Lisbon School of Economics & Management
Universidade de Lisboa

MASTER

MONETARY AND FINANCIAL ECONOMICS

MASTER'S FINAL WORK

DISSERTATION

REGULATING ACCESS TO HOUSING CREDIT: THE ROLE OF MACROPRUDENTIAL POLICY IN SHAPING AFFORDABILITY AND HOUSING DYNAMICS

MIGUEL FERREIRA TRINDADE MATOS OSÓRIO

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SUPERVISION:

ANDRÉ MANUEL VENTURA SOARES TEIXEIRA

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Miguel Osório 30/06/2025

Glossary

GDP - Gross Domestic Product

HCOB - Housing Cost Overburden ratio

FE - Fixed effects

LTV - Loan-to-Value ratio

DSTI - Debt service-to-income ratio

GDI - Gross Disposable Income

MaPP - Macroprudential Policy

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I would not have achieved this milestone without them.

Abstract

This dissertation examines the effects of borrower-based macroprudential policies, specifically the LTV and DSTI ratio, on housing market dynamics and affordability across Eurozone countries. Using panel fixed effect regressions from 2005 to 2020, the study evaluates how these tools influence house prices, rent prices, and the housing cost overburden rate. Results suggest that LTV tightening reduces housing prices and improves affordability, while DSTI effects are more moderate and statistically insignificant in most specifications. The aggregate macroprudential indexes show limited impact on rent prices but a consistent, influence in improving affordability. Robustness tests include a one-year lag on the macroprudential measures and the exclusion of the 2008-2011 financial crisis period, my analysis confirms that MaPP impacts the dependent variables with a delay effects, while also acknowledging that the Baseline results were influenced by the housing price drop, felt during the subprime crisis. Overall, the finding suggests that targeted macroprudential policy can effectively reduce house prices while improving affordability.

KEYWORDS: Macroprudential policy; Housing Prices; Affordability; Fixed Effects; Eurozone

JEL CODES: C23; E58; G21; G28; R21; R31.

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1. Introduction

The study of Macroprudential tools and their effects is still in its infancy. Following the great recession in 2008, policymakers and researchers saw the need to implement regulatory tools that could mitigate potential systemic risks in the financial system. The Great Recession exposed critical weaknesses in the existing regulatory framework, particularly the lack of oversight over mortgage lending practices and the failure to adequately recognize speculative behaviour in housing markets. In response, macroprudential policy gained prominence as a complement to monetary policy, aimed at mitigating systemic risk and curbing the build-up of credit booms.

Macroprudential policy's main objective is to safeguard the financial system and to minimize systemic risk, including risks that arise through structural or cyclical problems, such as excessive credit growth, maturity mismatches, and leverage. For instance, banks experiencing liquidity stress in the short run, due to maturity mismatch between short-term deposits and long-term loans, making the bank illiquid to potential externalities that may arise. To that extend, liquidity requirements, large significant exposure limits, and LTD ratio caps can be introduced as a Liquidity-based measure.

Furthermore, systemic risk may also arise from a failure of institutions, leading to a wholesale of the asset market, through fire sales, which in turn has a contagion effect on the rest of the banks' balance sheet. Excessive lending with looser credit standards might also lead to the accumulation of risk over time, resulting in credit booms and asset price bubbles, to counteract the formation of these risks, borrowed-based measures can be introduced, such as LTV ratio caps and DSTI ratio caps, (Bank of England, 2009).

Among the vast set of macroprudential tools, borrower-based especially LTV and DSTI caps, have been largely used by most countries to contain household leverage in a counter-cyclical way. Most papers try to investigate the effectiveness of such policies, Cerutti, et al. (2017) used a panel of 119 countries to check the effects of LTV, DSTI and capital requirements have on leverage and concluded that the tools tested are effective in reducing pro-cyclical leverage, working less well in busts than they do in boom phases, especially in emerging markets. Similarly, Gross & Población (2017) developed a dynamic balance sheet model for households to try and understand how macroprudential

policies would affect households risk profile, more specifically they assess unconstrained scenarios and compare the risk parameter responses, when LTVs and DSTIs caps are imposed. The simulation suggests that households that had the higher initial LTV ratios, see a higher drop in the probability of their loans to default, meaning that household's ability to meet their debt obligations is improved.

Despite extensive evidence on the effectiveness of macroprudential tools, several important topics are underexplored. This dissertation aims to address some of these gaps, by examining the effects of borrower-based macroprudential tools, mainly LTV and DSTI on how credit availability can affect households' affordability, exploring how changes in policies can relax housing burden situations. In addition, this thesis will also explore the dynamics of house prices in response to macroprudential regulation, by examining whether LTVs and DSTIs can smooth housing cycles.

Although most studies already tested the effects of macroprudential policy on housing prices, rent price dynamics are still underexplored especially under a panel setting, a big reason why is the fact that macroprudential policy, especially borrowed-based measures affect rent prices indirectly, since rent prices are more dependent on rent market dynamics, fiscal policy and disposable income of households rather than constraints in credit, making it hard to study, with possible biased or insignificant results. Furthermore, my thesis also contributes by studying these effects using fixed effect regressions controlling for unobserved time-invariant differences across the different countries.

This thesis contributes to the growing literature on macroprudential policy effects by analysing how LTV and DSTI ratio limits affect the housing market across Eurozone countries. While previous studies often focus on house price stabilization or on how such policies can make the financial sector more resilient, mitigating potential global financial crisis, this work provides a broader perspective by examining not only price dynamics (rent and housing prices), but also affordability pressures and households' decisions regarding their tenures.

By combining housing cost indicators with macroprudential policy data, the analysis captures both the supply-side and demand-side effects of regulatory tightening, offering new insights into how such tools shape market outcomes and the decisions of economic agents.

A second key contribution lies in the use of fixed effects regressions, which control for unobserved and time-invariant differences across countries and time, to explore heterogeneity in the effects of macroprudential policy, I estimate separate models testing three different macroprudential independent variables, first an index of tightening and loosening of 17 different macroprudential tools, LTVs and DSTIs, for all dependent variables two different fixed effect regressions were used, first a regression with demand, financial and supply-side controls and another regression with the use of a one-year lag on the macroprudential variables. Adding to that, I also present a rich and impactful analysis on how macroprudential policy can increase or decrease inequality in terms of housing burden indicators.

Macroprudential policy if effective can diminish the potential negative consequences of a financial crisis, since it lowers banks exposures to all kind of potential risks, such as non-performing loans, which can disrupt the snowball effect of asset depreciation, ensuring higher liquidity due to higher liquidity ratios, the decrease of credit due to borrowed-based macroprudential policy, mitigating the risk of non-performing loans and the potential bank losses associated with them.

This dissertation explores a key focus of macroprudential policies, two sets of tools that are commonly used to mitigate the risks associated with mortgage lending. These two instruments are the LTV and the DSTI. Among these, the LTV ratio is particularly important as it limits excessive leverage, the logic behind it is rather simple, a lower LTV implies that the borrower must contribute a higher share of the property's value upfront (e.g., 7% instead of a hypothetical 5% previously), reducing the loan amount. Ceteris Paribus, this results in lower interest payments, since interest is charged on a smaller principal. Even if the mortgage interest rate remains constant, the overall cost of borrowing is reduced.

Furthermore, loans with lower LTV ratios are generally considered less risky, which can lead lenders to offer more favourable rates. This in turn, facilitates repayments and lowers the likelihood of borrower default, another contribution for the reduction in defaults is the fact that borrowed-based policies restrict who can extend credit, limiting those that don't have the means to pay the upfront amount under the new regulation.

The second tool is the DSTI ratio, which aims to curb excessive private debt by limiting the percentage of a borrower's income that is allocated to servicing debt, by doing this regulators ensure that loans are granted only to households with sufficient incomes to meet the new ratio, thereby reducing households that contract new loans with already excessive debt, lowering the probability of default, bank exposures and bank losses.

Several studies already empirically tested whether macroprudential policies effectively reduce systemic risk, mitigating possible consequences of busts. My dissertation will not focus on this aspect of macroprudential policy, since it is already well documented, instead I will pivot to the borrower's aspect.

In theory, more restrictions can lead to a lower demand on mortgage credit, since the initial payment needs to be higher, and the borrower needs to have a less risky profile (lower DSTI), however this trend can have spillover effects, depending on a set of factors, as less borrowers are eligible for mortgages, if borrowed-based tightening's are effective.

To compensate banks might decide to increase mortgage margins, and on the other hand, since the borrower profile is less risky, banks might decide to reduce their margins, hence different countries might have different effects for the same policy implementation, depending on how strong the financial system is, and by how much mortgage demand is reduced and whether the borrower's risk profile declines.

