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Is Macroprudential Policy Driving Savings?*

André Teixeira† Zöe Venter‡

June 13, 2021

Abstract

This paper shows that the recent surge in savings is a result of tighter macroprudential policy. Using a difference-in-differences approach with staggered treatment adoption, we find that households in EU countries that adopted macroprudential policy between 2000 and 2019 increased their savings up to one third more than households in countries without macroprudential policy. Furthermore, our results indicate that the loan-to-value ratio explains most of the variation on savings. Finally, we find that a longer exposure to macroprudential policy exacerbates savings with searing consequences on growth.

JEL Classification: E21; E52; O47.

Keywords: Macroprudential policy, savings, growth, difference-in-differences.

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1 Introduction

Why is it that near or zero interest rates coexist with exuberant savings rates? In the wake of the Great Recession, it was brought to the fore that interest rates and savings should move in tandem (e.g., Guierrieri and Lorenzoni, 2011; Eggertsson and Krugman, 2011; Hall, 2011; Carroll et al., 2019). But if the interest rate is the only driver of savings, then savings should have crept downward in line with the recent decline in the interest rate. That households continue to save, regardless of loose monetary policy, suggests that current economic theory is not telling us the entire story. Admittedly, any factor that alters the relationship between the interest rate and credit could influence savings. Recent empirical research shows that tighter macroprudential policy curtails lending with deleterious effects on growth (e.g., Lim et al., 2011; Cerutti et al., 2017). Reconciling both views means that sounder underwriting standards may induce agents to save more to meet the tighter requirements.

This paper investigates whether the recent surge in savings is the result of tighter macroprudential policy. Our basic argument is that macroprudential policy has the ability to drive savings or, better yet, that macroprudential policy is intrinsically intertwined with spending. To thoroughly test this argument, we use a difference-in-differences (DiD) approach that exploits the staggered timing of macroprudential policy adoption in the EU from 2000 to 2019. Our main finding is that households in countries that implement macroprudential policies increase their savings between 1,4% and 3,1% more than households in countries without macroprudential regulation. Moreover, we find that restrictions to credit based on the Loan-to-Value (LTV) ratio explain most of the variation in savings. Lastly, we show that a longer exposure to macroprudential policy exacerbates the effect on savings.

We also rule out alternative explanations for the sustained surge in savings. One could argue that the increase in savings is potentially being driven by agents rebuilding their balance sheets after the Great Recession or even by pessimism about the economy. To address these issues, we split our sample into pre- and post-crisis periods. Not only do we find that macroprudential policy explains the recent rise in savings, but we also provide evidence that macroprudential policy drove savings up in the halcyon years preceding the Great Recession. This supports our argument that macroprudential policy is a key driver of savings.

Much of the existing literature focuses on the impact of macroprudential policy on financial stability. Instead, we examine how its effects ramify throughout the economy by reconciling the existing theoretical and empirical work on the complementarity of macroprudential and monetary policy. In particular, we show that savings are an important transmission channel through which macroprudential policy affects growth. In many ways, our findings are consistent with the credit view proposed by Bernanke and Blinder (1988). This strand of research suggests that an increase in the interest rate leads to credit rationing with pernicious effects for the economy; we, too, provide evidence that tighter macroprudential policy is at the root of the recent reduction in spending that imperils growth. If macroprudential policy makes it increasingly more difficult for households to borrow, they may never enjoy the more favourable borrowing conditions. A major implication of this finding is that, at least in the context of loose interest rate policies, macroprudential policy may play a more decisive role to spur credit. So, while we agree with the view that macroprudential policy can serve as a bulwark against financial instability, our results emphasize that policy makers should also consider the trade-off between growth and stability when choosing newfangled instruments.

Finally, to the best of our knowledge, we are among the first to implement a wide-scale DiD with staggered treatment adoption in a policy setting. Building on the work of Callaway and Sant'Anna (2020)[1], we exploit the timing differences in the adoption of macroprudential policy across Europe. This method allows us to assess the causal impact of macroprudential policy in disparate groups at different points in time. Moreover, we are able to compute an aggregate estimator that circumvents the challenge of interpreting multiple individual parameters in a large sample. Others could follow a similar approach to study policy implementation.

This paper is divided into four sections. Section I sets the stage by briefly discussing the existing literature. Section II explains the method and describes the data. Section III presents the empirical results. Section IV concludes.

2 Literature review

Our work is closely related to the recent literature on the impact of credit supply on savings. This nascent work is mainly theoretical, but it suggests that credit-loosening policies can trigger a hike in savings. For example, Carroll et al. (2019) argue that savings are driven by a gap between actual and "target" wealth, which is determined by credit conditions and uncertainty. In addition, they find that credit availability explains most of the long-term variation in savings and that fluctuations in net wealth and uncertainty have profound implications on the business-cycle. Relatedly, Guierrieri and Lorenzoni (2011) introduce durables in a DGE model with heterogeneous agents and find that a credit crunch is associated with an increment in

[1] We also estimate our models using the "did" package in R built by these authors.

savings. Moreover, Eggertsson and Krugman (2011) examine a deleveraging shock in a simple New Keynesian model to show that borrowers take on less debt today to accumulate more savings tomorrow. Worse yet, they argue that deleveraging can reduce the interest rate further and cause a steep increase in savings. In a similar vein, Hall (2011) shows that tighter credit leads to higher savings because the reduction in consumption by constrained households more than offsets the increase in consumption by unconstrained households. Altogether, the theoretical literature suggests that credit supply has a significant influence on savings.

