Narita, M., Nier, E., & Wang, N. (2019). Digging deeper: Evidence on the effects of macroprudential policies from a new database. (IMF Working Paper No. 19/66). International Monetary Fund. <https://doi.org/10.5089/9781498302708.001>
- Albuquerque, B., Cerutti, E., Chen, N., & Firat, M. (2025). From banks to nonbanks: Macroprudential and monetary policy effects on corporate lending. (IMF Working Paper No. 2025/096). International Monetary Fund. <https://doi.org/10.5089/9798229008976.001>
- Alper, K., Binici, M., Demiralp, S., Kara, H., & Özlü, P. (2018). Reserve requirements, liquidity risk, and bank lending behavior. *Journal of Money, Credit and Banking*, 50(4), 817–827. <https://doi.org/10.1111/jmcb.12475>
- Altavilla, C., Laeven, L., & Peydró, J.-L. (2020). Monetary and macroprudential policy complementarities: Evidence from European credit registers (ECB Working Paper Series No. 2504). European Central Bank.
- Aysan, A. F., Fendoğlu, S., & Kılınç, M. (2015). Macroprudential policies as buffer against volatile cross-border capital flows. *The Singapore Economic Review*, 60(01), 1550001. <https://doi.org/10.1142/S0217590815500010>

- Baziki, S. B., & Çapacıoğlu, T. (2021). Loan-to-Value Caps, Bank Lending, and Spillover to General-Purpose Loans (CBRT Working Paper No. 21/23). Central Bank of the Republic of Turkey.
- Binici, M., Erol, H., Kara, A. H., Özlü, P., & Ünalmiş, D. (2013). Interest Rate Corridor: A New Macroprudential Tool? CBRT Research Notes in Economics (No. 13/20). Central Bank of the Republic of Turkey.
- Borio, C. (2003). Towards a macroprudential framework for financial supervision and regulation? (BIS Working Papers No. 128). Bank for International Settlements.
- Central Bank of the Republic of Turkey. (2020). Annual report 2020.
- Cerutti, E., Claessens, S., & Laeven, L. (2017). The use and effectiveness of macroprudential policies: New evidence. *Journal of Financial Stability*, 28, 203–224. <https://doi.org/10.1016/j.jfs.2015.10.004>
- Chinn, M. D., & Ito, H. (2006). What matters for financial development? Capital controls, institutions, and interactions. *Journal of Development Economics*, 81(1), 163–192. <https://doi.org/10.1016/j.jdeveco.2005.05.010>
- Cizel, J., Frost, J., Houben, A., & Wierst, P. (2019). Effective macroprudential policy: Cross-sector substitution from price and quantity measures. *Journal of Money, Credit and Banking*, 51(5), 1209–1235. <https://doi.org/10.1111/jmcb.12630>
- Claessens, S. (2015). An overview of macroprudential policy tools. (IMF Working Paper No. 15/163). International Monetary Fund.
- Claessens, S., Cornelli, G., Gambacorta, L., Manaresi, F., & Shiina, Y. (2021). Do macroprudential policies affect non-bank financial intermediation? (BIS Working Papers No. 927). Bank for International Settlements.
- Çapacıoğlu, T. (2018, December 24). External debt rollover ratio in the banking sector. CBRT Blog.
- Değerli, A., & Fendoğlu, S. (2015). Reserve option mechanism as a stabilizing policy tool: Evidence from exchange rate expectations. *International Review of Economics & Finance*, 35, 166–179. <https://doi.org/10.1016/j.iref.2014.09.011>
- Dembiermont, C., Drehmann, M., & Muksakunratana, S. (2013). How much does the private sector really borrow? A new database for total credit to the private non-financial sector. *BIS Quarterly Review*, March, 65–81. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2248501
- Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74(366), 427–431.
- Drehmann, M., Borio, C., & Tsatsaronis, K. (2012). Characterising the financial cycle: Don't lose sight of the medium term! (BIS Working Papers No. 380). Bank for International Settlements.
- Financial Stability Board. (2015, November 19). Peer Review of Turkey.
- Financial Stability Board. (2023, December 18). Global Monitoring Report on Non-Bank Financial Intermediation 2023.
- Galati, G., & Moessner, R. (2013). Macroprudential policy—a literature review. *Journal of Economic Surveys*, 27(5), 846-878. <https://doi.org/10.1111/j.1467-6419.2012.00729.x>