Depending on the interactions of such effects rental market could indirectly experience changes as well, potentially increasing its prices if restriction on credit shifts demand from the housing sector to the rental, potentially increasing rental prices. However, as my results explain the interactions between macroprudential policy and rent prices does not demonstrate statistical significance, this is due to possible biased results as rent prices can be affected indirectly by credit constraints, while other idiosyncratic factors are not controlled for, such as fiscal policy, rent control policies, and stronger controls for specific rental supply.

Following the introductory discussion, this thesis seeks to respond two main research questions. First, how do LTV and DSTI constraints contribute to stabilizing housing markets in Eurozone member states, by influencing the dynamics of house and rent

prices? Second, what is the impact of borrowed-based measures on housing affordability and financial pressure, measured by the housing cost overburden rate?

These research questions are particularly relevant for my selected sample, Eurozone member states, where housing prices have been increasing in rapid pace, understanding whether borrowed-based measures such as LTV and DSTI caps can help stabilize housing dynamics, while also alleviating financial pressure on households. These finding provide relevant insights for policymakers that were unsure if macroprudential policy could have spillover effects on affordability.

The rest of this dissertation is structured as follows. Section 2 provides a comprehensive review of the existing literature, including the core objectives of macroprudential policy and its effects on output and financial stability. Section 3 outlines the data and methodology. It explains the rationale behind the control variables used, supported by the relevant literature, it discusses potential issues within the dataset in terms of observations and all the variable transformations. The methodology section also presents the econometric theory behind the use of fixed effect regressions and describes the baseline model used for the regressions. Section 4 highlights the baseline regressions by incorporating regression tables and interpreting the empirical findings. Section 5 presents two robustness tests, a lag version of the baseline regressions, and an analysis on a sample that excludes the subprime crisis. Section 6 concludes by summarising the main contributions, results, limitations of the dissertation, and suggestions for future academic research.

2. Literature Review

The literature about the uses and economic and social effects of macroprudential policies and all the other indirect effects is scarce; these regulatory measures were somewhat overlooked before the Great Recession of 2008, which illustrated apparent deficiencies in the financial sector.

It became evident that the previous macroeconomic policy framework was outdated, as evidenced by the lack of effectiveness in mitigating the effects of the banking crisis, and its global spread. A new set of regulations, inspired by the work of Crockett (2000) and the Bank of International Settlements (BIS), was introduced, and a new

macroeconomic paradigm emerged, one that complemented both monetary policy and macroprudential policies used for countercyclical management (Smets, 2014), while the use of monetary policy shifted to an interest rate based policy, ensuring price stability (controlled inflation), meanwhile, macroprudential policy focused on financial stability, ensuring increased resilience for potential negative shocks, preventing and or the very least control systemic risk (Smets, 2014; IMF, 2013).

The joint integration of macroprudential policy pushed the academia to study its effects. On the effectiveness of macroprudential tools, there is to date scarce empirical literature, (Galati & Moessner, 2013) although limited it has gained increasing academic interest, existing literature predominantly studies three key subgroups.

The first subgroup links macroprudential policies and credit growth and leverage, (Lim, et al., 2011) analysed these links using data from 49 countries, and found that credit growth and Asset price inflation declined after the implementation of LTV caps in more than half of the countries in the sample, DSTI, reserve requirements and dynamic provisioning rules were also effective in reducing the "procyclicality of credit and leverage".

In a similar way Dell'Ariccia, et al.(2012) studied the risks of "Credit Booms" and how macroprudential policy is useful to counteract these dangers, in a cross-country study Dell'Ariccia found that macroprudential policies (being the most effective loan eligibility criteria regulation, most notably LTV and DSTI restrictions), can reduce the risk exposure of a bust, ultimately mitigating the consequences and probability of a boom culminating in a major economic crash.

Although the existing literature provides a well-rounded foundation on the effectiveness of macroprudential policies, comprehensive cross-country evidence on the specific policies implemented across a large set of countries remains limited. Moreover, few studies assess which instruments are most effective in mitigating procyclicality in the financial system. Cerutti et al. (2017) seeks to address these gaps by examining the use of 12 macroprudential tools across a large and diverse sample of 119 countries. Their analysis explores the relationship between the application of these instruments and developments in credit and house prices. To avoid potential endogeneity problems, they apply the Arellano-Bond (1991), Generalized Method of Moments (GMM), and found

that emerging countries use macroprudential policies more frequently, while advanced countries use borrowed-based policies, like LTV and DSTI ratios more, furthermore, he found a pattern of decreasing growth of credit, being the effects more evident on emerging economies than in financially advanced and open countries. Moreover, he concludes that macroprudential policies have great use in managing financial cycles, predominantly on boom cycles.

The second subgroup of literature links macroprudential policies and their effects in managing housing prices, with the use of borrowed-based policies that aim to decrease the demand of mortgage loans. See (Kuttner & Shim, 2013; Cronin & McQuinn, 2016; Cerutti et al., 2017; Akinci & Olmstead-Rumsey, 2018; Kelly, et al., 2018).

Kelly et al. (2018) provides an empirical analysis on the Irish mortgage market between 2003 and 2010, focusing on the effects of LTV, LTI and DSR on credit availability and house prices. Their findings suggest that these macroprudential tools have substantial impact on house prices, with the level of application and timing (If competent regulatory bodies implement these policies during bust or boom phases), are crucial to determine the real effects of these policies.

Similarly, Akinci and Olmstead-Rumsey (2015), analyse macroprudential tightening and loosening for seven different macroprudential tools across 57 advanced and emerging economies between 2000Q1 to 2013Q4, their results indicate that tightening of such policies are associated with lower bank credit growth, housing credit growth and house price inflation.

In contrast, Kuttner and Shim (2013) conduct a broad panel analysis across 57 countries spanning over thirty year and find more mixed results. While DSTI caps are showed to have a significant effect on credit growth, LTV caps appear less significant, moreover, among all policies studied, only housing-related taxes exhibit a statistically significant impact on housing prices appreciation, while LTVs and DSTI ratios do not show relevant significance on house prices.

On the topic of Rental Market analysis Cronin and McQuinn (2016), show that a reduction in the LTV ratio (LTV tightening), leads to an increased rental demand, pushing up rental prices for a given house price level. Arguing that a lower mortgage accessibility

influences household tenure decision. In my study in section 4, as to corroborate this result, one would expect the coefficient of my dependent variable, Rent Prices, to be positive in response to an LTV tightening.

Lastly, some authors also try to investigate whether macroprudential tools have potential negative or positive effects on output growth, arguing that a reduction in credit availability could shrink the economy, as less investment is done, influencing the gross product generated in the short run, while some argue that in the long run macroprudential policy can have a positive effect on GDP growth and on the variable volatility – see (Boar, et al., 2017; Richter, et al., 2018; Kim & Mehrotra, 2018; Teixeira, 2022; Teixeira & Venter, 2023; Galán, 2024).

Richter et al. (2018) applies a narrative identification strategy based on the reading of policymaker's objectives when implementing changes in the maximum LTV ratios, finding that a 10-percentage point reduction in the maximum LTV ratio results in a 1,1-percentage point decline in Real GDP over a four-year horizon. Similarly, Kim & Mehrotra (2018), using a panel VAR framework on Asia-Pacific regions, show that tighter macroprudential policies have negative effects on macroeconomic aggregates such as Real GDP and the Price Level.

Contrarily, Boar et al. (2017) analyses a panel of 64 advanced and emerging countries, investigating the effects of macroprudential policies on a long-run setting on economic performance indicators, concluding that countries which more frequently use macroprudential tools, *ceteris paribus*, experience stronger and less volatile GDP growth, adding to that the authors evidence that non-systematic (reactive policies) macroprudential policies tend to be detrimental to growth.

Along the same lines, Gálan (2020) extended the use of quantile regressions of GDP growth, and found two distinct effects on growth, a negative effect on the median of GDP growth distribution, but also a positive effect on reducing the downside risk of GDP growth, arguing that this positive effect on Growth-at-Risk are larger than the negative effects on the median, suggesting a "net benefit" of macroprudential policies via lower volatility of GDP growth.

Adding to that Teixeira & Venter (2023) use a difference-in-difference (DID) model to investigate the effects that macroprudential policy has on aggregate demand, finding that MaPP reduces households consumption in the short and long-run, but interestingly firm investment increases in the long-run, concluding that although the impact of MaPP is negative, their results show that especially in the long-run "MaPP has a weaker macroeconomic cost than previously suggested in the literature".

Furthermore, Teixeira (2022) explores another channel that MaPP affects output growth, using individual data from 122 countries, exploring the effects that macroprudential policy has on both savings and borrowing, the empirical results suggest that higher MaPP is effective in reducing borrowing, but it also translates into increased savings by households, which negatively affect demand and subsequently output growth through the savings channel.