If the credit supply affects savings, then any policy that curbs or spurs credit may have the ability to drive savings. Previous literature is focused on the impact of conventional monetary policy on credit supply (Bernanke and Blinder, 1998). This credit view of monetary policy asserts that reducing credit supply can leave the economy teetering on the edge (Bernanke and Gertler, 1995; Ciccarelli et al., 2015). While the effects of monetary policy on credit are hard to overstate, they are hardly the only driver of savings.

Yet, most of the theoretical literature still assumes that the effect of credit supply on savings is only a function of the policy rate[2]. Recent empirical research, however, emphasizes the role of macroprudential policy on credit supply. In an influential study, Lim et al. (2011) show that targeted macroprudential policies like the LTV and the Debt-Service-to-Income (DSTI) ratios are effective tools to tame credit. Relatedly, Akinci and Olmstead-Rumsey (2015) confirm these results and extend them by looking at the cumulative impact of LTV and DSTI on credit growth. Finally, Cerutti et al. (2017) perform an extensive cross-country analysis using panel regressions and they find that borrower-based macroprudential policies are important tools to constrain credit. Interestingly, the authors also highlight that macroprudential policies are particularly effective to curtail lending during boom periods. Overall, the empirical evidence indicates that macroprudential policy reduces the supply of loans.

By linking the theory on credit and savings with the empirical evidence that macroprudential policy constrains credit, we investigate if the imposition of stricter prudential boundaries explains the sustained surge in savings. It is to these matters that we turn next.

[2]The few exceptions highlight the complementary role of monetary and macroprudential policy in curbing financial instability. For example, Borio and Shim (2007) find that macroprudential policy should be used to counteract instability when the ability of monetary policy to lean against the wind is limited. These results are consistent with the DGE model proposed by Angelini et al. (2011) that shows that macroprudential policy should support monetary policy in response to shocks that pose a dire threat to stability. Notwithstanding, none of these papers directly relates macroprudential policy to credit supply and private spending (or, equivalently, savings).

3 Methodology

3.1 Method

Our methodology closely follows that of Callaway and Sant'Anna (2020). Assume there are T periods where $t = 1, \ldots, T$ and D_t is a binary variable that equals 1 when a country implements a macroprudential policy in quarter t and 0 otherwise. Let's define G_g equal to 1 when a country is first treated in quarter g and 0 otherwise. Also, let's assign C equal to 1 to the countries that never implement a household-targeted macroprudential policy in our sample (i.e., never-treated countries) and 0 otherwise. This implies that each country in the sample has exactly one G_g or C equal to 1[3].

Then, we can define the generalized propensity score $p_g(X)$ as the probability that a country is treated conditional on having covariates X and belonging to group g or the control group, i.e., $p_g(X) = P(G_g = 1|X, G_g + C = 1)$. Thus, the observed outcome in each period t is estimated as follows:

$$Y_t = D_t Y_t(1) + (1 - D_t) Y_t(0) \tag{1}$$

where $Y_t(1)$ and $Y_t(0)$ are the potential outcomes in time t with and without treatment, respectively.

In contrast to a standard difference-in-differences approach, our main causal parameter of interest is a group-time average treatment effect ($ATT(g,t)$). Put simply, the $ATT(g,t)$ is the average treatment effect experienced by group g in time t with 'group' being defined as the first period in which household-targeted macroprudential policies were implemented. It is estimated as below:

$$ATT(g,t) = E[Y_t(1) - Y_t(0)|G_g = 1] \tag{2}$$

In our panel data setup, the ATT for group g in period t can be nonparametrically identified and estimated as following[4]:

$$ATT(g,t) = E\left[\left(\frac{G_g}{E[G_g]} - \frac{\frac{p_g(X)C}{1-p_g(X)}}{E\frac{p_g(X)C}{1-p_g(X)}}\right)(Y_t - Y_{g-1})\right] \tag{3}$$

We are particularly interested in studying how the effect of macroprudential policy changes by group and time. Yet, making inference based on several different

[3] The staggered DiD assigns to the treated group the countries that adopted at least one macroprudential tool and to the control group the countries that never implemented any tool.

[4] Assuming (conditional) parallel trends, irreversibility of treatment and covariate overlap. See Callaway and Sant'Anna (2020) for additional details.

$ATT(g,t)$ is often troublesome (if not impossible). Therefore, we aggregate the $ATT(g,t)$ to obtain fewer causal effect parameters, which are easier to interpret. These parameters are unbiased and consistent estimates of the treatment effect of each group[5].

In our setting, there are two main drawbacks related to the aggregation of the $ATT(g,t)$. For starters, the estimator may be biased due to selective treatment timing. Since countries choose the timing of implementation of macroprudential tools, those who implement earlier may also experience earlier the effects of being treated. Thus, combining the $ATT(g,t)$ across g and t using a simple average may overweight the effect of early-treated groups with more observations in post-treatment periods. As a means of getting around this problem, we compute the $ATT(g,t)$ specific to each treated group and we average them across all post-treatment periods:

$$\tilde{\theta_S}(g) = \frac{1}{\tau - g + 1} \sum_{t=2}^{\tau} 1\{g \leq t\} ATT(g,t) \tag{4}$$