- Galati, G., & Moessner, R. (2018). What do we know about the effects of macroprudential policy?. *Economica*, 85(340), 735-770. <https://doi.org/10.1111/ecca.12229>
- Hodula, M., & Ngo, A. (2024). Does macroprudential policy leak? Evidence from shadow bank lending in EU countries. *Economic Modelling*, 132, 106657. <https://doi.org/10.1016/j.econmod.2024.106657>
- Jiménez, G., Ongena, S., Peydró, J.-L., & Saurina, J. (2017). Macroprudential policy, countercyclical bank capital buffers, and credit supply: Evidence from the Spanish dynamic provisioning experiments. *Journal of Political Economy*, 125(6), 2126–2177. <https://doi.org/10.1086/694289>
- Jordà, Ò., Schularick, M., & Taylor, A. M. (2013). When Credit Bites Back. *Journal of Money, Credit and Banking*, 45: 3-28. <https://doi.org/10.1111/jmcb.12069>
- Kara, H. (2016a). A brief assessment of Turkey's macroprudential policy approach: 2011–2015. *Central Bank Review*, 16(3), 85–92. <https://doi.org/10.1016/j.cbrev.2016.08.001>
- Kara, H. (2016b). Turkey's experience with macroprudential policy. In *Bank for International Settlements (Ed.), Macroprudential policy (BIS Papers No. 86, pp. 123–139)*. Bank for International Settlements.
- Kuttner, K. N., & Shim, I. (2016). Can non-interest rate policies stabilize housing markets? Evidence from a panel of 57 economies. *Journal of financial stability*, 26, 31-44. <https://doi.org/10.1016/j.jfs.2016.07.014>
- Lim, C., Columba, F., Costa, A., Kongsamut, P., Otani, A., Saiyid, M., Wezel, T., & Wu, X. (2011). Macroprudential policy: What instruments and how to use them? Lessons from country experiences. (IMF Working Paper No. 11/238). International Monetary Fund.
- MacKinnon, J. G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Econometrics*, 11(6), 601-618. [https://doi.org/10.1002/\(SICI\)1099-1255\(199611\)11:6<601::AID-JAE417>3.0.CO;2-T](https://doi.org/10.1002/(SICI)1099-1255(199611)11:6<601::AID-JAE417>3.0.CO;2-T)
- Mimir, Y., Sunel, E., & Taşkın, T. (2012). Required reserves as a credit policy tool. (Working Paper No. 12/24). Central Bank of the Republic of Turkey.
- Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55(3), 703–708. <https://doi.org/10.2307/1913610>
- Oduncu, A., Akçelik, Y., & Ermişoğlu, E. (2013). A new macroprudential tool to limit the adverse effects of capital flow volatility on exchange rates: The Reserve Option Mechanism. *Central Bank Review*, 13(3), 45–60.
- Özen, E., Şahin, C., & Ünalnış, İ. (2013). External financial stress and external financing vulnerability in Turkey: Some policy implications for financial stability. *Central Bank Review*, 13 (Special Issue), 65–74.
- Pozsar, Z., Adrian, T., Ashcraft, A. B., & Boesky, H. (2010). Shadow banking (Staff Report No. 458). Federal Reserve Bank of New York.
- Rawdanowicz, Ł. (2010). The 2008–09 crisis in Turkey: Performance, policy responses and challenges for sustaining the recovery. OECD Economics Department

Working Papers, No. 819. OECD Publishing.
<https://doi.org/10.1787/5km36j7d320s-en>

Reinhardt, D., & Sowerbutts, R. (2015). Regulatory arbitrage in action: Evidence from banking flows and macroprudential policy. (Bank of England Working Paper No. 546). Bank of England.

Rey, H. (2015). Dilemma, not trilemma: The global financial cycle and monetary policy independence. (NBER Working Paper No. 21162). National Bureau of Economic Research.

Uysal, M. (2017). Financial stability and macroprudential policy: The Turkish case and its relationship with other policies. In Bank for International Settlements (Ed.), Financial stability and macroprudential policy (BIS Papers No. 94, pp. 349–364). Bank for International Settlements.

Varlık, S., & Berument, H. (2016). Credit channel and capital flows: a macroprudential policy tool? Evidence from Turkey. *The B.E. Journal of Macroeconomics*, 16(1), 145–170. <https://doi.org/10.1515/bejm-2015-0052>

APPENDIX

Table A.1. Unit Root Tests (ADF)