3. Data and Methodology

3.1. Data

I analyze the factors that influence housing prices in Eurozone countries over a nineteen-year period (2005-2020), focusing on three main determinants of housing prices and affordability constraints, demand-side, supply-side and financial determinants. Filling a gap in the housing literature, moreover I also test the effects that borrowed-based macroprudential policies have in the housing cycles.

The rising growth in housing prices, combining with rising financing costs, ultimately reduces the purchasing power of households, that will spend a higher percentage share of their disposable income to housing related expenditures such as mortgages and rents (Melecky & Paksi, 2024). Following this simple reasoning I will also analyze affordability and tenure decisions, specifically the housing cost overburden rate, that represents the percentage of households that spend more than 40% of their disposable income in housing expenditures, this trend of higher prices, while having a decrease in the purchasing power, will also affect tenure decisions.

As to construct a standardized fixed effect regression model, I will use demand, financial and supply controls to reduce bias across the panel. All my dependent variables depend directly or indirectly from these determinants.

If house prices rise, rent prices may follow the same behavior, as landlords may need to pay higher mortgages, furthermore there will be a higher cost of homeownership, potentially shifting the demand for housing to the rental market, in turn this increase demand in the rental market might push rent prices up, and vice versa (Duca, et al., 2021; Bo, 2024). As such if housing prices increase ceteris paribus, households' affordability will also be affected, especially the HCOB rate.

For the control variables, most studies focus on economic output influence, mostly represented by the GDP growth and labor market conditions, via the unemployment rate and the average wage (Maynou, et al., 2021; Cunha & Lobão, 2021), conventionally higher GDP growth, higher average wage growth with lower unemployment rate increases housing demand which in turn increases housing prices, in my study I opted to exclude average wages as it presented high multicollinearity values with GDP per capita growth and gross disposable income per capita of households, I also added demographic control, population growth, that influences the amount of credit extended and changes in housing demand.

Some authors add financial determinants to their models, as to check accessibility of households to mortgage financing and how does it affect demand (Égert & Mihaljek, 2007; Robstad, 2018; Maynou, et al., 2021), for the financial determinants I opted to integrate the Interbank rate, the Credit-to-GDP rate, and my independent variables the LTV, DSTI ratio and the Macroprudential index. As some authors explain, macroprudential policies and other financial determinants like the ones mentioned above, can influence housing prices, as they diminish credit growth and reduce demand for mortgage loans, reducing housing price growth (Kuttner & Shim, 2016; Cerutti et al. 2017; Kelly et al. 2018).

Demand and financial determinants are not the solely determinants that explain the housing cycles. Although less explored by the academia, more notably due to lack of data, supply determinants also play a big explanatory role (Borowiecki, 2009; Sivitanides, 2018; Geng, 2018; Belke & Keil, 2018; Melecky & Paksi, 2024). The scarcity of

international level data on supply determinants limits the cross-country analysis one can do, most authors when using supply variables focus on a single-country analysis and some panel analysis using regional data.

On my research I encountered this same difficulty, where construction cost data had to be removed from my analysis due to lack of available data, although these visible constraints, two supply controls are used in the next section. The first is building permits, which represent the number of residential buildings (excluding residences for communities) that receive official approval to construct a new building or to expand or remodel an existing one. The second is Investment in Dwellings (% of GDP), giving us a strong baseline on the future availability of both new and existing dwellings.

The Eurozone is composed of European Union member countries that have adopted the euro as their official currency, I selected these group of countries to reduce bias, as all these countries are under the same exchange rate and monetary policy regime, and all eurozone countries are considered developed, which makes the panel more uniform and comparable.

This analysis focuses on those member countries with comparable macroeconomic and housing related data, from 2001 to 2020. The initial database was established by merging several OECD, Eurostat and World Bank sources, that cover a broad set of indicators that were already described above.

Due to data limitations, the database was subjected to observation losses, from the initial maximum of 500 observations, if all data was available from 1995-2020 for all 20 member states. My dependent variables only had available data starting from 2001, while some important controls did not have data for Cyprus and Malta, which lead to their exclusion from the dataset, leading to a new maximum of 360 observations.

The Real House Price Index excluded another country, Croatia, and six other countries have data gaps, Estonia and Slovakia only have data from 2005 onwards, Latvia and Lithuania 2006 onwards, Luxembourg and Slovenia 2007 onwards, losing a total of 50 observations.

The Real Rent Price Index has the maximum number of observations 360, the HCOB on the other hand only has data starting from 2004 onwards, and with eight countries with

data gaps, Germany and Croatia only have data from 2010 onwards, Estonia Lithuania, Latvia, Netherlands, Slovakia and Slovenia from 2005 onwards.

GDI per capita was constructed by dividing the gross disposable income of households by total population, this transformation did not affect the number of observations, as data was available for all countries and years except for Germany (2011-2020) and Ireland (2009-2020).

GDP growth, population growth, unemployment rate and Investment in dwellings (% of GDP) have the maximum observations of 360. The Interbank rate is only missing 9 observations, while domestic credit to private sector (% of GDP) has gaps for six Eurozone countries, which decreased the number of observations to 320.

Finally, Building Permits is the variable with the biggest observation loss, since it only had available data from 2005 onwards for all countries.

In sum, the regressions for housing prices and housing cost overburden rate will have the lowest count of observations, but with low discrepancy from the other regressions, and supply controls shrinks the timeline to 2005-2020, and with a final 18 countries considered. For better understanding, data and sources are available in appendix 1.

Table 1. Descriptive Statistics.

Variables	Obs	Mean	Std. Dev.	Min	Max
Ltv Change	360	.061	.292	-1	1
Dsti Change	360	.042	.271	-1	1
Mapp Change	360	.103	.464	-1	2
Mapp Cum	360	.117	.525	-1	4
Hcob	290	8.982	6.778	2.2	45.5
Unemployment rate	360	9.267	4.607	1.805	27.686
Inv Dwell (%GDP)	360	4.633	2.153	.6	13.5
Interbank rate	351	1.401	1.981	-.556	9
Credit to GDP ratio	320	85.833	29.521	32.3	173.382
Building permits	288	74.509	125.059	2.1	735
Rent price index	360	90.446	17.301	33.025	133.365
GDI per capita	340	14,772.981	7,438.287	2,411.891	39,434.09
House prixe index	310	108.249	20.081	62.991	169.242

Population growth	360	.227	.819	-2.233	2.92
GDP per capita growth	360	3.248	4.861	-14.724	36.45

Note: The table presents summary statistics for the sample. "LTV Change" and "DSTI Change" are dummy variables coded one when the respondent is in a country that implements an LTV or DSTI ratio in twelve months prior to the survey and coded minus one if those ratios are relaxed. "MaPP Change" captures the net number of macroprudential policy actions taken in the previous year, assigning +1 for each tightening and -1 for each loosening. In contrast, "MaPP Cum" is a cumulative measure, recording the total number of active restrictions overtime – ongoing measures continue to be counted in subsequent years until they are lifted. The "Hcob" represents the percentage of households that pay 40% of their disposable income on housing related expenditures. "Inv Dwell (%GDP)" represents the annual gross investment in dwellings as a percentage of GDP, "Interbank rate" is the interest charged on short-term loans made between financial institutions. "Credit to GDP ratio" is the domestic credit to private sector by banks as a percentage to GDP. "Building permits" represent the final authorization to start work on a building project, and it is measured in thousands. "Rent price index" and "House price index", represent the evolution of real house and real rent prices, with base year 2015=100. "GDI per capita" is the total income available to each person for spending and saving after deducting income taxes and social contributions. "GDP per capita growth" represents the evolution of GDP at current U.S. dollar divided by midyear population. Finally, "Population growth" represents the annual variation of population.

3.2. Model Specification

To test my hypothesis, I use panel data regression using fixed effects. By focusing on within-country variations and discarding between-country differences, the fixed effect model helps to eliminate potential biases appearing from unobserved heterogeneity. This is particularly relevant in cross-country studies, where country-specific characteristics, such as institutional framework or long-term housing policies, could significantly influence the outcome variables. All that unexplained variability is "absorbed" by the fixed effects, providing more robust and consistent coefficient estimates than those obtained under a random effect model.

STATA was used to test my preliminary models. This tool allowed me to use a simple fixed effect model which controls for unobserved heterogeneity among the different cross sectional units (different countries), hence this type of model can help to avoid omitted variable bias, since it controls unobserved factors that might be correlated with both the dependent and independent variables, ensuring the improvement of coefficients, as the results reflect within-entity variations rather than cross-entity differences.