We then estimate the "overall ATT", θ_S, by aggregating the group-specific treatment effects across groups, as below:

$$\theta_S = \sum_{g=2}^{\tau} \tilde{\theta_S}(g) P(G = g) \tag{5}$$

Equation (6) is our summary measure of the effect of adopting macroprudential policy without overweighting the effect of the earlier-treated groups. This group parameter is an unbiased estimate of the impact of macroprudential policy on each treated group. Another potential drawback is that the effect of macroprudential policy on savings may be dynamic. For example, one may expect larger effects of macroprudential policy on savings in later periods. To account for the presence of dynamic treatment effects, we average the group-time ATT into treatment effects at different lengths of exposure to treatment, as follows:

$$\tilde{\theta_D}(e) = \sum_{g=2}^{\tau} \sum_{t=2}^{\tau} 1\{t - g + 1 = e\} ATT(g,t) P(G = g | t - g + 1 = e) \tag{6}$$

where e is the length of exposure to treatment. Finally, we average θ_D over all

[5]Not only is this likely to increase statistical significance, but it also reduces estimation uncertainty. See Wooldridge (2005), Goodman-Bacon (2018) and Athey and Imbens (2018) for an in-depth discussion.

possible values of e, as below:

$$\theta_D = \frac{1}{\tau - 1} \sum_{e=1}^{\tau-1} \tilde{\theta_D}(e) \tag{7}$$

Equation (7) is our summary measure for the dynamic treatment effects. It is worth noting that the main difference between θ_D and θ_S is in the weights: θ_D puts more emphasis on ATT (g,t) when g is significantly less than t. This enables groups with a longer exposure to macroprudential policy to be weighted more because we have few groups with longer periods of exposure. In the absence of selective treatment timing, the dynamic effects estimator captures the evolution of macroprudential policy effects over time.

Finally, we also run alternative model specifications that ensure that the parallel trends assumption holds conditional on a number of covariates deemed relevant in the literature. By construction, these covariates should be time invariant and affect savings, while remaining unaffected by macroprudential policy[6]. In any case, the results of our main model have a causal interpretation that remains valid under the unconditional or the conditional parallel trends assumption. This can be inspected visually in Figure 2 or using the Cramér-von Mises (CvM) test for the conditional parallel pre-trends assumption. The CvM approach is particularly suitable to our setting because we have heterogenous treatment groups. We find compelling evidence to not reject the unconditional parallel trends assumption (p-value: 0.953) nor the conditional parallel trends assumption (p-value: 0.948). This provides reassuring evidence that we can interpret a causal impact of macroprudential policy on household savings[7].

3.2 Data

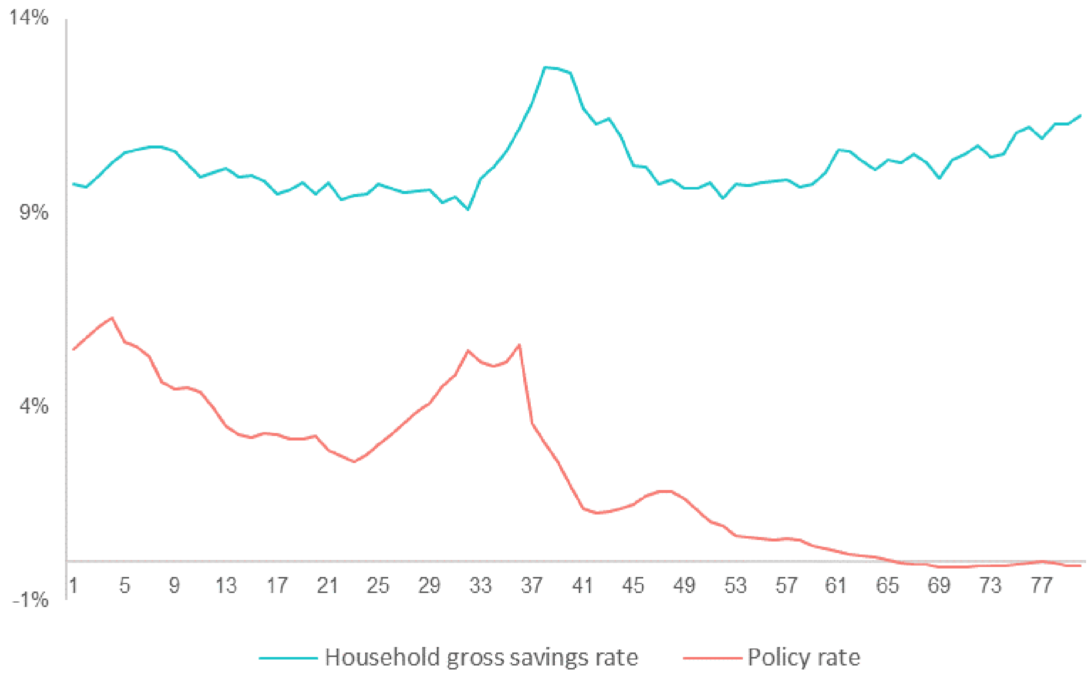
Our empirical setting uses quarterly data on 21 European countries covering the period 2000:Q1 to 2019:Q4[8]. Our main variables of interest are household gross savings and an indicator of household-targeted macroprudential policy. Later, we consider other potential explanatory variables in a number of robustness tests.

[6]When covariates are not time invariant, the "did" package in R sets the value of the covariate equal to the first quarter in the sample.

[7]Furthermore, our data does not suffer from stationarity issues. Results of Maddala and Wu test (Maddala and Wu, 1999) as well as the Pesaran test (Pesaran, 2007) are available in appendices.

[8]Our initial dataset comprises the 27 member states of the European Union and the United Kingdom. We exclude Cyprus, Malta, Luxembourg and Lithuania because households' gross savings exhibit severe swings. Additionally, Bulgaria, Greece and Romania are removed because household gross savings data is missing in the pre-treatment and/or post-treatment periods. Thus, our final dataset covers 21 countries from 2000:Q1 to 2019:Q4.