Variable	ADF (level)	p	Lag	ADF (Δ)	p	Lag	Order
NBFI CREDIT GROWTH	-6.0306	<0.01	0	-12.2417	<0.01	0	I(0)
MAPP_NET	-6.4688	<0.01	1	-8.9096	<0.01	1	I(0)
MAPP_T	-6.578	<0.01	0	-7.6231	<0.01	2	I(0)
MAPP_L	-8.195	<0.01	0	-9.2352	<0.01	2	I(0)
GDP GROWTH	-10.2847	<0.01	0	-8.3584	<0.01	2	I(0)
RIR	-1.9413	0.3129	1	-5.6728	<0.01	0	I(1)
CREDIT/GDP	-1.8239	0.3687	0	-6.6688	<0.01	3	I(1)
NBFI/CREDIT	-1.2144	0.6674	0	-7.0479	<0.01	0	I(1)
Z-SCORE	-0.0319	0.9558	4	-10.1208	<0.01	3	I(1)
VIX x KAOPEN	-3.5408	0.0097	0	-7.2984	<0.01	1	I(0)

Notes: The table reports Augmented Dickey–Fuller (ADF) unit-root tests for Turkey (2005Q1–2021Q4). The null is a unit root. Tests include a constant, select lags by SIC/BIC (max 10), and use MacKinnon (1996) one-sided p-values. Results are shown for levels and first differences (Δ). “Order” classifies series as I(0) if the null is rejected in levels (5%), and as I(1) if rejection occurs only after differencing.

Table A.2. ARDL lag-order selection by information criteria

Panel A: NET model

p	q	r	N	k	AIC	BIC	Best AIC	Best BIC
1	4	0	64	13	-170.81	-140.59		
1	4	1	64	19	-190.38	-147.20		✓
2	4	0	64	14	-171.59	-139.21		
2	4	1	64	20	-190.53	-145.19	✓	
1	5	0	63	14	-165.48	-133.33		
1	5	1	63	20	-184.69	-139.68		
2	5	0	63	15	-167.50	-133.21		
2	5	1	63	21	-186.05	-138.90		
1	6	0	62	15	-160.12	-126.09		
1	6	1	62	21	-178.40	-131.60		

Panel B: T/L model

p	q	r	N	k	AIC	BIC	Best AIC	Best BIC
1	4	0	64	18	-175.42	-134.40		
1	4	1	64	24	-193.67	-139.70	✓	✓
2	4	0	64	19	-175.31	-132.13		
2	4	1	64	25	-193.45	-137.32		
1	5	0	63	20	-168.19	-123.18		
1	5	1	63	26	-185.24	-127.37		
2	5	0	63	21	-168.39	-121.25		
2	5	1	63	27	-185.69	-125.69		
1	0	0	67	10	-158.93	-134.68		
1	0	1	66	16	-170.26	-133.04		

Notes: The table reports OLS-estimated ARDL(p,q,r) information criteria, where p is the number of lags on the dependent variable, q is the maximum lag on the policy variable(s) (including lag 0), and r indicates whether controls also enter with one lag (in addition to contemporaneous terms). In the T/L model, the same q applies to both MAPP_T and MAPP_L. Minimum AIC and BIC values within each block are flagged. N varies by lag requirements; k is the number of parameters.

Table A.3. Alternative policy lag windows (Q = 2, 4, 6): cumulative (Wald) tests

Q	N	NET: Σ MAPP_NET	T/L: Σ MAPP_T	T/L: Σ MAPP_L
2	66	-0.0026 [p=0.6361]	-0.0083 [p=0.2329]	-0.0176 [p=0.0293]**
4	64	0.0032 [p=0.6724]	-0.0095 [p=0.1828]	-0.0435 [p=0.0055]***
6	62	-0.0012 [p=0.9187]	-0.0069 [p=0.5033]	-0.0554 [p=0.0009]***

Notes: Entries report Wald tests for the cumulative policy effect, defined as the sum of coefficients over horizons $h = 0 \dots Q$, estimated with OLS and Newey–West HAC standard errors (Bartlett; maxlags=4). Specifications include the lagged dependent variable and the full set of baseline controls. N varies with Q due to additional lag requirements. ***, **, and * denote 1%, 5%, and 10% significance (two-sided).

Table A.4. Lead (Anticipation) Tests

Policy	Lead(t+1) coef.	p-value	Lead(t+2) coef.	p-value	Joint p-value	N
NET	+0.00058	0.8687	-0.00184	0.7590	0.9355	65
T	-0.00063	0.8925	-0.00644	0.4970	0.7924	65
L	-0.00589	0.2954	-0.00884	0.4566	0.4987	65

Notes: The table reports anticipation tests adding one- and two-quarter leads of each policy indicator to the baseline specification. P-values use Newey–West HAC standard errors (Bartlett; maxlags=4). “Joint p-value” tests $H_0: \text{lead}(t+1) = \text{lead}(t+2) = 0$. N is the number of observations.