The baseline model tests how the different macroprudential tools, demand, financial and supply determinants affect the dependent variables.

$$Dep_{it} = \beta_0 + \beta_1 iMapp_{it} + \beta_2 GDP\_percapita\_growth_{it} + \beta_3 Population\_Growth_{it} + \beta_4 GDI\_percapita_{it} + \beta_5 Credit\_GDP_{it} + \beta_6 Interbank_{it} + \beta_7 Unemployment_{it} + \beta_8 Inv\_Dwellings_{it} + \beta_9 Permits_{it} + \alpha_i + \varepsilon_{it} \quad (1)$$

The Dep_{it} refers to all the dependent variables that I tested for, those represent the evolution of Real House and Real Rent prices and the Housing cost overburden rate. The independent variable, $iMapp_{it}$ refers to four different macroprudential variables.

Two of these correspond to indices derived from 17 different macroprudential policies, "MaPP Change" and "MaPP Cum", the first captures the net number of macroprudential policy actions taken in the previous year, assigning a +1 for each policy tightening and -1 for each loosening, on the other hand "MaPP Cum" is a cumulative measure , recording the total number of active restrictions over time, where ongoing measures continue to be counted in subsequent years until they are lifted.

The remaining two independent variables correspond to individual macroprudential policies: the "LTV Change" and "DSTI Change." Both have the same construction as the previous variable, "MaPP Change," although their range only goes from -1 if the policy is relaxed to +1 if the policy is implemented.

The demand controls selected were, $GDP\_percapita\_growth_{it}$ which refers to the growth of GDP at current U.S. dollars divided by the midyear population, Gross Disposable Income per capita of households and NPISH growth rate ($GDI\_percapita_{it}$), Unemployment rate ($Unemployment_{it}$), Population growth ($Population\_Growth_{it}$), while the two financial controls selected were the Interbank rate ($Interbank_{it}$) and the Credit to GDP rate ($Credit\_GDP_{it}$). Furthermore, to account for possible effects arising from the housing supply two proxies for housing availability were also introduced, Permits issued for dwellings ($Permits_{it}$), and Investment in dwellings as a percentage of GDP ($Inv\_Dwellings_{it}$).

The baseline regression results are presented in three tables, each following the same structure, but applied to different dependent variables. Column 1 exhibits the effects of LTV, column 2 the effects of DSTI, column 3 the effects of "MaPP Change", and column 4 the effects of "MaPP Cum".

4. Baseline Results

For this section, based on the results presented in (Akinci & Olmstead-Rumsey, 2015; Cerutti et al, 2017; Kelly et al, 2018), we should expect LTV and DSTI ratios, as for the index of macroprudential tools to present a negative relationship with housing prices, meaning that the usage of macroprudential policy should exhibit a downward pressure on house prices, since macroprudential policy directly affects credit availability, and the housing market is dependent on credit conditions, which consequently should decrease the demand for mortgage loans, ultimately decreasing housing prices, see table 2.

For the rent prices variable, following the results of Cronin and McQuinn (2016), and other researchers, the expected effects of Macroprudential policy should in theory be positive, since a contraction in housing demand supposes a shift in household tenure choices to the rental market, pushing up rental prices, however the rental market presents different macroeconomic interactions, first contrarily to housing prices, rent prices are not affected directly from tightening actions of macroprudential policy, as their nature depend more on the dynamics of the rental market, such as changes in demand and supply, fiscal policy and disposable income of households, this indirect link with macroprudential policy can shape the rental market, but in my model the statistical significance might be limited, has MaPP tightening could not be directly affecting changes in the rental prices, see table 3.

The dependent variable housing cost overburden rate represents the percentage of households that pay more than 40% of their disposable income in housing related expenditures such as mortgage payments and rents, which means that this variable depends on a few factors, hence results might be mixed depending on the effects that macroprudential policy have on both housing prices and disposable income of households, as most studies suggest, macroprudential policy has a negative relationship with housing prices, but it might also slowdown the economy in the short-run, reducing investment and output via credit decline, which in turn contributing to a potential decline in households disposable income, see table 4.

Although I expect LTV to have a more impactful effect, since it affects all borrowers, it being effective in reducing housing prices, with a higher effect than the anticipated increase in rental prices, leading to a more affordable aggregate housing sector.

Table 2. Baseline regression – effects of Macroprudential measures on housing prices.

Variables	Housing Prices			
LTV_{it}	-1.088			
	(1.963)			
$GDP\_percapita\_growth_{it}$	-0.185	-0.213	-0.197	-0.205
	(0.209)	(0.199)	(0.207)	(0.207)
$Population\_Growth_{it}$	3.924	3.969	3.967	3.992
	(3.493)	(3.477)	(3.494)	(3.513)
$GDI\_percapita_{it}$	0.00477***	0.00479***	0.00477***	0.00478***
	(0.000997)	(0.000986)	(0.000992)	(0.000983)
$Credit\_GDP_{it}$	0.0543	0.0498	0.0521	0.0502
	(0.0988)	(0.0980)	(0.0992)	(0.101)
$Interbank_{it}$	3.078***	3.167***	3.126***	3.151***
	(0.937)	(0.898)	(0.920)	(0.907)
$Unemployment_{it}$	-0.920	-0.868	-0.893	-0.874
	(0.540)	(0.518)	(0.536)	(0.539)
$Inv\_Dwellings_{it}$	4.022***	4.100***	4.079***	4.104***
	(1.323)	(1.389)	(1.364)	(1.383)
$Permits_{it}$	-0.00404	-0.00425	-0.00443	-0.00445
	(0.0206)	(0.0208)	(0.0208)	(0.0209)
$DSTI_{it}$		0.777		
		(1.102)		
$MaPP\_Change_{it}$			-0.0782	
			(0.896)	
$MaPP\_Cum_{it}$				0.166
				(0.786)
Constant	12.93	12.01	12.57	12.29
	(22.17)	(22.01)	(22.12)	(21.89)
Observations	243	243	243	243
R-squared	0.775	0.774	0.774	0.774
Number of countries	17	17	17	17

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: This table reports estimates for the impact of macroprudential policy on the Real House Price Index to determine whether MaPP variables are effective in managing housing cycles. All specifications present results from the within estimator which controls for country fixed effects. The structure is as follows: Col.1 tests the impact of "LTV Change"; Col.2 the impact of "DSTI Change"; Col.3 the impact of "MaPP Change", and Col.4 the impact of "MaPP Cum". The subsequent table 3 and 4, follow the same structure, only changing the dependent variable analyzed.

Table 3. Baseline regression – effects of Macroprudential measures on Rent prices.

Variables	Rent Prices			
LTV_{it}	0.0675			
	(1.181)			
$GDP\_percapita\_growth_{it}$	-0.0767	-0.0484	-0.0577	-0.0501
	(0.127)	(0.122)	(0.123)	(0.126)
$Population\_Growth_{it}$	5.737*	5.786*	5.747*	5.691*
	(3.094)	(3.124)	(3.094)	(3.048)
$GDI\_percapita_{it}$	0.00365***	0.00362***	0.00365***	0.00365***
	(0.000993)	(0.000988)	(0.000990)	(0.000991)
$Credit\_GDP_{it}$	-0.0599	-0.0555	-0.0569	-0.0532
	(0.0626)	(0.0632)	(0.0632)	(0.0635)
$Interbank_{it}$	-1.503**	-1.566**	-1.548**	-1.560**
	(0.544)	(0.550)	(0.553)	(0.558)
$Unemployment_{it}$	0.146	0.106	0.117	0.0864
	(0.631)	(0.636)	(0.641)	(0.654)
$Inv\_Dwellings_{it}$	1.548**	1.507**	1.492**	1.449**
	(0.655)	(0.655)	(0.662)	(0.662)
$Permits_{it}$	-0.0381**	-0.0385**	-0.0380**	-0.0381**
	(0.0171)	(0.0173)	(0.0171)	(0.0171)
$DSTI_{it}$		-1.700		
		(1.640)		
$MaPP\_Change_{it}$			-0.659	
			(0.987)	
$MaPP\_Cum_{it}$				-0.835
				(0.914)
Constant	36.97*	37.77*	37.41*	37.52*
	(21.15)	(21.05)	(21.18)	(21.20)
Observations	256	256	256	256
R-squared	0.632	0.634	0.633	0.633
Number of countries_wid1	18	18	18	18

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Baseline regression – effects of Macroprudential measures on the HCOB rate.