Figure 1: Gross Household Savings (%) during 2000-2019



Note: The y-axis compares the gross household savings rate to the policy rate and the x-axis is the number of quarters in our sample.

The household gross savings was collected from Eurostat's national accounts. It is defined as gross savings divided by gross disposable income with the latter being adjusted for the change in net equity of households in pension funds reserves. This data was readily available for most of the countries in the sample; when missing, it was interpolated from the annual series using a standard quadratic interpolation[9]. In Figure 1, we can see that household savings continued to increase amid the low interest rates during this period. The hike in the savings rate around quarter 40 corresponds to the period of the Great Recession and it may reflect a precautionary motive. The savings rate kept increasing rapidly in the period post-crisis and it is now significantly higher than in the pre-crisis period.

The variable on household-targeted macroprudential policy was built from the IMF iMaPP database on macroprudential policies (Alam et al., 2019)and updated with information from the ECB Macroprudential Bulletins. We assigned to the treated groups all the countries that implemented a macroprudential instrument targeting households' access to credit during this period, particularly LTV and DSTI

[9]Household gross savings was only interpolated for Estonia, Slovakia, Slovenia, Croatia, Hungary and Latvia. In the robustness checks, we omit Croatia because data is not available at the beginning of the series for the period 2000-2008.

ratios or loan restrictions[10]. As a result, the treated group in our main model contains 16 countries corresponding to 76% of the sample. The control group in our mail model is composed of countries that never implement a household-targeted macroprudential tool.

Although our sample of EU countries is fairly homogeneous, we consider the possibility that there may be covariate-specific trends in savings across groups. Therefore, we collect data on a number of factors that may vary across EU countries and that could potentially explain the variation on household gross savings. Our choice of explanatory variables is grounded on the existing literature[11], which suggests that monetary policy, government spending and households' income may also explain part of the variation on savings[12]. Our choice of explanatory variables is grounded on the existing literature, which suggests that monetary policy, government spending and households' income may also explain part of the variation on savings. To account for these possibilities, we run alternative specifications of our model that include the policy rate collected from the IMF IFS; the government budget balance from the ECB Macroprudential Database (MPDB); and the households' gross disposable income also available at the ECB MPDB[13].

4 Results

4.1 Main Results

Table 1 provides the results from our baseline DiD model. In this model, the main dependent variable is the household gross savings rate. Column 1 presents the results when the control group is composed by countries that have never implemented macroprudential (i.e., "never treated"); additionally, these results are

[10]We follow an approach similar to Lim et al. (2011) that focuses on policy tools that target banks' exposure to household risks, namely the LTV ratio, DSTI ratio and other loan restrictions.

[11]Other potential factors affecting the savings rate include stock market volatility and unemployment. It is worth noting that, by construction, the DiD may produce spurious results if we introduce covariates that can influence macroprudential policy. Given that macroprudential tools are often implemented in response to greater volatility in the markets and also variability in unemployment, we opt to run panel regressions with fixed effects to test the role played by these factors. The results obtained are in line with our estimations from the DiD (available on request). These results are not unexpected. After all, our sample is composed of EU countries that are fairly homogeneous and whose capital and labor markets usually move in the same direction.

[12]Countries with higher interest rates tend to benefit savers at the expense of borrowers (e.g., Coibion et al., 2017). Also, it is a stylized fact that Ricardian agents increase their savings when the government runs a budget deficit (Barro, 1974). Lastly, the marginal propensity to save increases with income (e.g., Dynan et al., 2004).

[13]Detailed descriptions and sources of the data are available in Appendix A.

estimated using the doubly robust method [14] and are aggregated by group. The remaining columns present the results using alternative specifications for the control group[15], the estimation method and the aggregation [16].

Broadly speaking, we find that the adoption of macroprudential policy is associated with a sharp increase in the gross household savings rate. This result is statistically significant in every model specification. In our main model, with no covariates, we find that macroprudential policy results in a 1.91% increment in the gross household savings rate. The size of the impact is surprisingly consistent across models - ranging from 1.39% to 3.10% - and it is only marginally lower when we increase the size of the control group to include not yet treated countries. If we consider that the average savings rate for both treated and non-treated countries in our sample is approximately 10.27%, this corresponds to an increase of up to one third in savings. These results corroborate our hypothesis that households increased their savings over and above what they would have had had they not faced macroprudential regulation.

As discussed earlier, a potential concern with our analysis is that we may overweight the early-treated groups. To address this issue, we compute each treated group's $ATT(g,t)$ and we then average them across all post-treatment periods.

The group effects of macroprudential policy on savings under unconditional parallel trends range from -2.70% to 8.45%, but they are mainly positive: only 1 out of 13 group effects was found negative and statistically significant, which contrasts sharply with the 8 positive group effects that are statistically significant. On the whole, there is a statistically significant positive impact of macroprudential policy on household gross savings.

Figure 2 displays the "dynamic" impact of macroprudential policy on savings under unconditional parallel trends. Figure 2 shows that the effect on household savings remains largely positive across time and indeed becomes stronger as the

[14] The ATT is computed using OLS regression to calculate the difference between the treated and the control groups for each observation. These differences are then weighted according to the probability of each observation occurring. This method does not extrapolate and it avoids the weaknesses associated with individual OLS and IPW.

[15] In the main model, we use a pool of countries in our control group who never implement macroprudential policy throughout the sample period. In addition, we can force the control group to include the countries that did not implement macroprudential policy at the time of "treatment". This increases the size of the control group at the expense of treatment heterogeneity (Sant'Anna and Marcus, 2020). Results remain consistent regardless of the control group specification.

[16] To circumvent the issue of earlier treatment groups being overweighted, we aggregate using group and dynamic effects. Our main model uses group aggregation, which allows us to see the group specific effect of macroprudential policy on savings. Using dynamic aggregation as an alternative specification enables us to study the impact of lengthening the duration of macroprudential policy.

Table 1: Results from the Baseline Model

Model	I	II	III	IV	V
Period	2000-2019	2000-2019	2000-2019	2000-2019	2000-2019
Treatment Group	Never Treated	Not Yet Treated	Never Treated	Not Yet Treated	Never Treated
Estimation	Doubly Robust	Doubly Robust	Doubly Robust	Doubly Robust	Regression
Aggregation	Group	Group	Dynamic	Dynamic	Group
Dependent	Gross Savings	Gross Savings	Gross Savings	Gross Savings	Gross Savings
Covariates	-	-	-	-	Disposable Income
ATT	1.91%	1.74%	3.10%	2.98%	1.39%
Stat. Significant	Yes	Yes	Yes	Yes	Yes

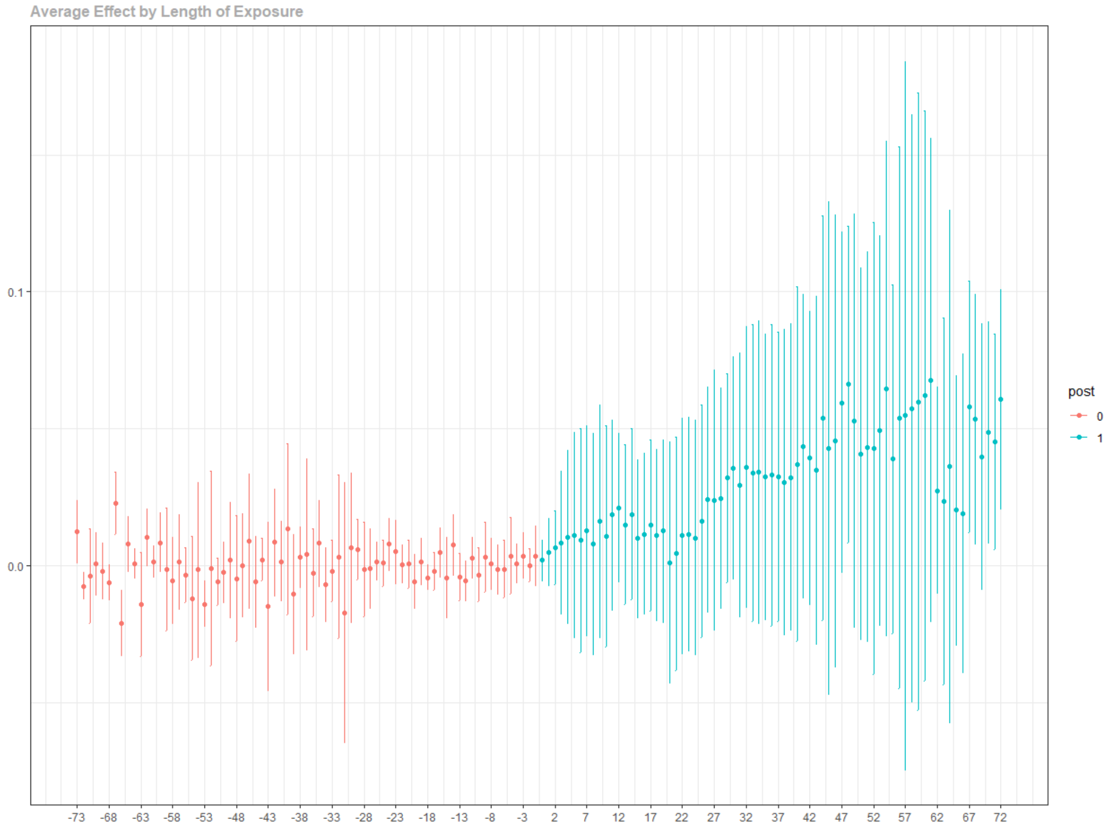
Note: The table reports the aggregated group treatment effect (ATT(g,t)) parameters estimated in Eq. (4) under both the unconditional and the conditional parallel trends assumption to evaluate the impact of macroprudential policy on savings across groups. The aggregated dynamic treatment effect parameters under unconditional parallel trends are also reported to evaluate the impact of macroprudential policy on savings over time. ATT(g,t) is the average treatment effect experienced by group g in time t. Statistical significance is reported at a 5% level.

length of exposure to macroprudential policy also increases[17]. On the whole, these results lend support to the argument that households save more in response to tighter macroprudential regulation.

As discussed earlier, a potential concern with our analysis is that we may overweight the early-treated groups. To address this issue, we compute each treated group's ATT (g,t) and we then average them across all post-treatment periods. The group effects of macroprudential policy on savings under unconditional parallel trends range from -2.70% to 8.45%, but they are mainly positive: only 1 out of 13 group effects was found negative and statistically significant, which contrasts sharply with the 8 positive group effects that are statistically significant. On the whole, there is a statistically significant positive impact of macroprudential policy on household gross savings.

[17] One should interpret these findings with care. It is worth noting that the dynamic impact of macroprudential policy on savings only becomes statistically significant after several quarters. In general, though, this impact is positive and increases over time, which corroborates our results.