Variables	HCOB			
LTV_{it}	-1.057*			
	(0.578)			
$GDP\_percapita\_growth_{it}$	0.103*	0.0934	0.103*	0.107*
	(0.0545)	(0.0570)	(0.0544)	(0.0533)
$Population\_Growth_{it}$	0.287	0.305	0.308	0.273
	(0.838)	(0.870)	(0.843)	(0.836)
$GDI\_percapita_{it}$	6.17e-05	4.99e-05	4.80e-05	5.18e-05
	(0.000302)	(0.000304)	(0.000308)	(0.000306)
$Credit\_GDP_{it}$	0.0142	0.0125	0.0141	0.0163
	(0.0149)	(0.0166)	(0.0155)	(0.0145)
$Interbank_{it}$	0.220	0.246	0.223	0.216
	(0.212)	(0.225)	(0.217)	(0.215)
$Unemployment_{it}$	0.336**	0.354**	0.339**	0.321**
	(0.127)	(0.125)	(0.125)	(0.124)
$Inv\_Dwellings_{it}$	-1.455***	-1.399**	-1.429***	-1.455***
	(0.458)	(0.493)	(0.470)	(0.459)
$Permits_{it}$	0.0146***	0.0142**	0.0142**	0.0142**
	(0.00495)	(0.00505)	(0.00504)	(0.00501)
$DSTI_{it}$		-0.144		
		(0.582)		
$MaPP\_Change_{it}$			-0.430*	
			(0.227)	
$MaPP\_Cum_{it}$				-0.522**
				(0.199)
Constant	8.650	8.524	8.736	8.795
	(5.990)	(5.984)	(6.064)	(6.019)
Observations	256	256	256	256
R-squared	0.525	0.515	0.520	0.523
Number of countries	18	18	18	18

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table baseline regressions display the fixed effects regression results of the relationship between macroprudential tools and other economic controls on the three different dependent variables (Housing Prices, Rent Prices and Housing cost overburden rate) in Eurozone member states. The analysis includes four macroprudential indicators, LTV, DSTI, MaPP Change and MaPP Cumulative, and controls for demand, financial and

supply-side determinants. Table 2 displays the relationship between housing prices and the independent and control variables, table 3 the relationship with rent prices, and table 4 with the HCOB rate.

The LTV presents some promising results across the different observations, although without statistical significance in two out of three models, this lack of statistical significance for the housing index and rent index might reflect the not immediate impact of borrowed-based measures, moreover, rent prices as explained before is not impacted directly by credit constraints, they depend indirectly via the decrease demand for mortgage loans, hence for this variable insignificance might arise from this indirect effect, and the lack of fiscal policy controls presented in my model.

LTV tightening is associated with a -1.09% decrease in housing prices, although it lacks statistical significance, this result aligns with the theoretical expectations that stricter LTV limits reduce borrowing capacity, cooling housing demand and thereby lowering house prices.

With respect to rent prices an LTV tightening is associated with a small and statistically insignificant positive coefficient of 0.07%. This suggests that LTV tightening does not have an immediate or strong impact on rental price dynamics. However, the positive sign aligns with the theoretical expectation that stricter LTV limits reduce mortgage access across all income levels, thereby pushing some potential homeowners into the rental market and creating upward pressure on rent prices.

Regarding the HCOB rate, an LTV tightening is associated with a statistically significant negative coefficient of -1.06%, supporting the hypothesis that tightening LTV ratios helps reduce the HCOB rate. By limiting mortgage borrowing relative to the value of the property, LTV restrictions reduce the probability of highly leveraged purchases that could push households into cost burden situations, as it also stabilizes housing dynamics.

In contrast DSTI presents at first glance unexpected results, although with statistically insignificant results. It exhibits a positive relationship with housing prices, with coefficient 0.78%, a plausible explanation is the composition shift that occurs when DSTI caps are tightened, as lower income or more financially vulnerable borrowers may be excluded from the mortgage market, while higher income households, that are less

constraint by DSTI limits, become more active. These buyers are often able to purchase more expensive properties, which can raise average transaction prices even if the total number of transaction declines.

Note that this does not happen in the case of LTV, as a LTV tightening affects all type of borrowers equally, as a higher income household still needs to pay a higher downpayment associated with the respective loan, which is not the case for DSTI, therefore a positive effect on house prices may emerge not from increased demand, but from a shift in the distribution of demand towards wealthier segments. Hence, we can conclude that DSTI is not effective in managing housing cycles.

For the real rent price index, DSTI shows a negative coefficient of -1.70%, this result is expected if we assume that demand for medium to high end housing increases, which potentially leads to a decrease demand of these type of rentals, leading to an aggregate fall of the Rent prices, we should also note that rent prices are not directly affected by credit constraints, hence results suffered in terms of statistical relevance.

In respect to the HCOB rate, the DSTI variable presents a negative but statistically insignificant coefficient of -0.14%. This result suggests that DSTI tightening does not significantly affect the HCOB rate in this sample. This might be due to DSTI policies primarily affecting lower-income households who are already at the margin of affordability.

Looking at the MaPP indexes and their relationship with housing prices, “MaPP Change”, displays a statistically insignificant negative coefficient of -0.08% reflecting a small dampening effect of broader macroprudential tightening’s on house prices. However, “MaPP Cum” exhibits an insignificant effect but positive with coefficient of 0.17%, revealing that a lasting broader macroprudential tightening could in the short-run slightly increase housing prices.

The lack of statistical significance may stem from the aggregated nature of these indexes, which pool together 17 different tools that do not uniformly affect mortgage lending or housing dynamics, still the positive coefficient exhibited for the accumulation of MaPP policies shows some interesting and policy relevant result, showing that if the

goal is to stabilize housing prices, the interaction of some tools in a long lasting setting could disrupt that objective.

Both macroprudential policy indexes, “MaPP Change” and “MaPP Cum”, present negative and statistically insignificant coefficients (-0.66% and -0.84% respectively) regarding their interactions with rent prices, suggesting that aggregate macroprudential tightening’s transmission to rent prices appears limited. The lack of statistical significance could reflect the broader nature of these indexes, in which some tools might not influence rental dynamics.

In respect to the HCOB rate, both macroprudential indexes, “MaPP Change” and “MaPP Cum”, show negative coefficients. “MaPP Change” is statistically significant with coefficient -0.43%. Similarly, “MaPP Cum” is significant with coefficient -0.52%. These results suggest that broader macroprudential tightening contributes to reducing housing cost burdens over time, likely due to their nature of stabilizing financial cycle by mitigating systemic risk, smoothing out affordability concerns.

The coefficient of GDP per capita growth rate is negative across all specifications in regards to housing prices, ranging from -0.19%% to -0.21%, though none of these estimates are statistically significant, furthermore it also presents a negative relationship in respect to rent prices, with coefficients ranging from -0.05% and -0.08%, these findings contrasts with the standard expectations that economic growth theory dictated, by boosting income and confidence, it should lead to an increased housing demand and price appreciation.

One potential explanation lies in the countercyclical nature of macroprudential policy used in the models, that are typically implemented during economic expansions, as to reduce potential excessive credit and leverage, as most authors suggest at least in the short-run, MaPP may cause a reduction in GDP growth as it should also do in GDP per capita growth, which may dampen the positive effects of growth on housing prices.

Another plausible explanation comes from the nature of this variable, as an increase in GDP per capita growth might also come from the reduction of total population, which in the short-run should increase the ratio, with lower population demand for housing decreases and potentially housing prices.

Additionally, GDP per capita growth rate affects positively the HCOB rate, with statistically significant coefficients ranging from 0.09% to 0.11%, a plausible explanation for this effect is that GDP growth affects disproportionally higher income households the most, and since majority of households in overburden situation, belong to the lower brackets of income, and increase in GDP per capita might not translate into lower housing burden for households.

Population growth exhibits expected results, as an increase in the ratio directly translates into an increase in housing and rent demand, although without statistical significance, a one percentage point increase in population growth leads to a high positive coefficient of 3.97% in housing prices, moreover it seems that the effects are higher for the rental market, having a positive and statistical significance coefficient of around 5.79%. Contrarily, it seems that population growth does not exhibit a high impact on the HCOB rate, with statistical insignificant results of around 0.30%.

GDI per capita affects both the housing and rental markets, as a higher disposable income should in theory increase demand for both markets, my results exhibits exactly that, if I scale the variable to 1000€ increase in the control variable, this will lead to a statistically significant coefficient of 4.77% for housing prices and 3.65%, indicating that rising households incomes is a key driver of housing demand and price appreciation. Moreover, an increase in disposable income ceteris paribus, decreases the HCOB rate, but my results show that if there is an increase of 1000€, it will lead to an increase of the HCOB rate, suggesting that housing prices appreciates more than the gross disposable income, worsening burden situation of households.

The interbank rate displays a positive and statistically significant effect for housing price models (coefficients around 3.08% and 3.17%), and a negative and statistically significant effect on rental prices (coefficients around -1.50% and -1.57%), although counterintuitive, since higher interest rates should I theory reduce borrowing, an increase in the interest rates may reflect measures taken during economic booms, when housing markets are already “hot”, as such speculatory behavior and optimism may delay possible effects of monetary policy. Hence, the positive relationship might not derive from the impact of increasing interest rates, but from a period of speculation and high investment, a lagged effect of monetary policy might be more suitable to understand its real effects.