Figure 2: Group Impact of Macroprudential Policy Under Unconditional Parallel Trends



Note: The x-axis is the length of exposure to the treatment. Length of exposure equal to 0 provides the average effect of implementing macroprudential policy across groups in the time period when they first implement macroprudential policy (instantaneous treatment effect). Length of exposure equal to -1 corresponds to the time period before groups implement macroprudential policy, and length of exposure equal to 1 corresponds to the first time period after initial implementation.

Figure 2 displays the "dynamic" impact of macroprudential policy on savings under unconditional parallel trends. It shows that the effect on household savings remains largely positive across time and indeed becomes stronger as the length of exposure to macroprudential policy also increases[18]. This dynamic effect lends support to the argument that households save more in response to tighter macroprudential regulation; but they also emphasize the need for policy makers to continuously adjust the macroprudential stance due to a potential snowballing effect on savings.

[18]One should interpret these findings with care. It is worth noting that the dynamic impact of macroprudential policy on savings only becomes statistically significant after several quarters. In general, though, this impact is positive and increases over time, which corroborates our results.

4.2 Individual Policy Choices

In this subsection, we disaggregate the effect of individual household-targeted macroprudential instruments. This enables us to determine the instruments that a more important role in driving savings. In particular, we look separately at the LTV ratio and the loan restrictions . To study the individual policy choices, we need to ensure that the treated country has not yet implemented one of the other household policy choices at the time of treatment. Additionally, the country should only implement a single household targeted policy in that period to ensure that we can properly disaggregate the impact of the individual policy choice.

Tables 2 and 3 presents the results of the impact of LTV ratios and loan restrictions on savings, respectively. We find that LTV ratios result in an increase in savings between 2.46% and 4.4%. In contrast, loan restrictions lead to a decrease in savings of roughly 0.61%. The impact of the LTV ratio is statistically significant in all cases, while the impact of loan restrictions is not. In summary, we find suggestive evidence that the increase in household savings may be driven first and foremost by macroprudential tools that explicitly restrict the amount borrowed, such as the LTV ratio.

Table 2: Results for LTV Ratios

Model	I	II	III	IV	V
Period	2000-2019	2000-2019	2000-2019	2000-2019	2000-2019
Macroprudential Instrument	LTV	LTV	LTV	LTV	LTV
Treatment Group	Never Treated	Not Yet Treated	Never Treated	Not Yet Treated	Never Treated
Estimation	Doubly Robust	Doubly Robust	Doubly Robust	Doubly Robust	Regression
Aggregation	Group	Group	Dynamic	Dynamic	Group
Dependent	Gross Savings	Gross Savings	Gross Savings	Gross Savings	Gross Savings
Covariates	-	-	-	-	Disposable Income
ATT	3.44%	3.37%	4.4%	4.35%	2.46%
Stat. Significant	Yes	Yes	Yes	Yes	Yes

Note: The table reports the aggregated group treatment effect (ATT) parameters estimated in Eq. (4) under both the unconditional and the conditional parallel trends assumption to evaluate the impact of LTV ratios on savings across groups. The aggregated dynamic treatment effect parameters under unconditional parallel trends are also reported to evaluate the impact of LTV ratios on savings over time. ATT(g,t) is the average treatment effect experienced by group g in time t. Statistical significance is reported at a 5% level.

Table 3: Results for Loan Restrictions

Model	I	II	III	IV	V
Period	2000-2019	2000-2019	2000-2019	2000-2019	2000-2019
Macroprudential Instrument	Loan Restrictions	Loan Restrictions	Loan Restrictions	Loan Restrictions	Loan Restrictions
Treatment Group	Never Treated	Not Yet Treated	Never Treated	Not Yet Treated	Never Treated
Estimation	Doubly Robust	Doubly Robust	Doubly Robust	Doubly Robust	Doubly Robust
Aggregation	Group	Group	Dynamic	Dynamic	Group
Dependent	Gross Savings	Gross Savings	Gross Savings	Gross Savings	Gross Savings
Covariates	-	-	-	-	Disposable Income
ATT	-0.61%	-0.53%	-0.40%	-0.32%	-0.78%
Stat. Significant	No	No	No	No	No

Note: The table reports the aggregated group treatment effect (ATT) parameters estimated in Eq. (4) under both the unconditional and the conditional parallel trends assumption to evaluate the impact of loan restrictions on savings across groups. The aggregated dynamic treatment effect parameters under unconditional parallel trends are also reported to evaluate the impact of LTV ratios and loan restrictions on savings over time. ATT(g,t) is the average treatment effect experienced by group g in time t. Statistical significance is reported at a 5% level.

Table 2 presents the results of impact of LTV ratios and loan restrictions on savings. Models I to V look at the impact of LTV ratios on household savings. Models VI to X look at the impact of loan restrictions on savings. We find that LTV ratios result in an increase in savings between 3.35% and 5.27%. Loan restrictions lead to a decrease in savings of roughly 0.5%. The impact of the LTV ratio is statistically significant in all cases. The impact of loan restrictions is not. In summary, the increase in household savings is being driven by LTV ratios. In general, macroprudential policy measures that restrict lending to particular sectors play an important role in curbing credit. Thus, measures that restrict the access to lending play an important role in the savings surge.

4.3 Robustness checks

Up to this point, this paper has shown that the persistent increase in savings is likely a result of tighter macroprudential policy. Yet, several other factors may be driving the increase in savings during this period. For example, households may be rebalancing their balance sheets following the Great recession or they may be pessimistic about the prospects of the economy.

To address these issues, we divide our sample into pre- and post-crisis periods as a robustness check. By studying the period pre-crisis as well as the period post-crisis, we can rule out the possibility that the soaring savings are only a consequence of low consumer confidence or balance sheet rebalancing.

Table 4: Results for 2000-2008 and 2010-2019

Model	I	II	III	IV	V	VI	VII
Period	2000-2008	2000-2008	2000-2008	2000-2008	2000-2008	2000-2008	2000-2008
Treatment Group	Never Treated	Not Yet Treated	Never Treated	Not Yet Treated	Never Treated	Never Treated	Never Treated
Estimation Method	Doubly Robust	Doubly Robust	Doubly Robust	Doubly Robust	Regression	Regression	Regression
Aggregation Method	Group	Group	Dynamic	Dynamic	Group	Group	Group
Dependent	Gross Savings	Gross Savings	Gross Savings	Gross Savings	Gross Savings	Gross Savings	Gross Savings
Covariates	-	-	-	-	Policy Rate	Disposable Income	Government Deficit
ATT	1.15%	1.22%	-0.13%	-0.05%	1.30%	0.53%	1.30%
Statistically Significant	Yes	Yes	No	No	Yes	No	Yes

Note: The table reports the aggregated group treatment effect (ATT) parameters estimated in Eq. (4) under both the unconditional and the conditional parallel trends assumption to evaluate the impact of macroprudential policy on savings across groups for the pre-crisis period. The aggregated dynamic treatment effect parameters under unconditional parallel trends are also reported to evaluate the impact of macroprudential policy on savings over time for the pre-crisis period. ATT(g,t) is the average treatment effect experienced by group g in time t. Statistical significance is reported at a 5% level.

Table 5: Results for 2010-2019

Model	IX	X	XI	XII	XIV	XV	XVI
Period	2010-2019	2010-2019	2010-2019	2010-2019	2010-2019	2010-2019	2010-2019
Treatment Group	Never Treated	Not Yet Treated	Never Treated	Not Yet Treated	Never Treated	Never Treated	Never Treated
Estimation Method	Doubly Robust	Doubly Robust	Doubly Robust	Doubly Robust	Doubly Robust	Regression	Regression
Aggregation Method	Group	Group	Dynamic	Dynamic	Group	Group	Group
Dependent	Gross Savings	Gross Savings	Gross Savings	Gross Savings	Gross Savings	Gross Savings	Gross Savings
Covariates	-	-	-	-	Disposable Income	Disposable Income, Government Deficit	Government Deficit
ATT	0.90%	0.86%	1.2%	1.16%	0.75%	0.85%	0.91%
Statistically Significant	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The table reports the aggregated group treatment effect (ATT) parameters estimated in Eq. (4) under both the unconditional and the conditional parallel trends assumption to evaluate the impact of macroprudential policy on savings across groups for the post-crisis period. The aggregated dynamic treatment effect parameters under unconditional parallel trends are also reported to evaluate the impact of macroprudential policy on savings over time for the post-crisis period. ATT(g,t) is the average treatment effect experienced by group g in time t. Statistical significance is reported at a 5% level.

Tables 4 and 5 present the results for the pre-crisis period and post-crisis periods, respectively. Our estimations reveal that macroprudential policy resulted in a 1.15% increase in gross household savings in the pre-crisis period and a 0.90% increase in the gross household savings rate post-crisis period. Ergo, the increase in savings is positive and statistically significant. As one would expect, our results suggest that the panic sowed by the Great Recession triggered a rise in savings; nonetheless, savings grew unabated in the period following the crisis, which suggests that panic cannot be the factor driving savings. Moreover, we would like to point out that households only rebalance their balance sheets in the aftermath of a crisis; yet, our results show that macroprudential policy already explains the surge in savings before the crisis took place. Although we do not attempt to provide indisputable evidence on this matter, our DiD with multiple time periods in the pre-crisis period shows that savings respond positively to tighter macroprudential requirements. These results hold regardless of the choice of treatment group, covariates and estimation methods.

Finally, an unintended consequence of our model choice is that we cannot capture the effects of either loosening or removing a policy. For instance, our results may vary when we consider the overall number of macroprudential policies adopted in the country or the intensity of these requirements. To validate our results, we run a panel regression of savings on a cumulative index of household targeted macroprudential policy . We find that a one unit increase in the number of macroprudential tools spurs savings between 5% to 11%. Overall, these results are consistent with our previous findings and provides additional evidence that macroprudential policy drives household savings.

5 Conclusion

The recent surge in savings amid low interest rates emphasizes the need for theory to examine why interest rates may sometimes fail to drive spending. This paper focuses on the role of macroprudential policy and its effects on savings. Using a DiD approach with multiple groups and time periods, we show that credit restrictions imposed by macroprudential policy are inextricably intertwined with the sustained surge in savings.

We do not intend to survey the whole collection of factors that affect savings through credit nor do we contend that macroprudential policy is some deus ex machina explanation for the increase in savings. We do, however, provide compelling evidence that macroprudential policy is a key driver of savings, particularly in the context of low interest rates. Going forward, DGE models and empirical work could offer alternative explanations by disentangling the effects of the interest rate from other factors that restrict access to credit.

In addition, some limitations of our method point to potential research opportunities. First, our DiD approach assumes that a country becomes treated as soon as it implements a macroprudential policy; however, our model does not fully explore the effects of a change in the overall macroprudential stance. For example, it would be interesting to separate the effects of tightening, loosening or removing macroprudential policies on households' savings. Further, when we run separate DiDs for each individual instrument, we find suggestive evidence that the type of instrument determines the response of households. Thus, understanding the role of macroprudential tools on savings remains a potentially fruitful area for research.