The unemployment rate exhibits expected results across all specifications, presenting a negative but statistically insignificant relationship with housing prices, with coefficients of around -0.92%, a positive but statistically insignificant relationship with rent prices, with coefficients of around 0.15%, and a positive and statistically significant relationship with the HCOB rate, with coefficients of around 0.35%. These results confirm that worsen labor conditions leads to a decrease demand of housing, as banks are most likely refusing to borrow to anyone that does not have a stable income, furthermore, rent prices rise slightly, as it can be a shift of demand that overturns the decrease in incomes.

Investment in dwellings (% of GDP) displays a strong, positive and highly statistically significant coefficient of 4.10%, suggesting that periods of robust investment are associated with rising prices, possibly because such investment follows rather than leads market demand. Similarly, it shows a positive and statistically significant association with rent prices, with coefficients of approximately 1.49% likely reflecting demand-driven investment activity in booming rental markets.

In contrast it shows a consistently negative and highly significant effect with coefficients -1.46%, this result is counterintuitive, since the previous analysis showed that an increase in investment increases both the housing and rental markets. However, an increase in dwelling investment also increases supply for more affordable housing, as there can be vacancies for affordable dwellings, possibly decreasing the HCOB rate.

Building Permits show a negative and statistically insignificant effect in housing prices but expected as increased supply of new dwellings should decrease the prices on aggregate, scaled results show that a 10000 permit increase is associated with a decline of roughly -0.04%, similarly it also exhibits a negative but statistically significant effect on rent prices, scaled results show that a 10000 permit increase is associated with a decline of approximately -0.39%.

Overall, the results suggest that macroprudential policy are not effective in controlling housing prices in the short-run, a one-year lag analysis will be executed in the next section, as to better understand macroprudential effectiveness.

Rental prices in the Eurozone are more strongly driven by structural fundamentals, particularly demographic growth and household income than by short-term

macroprudential interventions. While LTV tightening may induce modest upward pressure on rents by broadly restricting access to homeownership, DSTI measures appear to exert a broader dampening effect on both ownership and rental markets, particularly through their focus on more vulnerable households.

The consistently insignificant results across MaPP variables further suggest that general macroprudential tightening does not translate into pronounced rental price effects, at least not in the short term or through aggregate channels. For the HCOB rate the borrower-based macroprudential policies, particularly LTV restrictions and the broader macroprudential tightening indexes, are associated with reductions in the housing cost overburden rate. While DSTI policies do not show a statistically significant impact, the broader regulatory environment, along with economic and supply-side factors, plays a substantial role in shaping housing affordability in the Eurozone.

5. Robustness tests

To do the robustness tests I adopted two different strategies, the first one will be to see the lagged effects of macroprudential policy, following the same strategy of the models investigated in the previous section, but adding a one-year lag to the macroprudential variables as it can be seen in equation (2), second, I re-estimated the baseline model using equation (1) and (2) after excluding the 2008-2011 period, which corresponds to the great financial crisis, to confirm that the observed effects are not solely driven by the crisis shock.

$$Dep_{it} = \beta_0 + \beta_1 iMapp_{it-1} + \beta_2 GDP\_percapita\_growth_{it} + \beta_3 Population\_Growth_{it} + \beta_4 GDI\_percapita_{it} + \beta_5 Credit\_GDP_{it} + \beta_6 Interbank_{it} + \beta_7 Unemployment_{it} + \beta_8 Inv\_Dwellings_{it} + \beta_9 Permits_{it} + \alpha_i + \varepsilon_{it} \quad (2)$$

5.1. Lagged Effects of Macroprudential Policy: Baseline Evidence

By Lagging the Macroprudential variables, I seek to understand the possibility that the impact of MaPP is not immediate, and that delayed effects exist, due to adjustment frictions in credit markets, and demand and supply responses. The results for tables 5, 6 and 7 will be analyzed below.

Table 5. Robustness test – lagged effects of Macroprudential measures on housing prices.

Variables	Housing Prices			
$GDP\_percapita\_growth_{it}$	-0.161	-0.200	-0.183	-0.186
	(0.188)	(0.198)	(0.191)	(0.193)
$Population\_Growth_{it}$	4.027	3.955	4.076	3.986
	(3.408)	(3.489)	(3.451)	(3.473)
$GDI\_percapita_{it}$	0.00486***	0.00477***	0.00479***	0.00478***
	(0.000982)	(0.000987)	(0.000993)	(0.000992)
$Credit\_GDP_{it}$	0.0624	0.0514	0.0566	0.0571
	(0.0977)	(0.0973)	(0.0980)	(0.0990)
$Interbank_{it}$	3.016***	3.137***	3.071***	3.084***
	(0.912)	(0.904)	(0.908)	(0.902)
$Unemployment_{it}$	-0.982*	-0.885	-0.944*	-0.944*
	(0.542)	(0.515)	(0.533)	(0.530)
$Inv\_Dwellings_{it}$	3.855***	4.089***	3.988***	4.000***
	(1.247)	(1.370)	(1.292)	(1.310)
$Permits_{it}$	-0.00336	-0.00436	-0.00453	-0.00452
	(0.0201)	(0.0209)	(0.0205)	(0.0206)
LTV_{it-1}	-4.146**			
	(1.851)			
$DSTI_{it-1}$		0.234		
		(0.840)		
$MaPP\_Change_{it-1}$			-1.346	
			(0.900)	
$MaPP\_Cum_{it-1}$				-0.862
				(0.888)
Constant	12.13	12.40	12.88	12.85
	(22.03)	(22.04)	(22.18)	(22.12)
Observations	243	243	243	243
R-squared	0.780	0.774	0.776	0.775
Number of countries	17	17	17	17

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: This table reports the one-year lag of macroprudential policy estimates for the impact on the Real House Price Index to determine whether MaPP variables affect housing prices with a one-year delay. All specifications present results from the within estimator which controls for country fixed effects. The structure is as follows: Col.1 tests the impact of "LTV Change"; Col.2 the impact of "DSTI Change"; Col.3 the impact of "MaPP Change", and Col.4 the impact of "MaPP Cum". The subsequent table 3 and 4, follow the same structure, only changing the dependent variable analyzed.

Table 6. Robustness test – lagged effects of Macroprudential measures on Rent prices.

Variables	Rent Prices			
$GDP\_percapita\_growth_{it}$	-0.0790	-0.0685	-0.0689	-0.0656
	(0.127)	(0.122)	(0.123)	(0.124)
$Population\_Growth_{it}$	5.728*	5.852*	5.785*	5.765*
	(3.107)	(3.235)	(3.198)	(3.153)
$GDI\_percapita_{it}$	0.00364***	0.00364***	0.00366***	0.00367***
	(0.00100)	(0.000990)	(0.000996)	(0.000999)
$Credit\_GDP_{it}$	-0.0605	-0.0572	-0.0578	-0.0557
	(0.0632)	(0.0625)	(0.0634)	(0.0637)
$Interbank_{it}$	-1.499**	-1.543**	-1.525**	-1.530**
	(0.539)	(0.543)	(0.542)	(0.545)
$Unemployment_{it}$	0.152	0.107	0.123	0.105
	(0.627)	(0.639)	(0.640)	(0.648)
$Inv\_Dwellings_{it}$	1.564**	1.507**	1.501**	1.473**
	(0.652)	(0.668)	(0.682)	(0.685)
$Permits_{it}$	-0.0382**	-0.0387**	-0.0381**	-0.0382**
	(0.0171)	(0.0174)	(0.0172)	(0.0173)
LTV_{it-1}	0.381			
	(1.421)			
$DSTI_{it-1}$		-1.783		
		(2.316)		
$MaPP\_Change_{it-1}$			-0.576	
			(1.305)	
$MaPP\_Cum_{it-1}$				-0.709
				(1.175)
Constant	37.04*	37.68*	37.12*	37.15*
	(21.12)	(21.14)	(21.11)	(21.15)
Observations	256	256	256	256
R-squared	0.632	0.634	0.632	0.633
Number of countries	18	18	18	18

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7. Robustness test – lagged effects of Macroprudential measures on the HCOB rate.

Variables	HCOB			
$GDP\_percapita\_growth_{it}$	0.102	0.0902	0.0958	0.0970
	(0.0625)	(0.0559)	(0.0602)	(0.0603)
$Population\_Growth_{it}$	0.328	0.288	0.334	0.317
	(0.811)	(0.863)	(0.828)	(0.834)
$GDI\_percapita_{it}$	8.72e-05	5.46e-05	5.89e-05	6.18e-05
	(0.000296)	(0.000304)	(0.000304)	(0.000303)
$Credit\_GDP_{it}$	0.0149	0.0119	0.0135	0.0145
	(0.0149)	(0.0170)	(0.0161)	(0.0158)
$Interbank_{it}$	0.232	0.255	0.237	0.237
	(0.220)	(0.226)	(0.223)	(0.223)
$Unemployment_{it}$	0.334**	0.361**	0.342**	0.334**
	(0.124)	(0.130)	(0.127)	(0.128)
$Inv\_Dwellings_{it}$	-1.468***	-1.391**	-1.424***	-1.436***
	(0.452)	(0.496)	(0.461)	(0.455)
$Permits_{it}$	0.0145***	0.0143**	0.0142**	0.0141**
	(0.00494)	(0.00516)	(0.00501)	(0.00500)
LTV_{it-1}	-1.348*			
	(0.669)			
$DSTI_{it-1}$		0.203		
		(0.391)		
$MaPP\_Change_{it-1}$			-0.386	
			(0.250)	
$MaPP\_Cum_{it-1}$				-0.404*
				(0.213)
Constant	8.254	8.378	8.550	8.557
	(5.893)	(5.965)	(5.987)	(5.961)
Observations	256	256	256	256
R-squared	0.529	0.515	0.518	0.519
Number of countries	18	18	18	18

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

LTV tightening is associated with a -4.15% decrease in housing prices, presenting a more impactful effect once lagged and with statistical significance. This result aligns with the theoretical expectations of the effects of LTV, but it also confirms that potential macroprudential effects have a delayed effect. With respects to rent prices an LTV tightening also presents a stronger effect than in table 3, while still being insignificant with coefficient 0.38%. Regarding the HCOB rate a lagged LTV tightening is associated

to a negative and statistically significant coefficient of -1.35%. These coefficients align with the baseline results, presenting stronger negative effects for the housing prices and HCOB rate, and a stronger positive effect for rent.

The lagged DSTI presents similar results as the ones analyzed in the baseline regressions, maintaining statistical insignificant results across all specifications. The positive relationship with housing prices decreases slightly to 0.23%, and its relationship with rent prices was nearly unchanged with coefficient -1.78%. These results strengthen my conclusion that DSTI is not effective in stabilizing housing appreciation.

Regarding the MaPP indexes and their relationship with housing prices, "MaPP Change", displays a statistically insignificant negative coefficient of -1.35%, a substantial jump when comparing with its immediate effect showed in the previous section. Furthermore, "MaPP Cum" exhibits an insignificant effect but negative result with coefficient of -0.86%, contrary to the small positive result when no lag was used, revealing that broader macroprudential measures take time to materialize.

Both macroprudential policy indexes, "MaPP Change" and "MaPP Cum", present similar negative and statistically insignificant coefficients when comparing to the baseline results, with a slight reduction of their impact (-0.58% and -0.71% respectively) regarding their interactions with rent prices, suggesting that aggregate macroprudential tightening's transmission to rent prices appears limited, even when we consider a lagged effect of such measures. For the HCOB rate both display similar negative results, "MaPP Change" a negative and statistically insignificant coefficient of -0.39%, and "MaPP Cum" a negative and statistically significant coefficient of -0.40%.

In sum, the lagged effects of the four macroprudential tools exhibit a more statistically sound result, with more impact on their relationship with the dependent variables, except for the changed signed for the variable "MaPP Cum" when addressing housing prices, all the other specifications demonstrate similar equal coefficient signs in respect to those of the baseline regressions.

5.2. Macroprudential Effects: Evidence Excluding the 2008–2011 Crisis

To further test the stability of the results, a robustness check was conducted by excluding the period from 2008 to 2011, which corresponds to the beginning of the global financial crisis and its aftermath. This period was characterized by extraordinary market conditions and extensive policy intervention (e.g. quantitative easing), which could distort the effectiveness of macroprudential measures. The new estimates confirm the overall trends found in the LTV and DSTI variables but indicate shifts in coefficient sign for both MaPP indexes when testing for housing and rent prices, as is presented in tables 8, 9 and 10.

Table 8. Robustness test – effects of Macroprudential measures on house prices (excluding the years 2008-2011).

Variables	Housing Prices			
LTV_{it}	-0.700			
	(1.877)			
$GDP\_percapita\_growth_{it}$	-0.242	-0.283	-0.267	-0.289
	(0.236)	(0.213)	(0.222)	(0.217)
$Population\_Growth_{it}$	1.676	1.589	1.673	1.724
	(3.611)	(3.585)	(3.614)	(3.627)
$GDI\_percapita_{it}$	0.00557***	0.00565***	0.00561***	0.00564***
	(0.000982)	(0.000961)	(0.000977)	(0.000959)
$Credit\_GDP_{it}$	-0.0545	-0.0655	-0.0615	-0.0720
	(0.101)	(0.1000)	(0.101)	(0.0998)
$Interbank_{it}$	4.213***	4.351***	4.316***	4.399***
	(1.352)	(1.306)	(1.328)	(1.315)
$Unemployment_{it}$	-0.718	-0.626	-0.656	-0.571
	(0.708)	(0.667)	(0.686)	(0.653)
$Inv\_Dwellings_{it}$	3.173**	3.229**	3.227**	3.289**
	(1.336)	(1.404)	(1.383)	(1.403)
$Permits_{it}$	0.0156	0.0168	0.0160	0.0168
	(0.0179)	(0.0182)	(0.0182)	(0.0184)
$DSTI_{it}$		1.559		
		(1.046)		
$MaPP\_Change_{it}$			0.446	
			(0.771)	
$MaPP\_Cum_{it}$				0.958
				(0.824)
Constant	8.319	6.662	7.281	6.351

	(21.28)	(20.74)	(21.05)	(20.56)
Observations	185	185	185	185
R-squared	0.812	0.813	0.812	0.813
Number of countries	17	17	17	17

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: This table reports estimates for the impact of macroprudential policy on the Real House Price Index, excluding the years of the subprime crisis (2008-2011), to determine whether MaPP variables results are effective under a "normal" economic period, without crisis shocks. All specifications present results from the within estimator which controls for country fixed effects. The structure is as follows: Col.1 tests the impact of "LTV Change"; Col.2 the impact of "DSTI Change"; Col.3 the impact of "MaPP Change", and Col.4 the impact of "MaPP Cum". The subsequent table 3 and 4, follow the same structure, only changing the dependent variable analyzed.

Table 9. Robustness test – effects of Macroprudential measures on Rent prices (excluding the years 2008-2011).

Variables	Rent Prices			
LTV_{it}	1.525			
	(0.936)			
$GDP\_percapita\_growth_{it}$	-0.102	-0.0749	-0.0924	-0.0869
	(0.0674)	(0.0653)	(0.0664)	(0.0686)
$Population\_Growth_{it}$	4.454	4.538	4.450	4.478
	(3.035)	(3.068)	(3.030)	(3.041)
$GDI\_percapita_{it}$	0.00343***	0.00341***	0.00343***	0.00343***
	(0.000957)	(0.000958)	(0.000960)	(0.000957)
$Credit\_GDP_{it}$	-0.0757	-0.0679	-0.0728	-0.0715
	(0.0712)	(0.0724)	(0.0721)	(0.0739)
$Interbank_{it}$	-1.599**	-1.675**	-1.632**	-1.647**
	(0.572)	(0.579)	(0.575)	(0.571)
$Unemployment_{it}$	0.750	0.697	0.730	0.721
	(0.559)	(0.575)	(0.571)	(0.583)
$Inv\_Dwellings_{it}$	2.051***	1.977***	2.004***	1.994***
	(0.635)	(0.660)	(0.642)	(0.653)
$Permits_{it}$	-0.0257	-0.0262	-0.0256	-0.0257
	(0.0159)	(0.0161)	(0.0160)	(0.0161)
$DSTI_{it}$		-0.531		
		(0.713)		
$MaPP\_Change_{it}$			0.262	
			(0.406)	
$MaPP\_Cum_{it}$				0.0701
				(0.469)
Constant	34.86	35.44	34.99	35.12
	(21.36)	(21.47)	(21.52)	(21.45)

Observations	198	198	198	198
R-squared	0.681	0.679	0.679	0.679
Number of countries	18	18	18	18

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10. Robustness test – effects of Macroprudential measures on the HCOB rate (excluding the years 2008-2011).