Notwithstanding, we have shown that savings are an important transmission channel through which macroprudential policy affects growth. In fact, we find that a longer exposure to macroprudential policy amplifies the effect on savings with a detrimental impact on growth. These results have profound implications for policy makers trying to halt a crisis. While macroprudential policy may be an effective tool to curb instability, it can also grip the economy when left unattended. As macroprudential policy has the ability to drive savings, policy makers should be cautious about using it liberally.

Appendices

A Data Description

Variable	Type	Source	Details
HH_Gross_savings_rate	Dependent	Eurostat	Gross saving (B8G) divided by gross disposable income adjusted for changes in pension entitlements (B6G + D8net); Seasonally and calendar adjusted. Quarterly data.
Policy_rate	Control	IMF IFS	Central Bank Policy Rate; Short-term interest rate (%). Quarterly data.
Gov_budget_balance	Control	ECB MPDB	The government surplus/deficit is equal to revenue minus expenditure. Net lending (pos) / net borrowing (neg). Ratio to gross domestic product. Neither seasonally adjusted nor calendar adjusted - ESA 2010. Quarterly data.
Gross_disposable_income_YoY	Control	ECB MPDB	Gross national income (at market prices) + current transfers receivable by resident units from the rest of the world - current transfers payable to non-resident units from the rest of the world. Neither seasonally adjusted nor calendar adjusted - ESA 2010. Per capita, year-on-year growth rate. Quarterly data.
LoanR_HH	Policy	IMF iMaPP	Household loan restrictions which include loan limits and may be conditioned on loan characteristics like the maturity, the size, the type of interest rate and the LTV ratio. Index cumulated to a quarterly frequency.
LTV	Policy	IMF iMaPP	Limits to the loan-to-value ratios, including those mostly targeted at housing loans, but also includes those targeted at automobile loans, and commercial real estate loans. Index cumulated to a quarterly frequency.
DSTI	Policy	IMF iMaPP	Limits to the debt-service-to-income ratio and the loan-to-income ratio, which restrict the size of debt services or debt relative to income. They include those targeted at housing loans, consumer loans, and commercial real estate loans. Index cumulated to a quarterly frequency.

Note: Data sources as well as the details of each variable included in our analysis.

B Unit Root Tests

Maddala and Wu Test (Maddala and Wu, 1999) for the Presence of a Unit Root
H0: Presence of a Unit Root

	Observations	Statistic	P-Value
Policy Rate	1680	69.200	0.005
hh_gross_savings_rate	1680	184.765	0.0000
gov_deficit	1652	810.475	0.0000
gross_disposable_income_yoy	1680	864.993	0.0000

Pesaran Test (Pesaran, 2007) for the Presence of a Unit Root
H0: Presence of a Unit Root

	Observations	Statistic	P-Value
Policy Rate	1680	-6.716	0.0000
hh_gross_savings_rate	1680	-3.699	0.0000
gov_deficit	1652	-20.320	0.0000
gross_disposable_income_yoy	1680	-16.043	0.0000

Note: First generation Maddala and Wu Test for panel unit roots (Maddala and Wu, 1999) results based on: Ho: All panels contain unit roots and Ha: At least one panel is stationary. The results of an Inverse Chi-squared test are presented in the above table with both the Test Statistic as well as the p-value being quoted. The presence of a unit root is rejected for the cases where the p-value < 0.1. Statistical test results based on regression equations with sum of the macroprudential policy choices included as the index value.

C Macroprudential Policy Implementation in the Sample

Country	Date of implementation	Policy Implemented
Croatia	2006-Q4	LTV
Czech Republic	2015-Q2	LTV, Loan Restrictions
Denmark	2003-Q2	Loan Restrictions
Estonia	2015-Q1	LTV, Loan Restrictions, DSTI
Finland	2010-Q1	LTV
Hungary	2010-Q1	LTV, Loan Restrictions, DSTI
Ireland	2001-Q4	LTV
Latvia	2007-Q2	LTV
Netherlands	2007-Q1	DSTI
Poland	2006-Q4	Loan Restrictions
Portugal	2018-Q3	LTV, Loan Restrictions, DSTI
Slovakia	2014-Q4	LTV
Slovenia	2016-Q3	LTV, DSTI
Spain	2009-Q1	Loan Restrictions
Sweden	2004-Q3	LTV
United Kingdom	2009-Q1	Loan Restrictions

Note: Date of first implementation of macroprudential policy for every country in our sample and brief description of the policy.

D Description of Control and Treated Groups

Sample Period	Control Group	Treated Group
2000-2019	Austria	Croatia
	Belgium	Czech Republic
	France	Denmark
	Germany	Estonia
	Italy	Finland
		Hungary
		Ireland
		Latvia
		Netherlands
		Poland
		Portugal
		Slovakia
		Slovenia
		Spain
		Sweden
		United Kingdom
2000-2008	Austria	Denmark
	Belgium	Ireland
	Czech Republic	Latvia
	Estonia	Netherlands
	Finland	Poland
	France	Sweden
	Germany	
	Hungary	
	Italy	
	Portugal	
	Slovakia	
	Slovenia	
	Spain	
	United Kingdom	
2010-2019	Austria	Czech Republic
	Belgium	Estonia
	France	Portugal
	Germany	Slovakia
	Italy	Slovenia

Note: Treated and control group members for the full sample, pre-crisis sample and the post-crisis sample. A country is assigned to the control group when the country has not implemented macroprudential policy and does not implement macroprudential policy at any point during the sample period. A country is assigned to the treatment group when the country has implemented macroprudential policy at some point during the sample period.

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