Variables	HCOB			
LTV_{it}	-1.318*			
	(0.668)			
$GDP\_percapita\_growth_{it}$	0.0922	0.0821	0.0933	0.0998*
	(0.0541)	(0.0599)	(0.0558)	(0.0572)
$Population\_Growth_{it}$	-0.000934	0.00121	0.0409	0.0220
	(1.025)	(1.100)	(1.037)	(1.026)
$GDI\_percapita_{it}$	0.000150	0.000144	0.000137	0.000138
	(0.000274)	(0.000276)	(0.000280)	(0.000276)
$Credit\_GDP_{it}$	0.0153	0.0122	0.0154	0.0203
	(0.0263)	(0.0275)	(0.0261)	(0.0238)
$Interbank_{it}$	0.330	0.365	0.334	0.325
	(0.237)	(0.263)	(0.247)	(0.240)
$Unemployment_{it}$	0.367**	0.389**	0.367**	0.334**
	(0.136)	(0.143)	(0.136)	(0.124)
$Inv\_Dwellings_{it}$	-1.561***	-1.511***	-1.540***	-1.572***
	(0.424)	(0.461)	(0.435)	(0.425)
$Permits_{it}$	0.0165***	0.0164***	0.0162***	0.0158***
	(0.00447)	(0.00453)	(0.00449)	(0.00440)
$DSTI_{it}$		-0.261		
		(0.679)		
$MaPP\_Change_{it}$			-0.542*	
			(0.266)	
$MaPP\_Cum_{it}$				-0.689**
				(0.296)
Constant	7.278	7.135	7.387	7.467
	(5.532)	(5.635)	(5.658)	(5.571)

Observations	198	198	198	198
R-squared	0.577	0.562	0.569	0.577
Number of countries	18	18	18	18

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Regarding the LTV measure, the effect on housing prices decreases in magnitude from -1.09% to -0.70%, remaining statistically insignificant, interestingly the effect on rent prices increases by a substantial margin from 0.07% in the baseline model, to 1.53%, although still statistical insignificant it transmits a strong sign that the decrease in housing demand can materialize into increases in rent demand and subsequently in rent prices. However, the HCOB rate effect remains negatively stable and statistically significant, going from -1.06% in the baseline model to -1.32% in table 6.

The DSTI measure remains statistically insignificant across all specifications, and with minor changes in coefficient magnitude, maintaining a positive relationship with housing prices, going from 0.78% in the baseline model to 1.56%. The relationship with rent prices exhibits a stronger negative coefficient of 1.70% in respect to the baseline's -0.53%. Regarding the HCOB, the DSTI does not seem to be significant not in terms of impact nor statistically.

In contrast, results changed for both MaPP variables. In the baseline model, MaPP Change has a small and statistically insignificant effect on housing prices (-0.08%), rent prices (-0.66%) and the HCOB rate (-0.43%). However, when the crisis years were excluded, the coefficient for housing prices turned slightly positive (0.45%) and for rent prices the effect increased to (0.26%), notably the HCOB rate remained close and statistically significant from the baseline results, with coefficient -0.54%.

These results suggest that under more "normal" economic environment the broader macroprudential measures might help appreciate the housing prices, hence if the objective is to stabilize housing prices, policy makers should adopt the most effective macroprudential tool for their specific economic situation, since the adoption of a large set of tools acting simultaneously could have contrary effects.

Similarly, "MaPP Cum" exhibits a positive but statistically insignificant coefficient of 0.96% on housing prices, an increase from the baseline result of 0.17%, and a shift from a negative effect of -0.84% in the baseline model, for a positive effect of 0.07% for rent prices. However, the HCOB remained statistically significant and with stable negative results across the baseline and robustness model, with a new effect of -0.69%.

5.3. Lagged Effects of Macroprudential Policy: Excluding the 2008–2011 Crisis

Table 11, 12 and 13 uses equation (2) to better understand the one-year delayed effects of macroprudential measures on a subgroup of the dataset that excludes from the analysis the beginning of the great financial crisis, and its aftermath effects (2008-2011). I will analyze the results obtained comparing them to both previous robustness tests.

Table 11. Robustness test – lagged effects of Macroprudential measures on housing prices (excluding the years 2008-2011).

Variables	Housing Prices			
$GDP\_percapita\_growth_{it}$	-0.186	-0.199	-0.201	-0.205
	(0.185)	(0.201)	(0.194)	(0.199)
$Population\_Growth_{it}$	1.128	0.726	1.040	0.917
	(3.299)	(3.332)	(3.336)	(3.353)
$GDI\_percapita_{it}$	0.00568***	0.00574***	0.00568***	0.00570***
	(0.000970)	(0.000972)	(0.000993)	(0.000985)
$Credit\_GDP_{it}$	-0.0686	-0.0867	-0.0774	-0.0845
	(0.0977)	(0.0987)	(0.0976)	(0.0953)
$Interbank_{it}$	4.269***	4.450***	4.380***	4.437***
	(1.379)	(1.371)	(1.383)	(1.376)
$Unemployment_{it}$	-0.707	-0.563	-0.637	-0.580
	(0.704)	(0.699)	(0.697)	(0.669)
$Inv\_Dwellings_{it}$	2.957**	3.072*	3.038**	3.080**
	(1.355)	(1.459)	(1.406)	(1.422)
$Permits_{it}$	0.0215	0.0236	0.0218	0.0227
	(0.0174)	(0.0180)	(0.0177)	(0.0179)
LTV_{it-1}	-2.347			
	(2.233)			
$DSTI_{it-1}$		1.403*		
		(0.757)		
$MaPP\_Change_{it-1}$			-0.163	

			(0.875)	
$MaPP\_Cum_{it-1}$				0.399
				(0.933)
Constant	7.899	6.239	7.386	6.758
	(21.64)	(21.41)	(21.85)	(21.60)
Observations	168	168	168	168
R-squared	0.819	0.818	0.817	0.817
Number of countries	17	17	17	17

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: This table reports estimates for the one-year lag impact of macroprudential policy on the Real House Price Index, excluding the years of the subprime crisis (2008-2011), to determine whether MaPP variables results are effective under a "normal" economic period, without crisis shocks, while also determining if MaPP variables affect housing prices with a delay. All specifications present results from the within estimator which controls for country fixed effects. The structure is as follows: Col.1 tests the impact of "LTV Change"; Col.2 the impact of "DSTI Change"; Col.3 the impact of "MaPP Change", and Col.4 the impact of "MaPP Cum". The subsequent table 3 and 4, follow the same structure, only changing the dependent variable analyzed.

Table 12. Robustness test – lagged effects of Macroprudential measures on Rent prices (excluding the years 2008-2011).

Variables	Rent Prices			
$GDP\_percapita\_growth_{it}$	-0.0219	-0.0136	-0.0174	-0.0174
	(0.0624)	(0.0682)	(0.0655)	(0.0668)
$Population\_Growth_{it}$	4.003	4.028	3.935	4.001
	(2.741)	(2.892)	(2.810)	(2.822)
$GDI\_percapita_{it}$	0.00333***	0.00335***	0.00335***	0.00334***
	(0.000903)	(0.000909)	(0.000904)	(0.000904)
$Credit\_GDP_{it}$	-0.0985	-0.0948	-0.0986	-0.0987
	(0.0650)	(0.0673)	(0.0668)	(0.0678)
$Interbank_{it}$	-1.709***	-1.746***	-1.715***	-1.728***
	(0.583)	(0.591)	(0.583)	(0.582)
$Unemployment_{it}$	0.794	0.771	0.799	0.798
	(0.494)	(0.526)	(0.510)	(0.516)
$Inv\_Dwellings_{it}$	1.852**	1.798**	1.831**	1.831**
	(0.672)	(0.691)	(0.675)	(0.685)
$Permits_{it}$	-0.0194	-0.0192	-0.0188	-0.0189
	(0.0128)	(0.0137)	(0.0133)	(0.0134)
LTV_{it-1}	1.670			
	(1.183)			
$DSTI_{it-1}$		0.424		
		(1.101)		
$MaPP\_Change_{it-1}$			0.697	

			(0.596)	
$MaPP\_Cum_{it-1}$				0.498
				(0.612)
Constant	38.34*	38.21*	37.99*	38.13*
	(20.28)	(20.59)	(20.36)	(20.36)
Observations	180	180	180	180
R-squared	0.731	0.729	0.730	0.730
Number of countries	18	18	18	18

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 13. Robustness test – lagged effects of Macroprudential measures on the HCOB rate (excluding the years 2008-2011).

Variables	HCOB			
$GDP\_percapita\_growth_{it}$	0.0730	0.0627	0.0661	0.0677
	(0.0683)	(0.0540)	(0.0624)	(0.0639)
$Population\_Growth_{it}$	-0.0161	-0.168	-0.00336	-0.0133
	(0.991)	(1.120)	(1.026)	(1.032)
$GDI\_percapita_{it}$	0.000171	0.000161	0.000147	0.000149
	(0.000253)	(0.000271)	(0.000270)	(0.000267)
$Credit\_GDP_{it}$	0.0204	0.0127	0.0182	0.0206
	(0.0302)	(0.0330)	(0.0321)	(0.0312)
$Interbank_{it}$	0.323	0.390	0.348	0.346
	(0.244)	(0.274)	(0.259)	(0.256)
$Unemployment_{it}$	0.399**	0.453**	0.410**	0.394**
	(0.151)	(0.177)	(0.164)	(0.158)
$Inv\_Dwellings_{it}$	-1.545***	-1.466***	-1.504***	-1.521***
	(0.372)	(0.433)	(0.388)	(0.383)
$Permits_{it}$	0.0170***	0.0175***	0.0167***	0.0165***
	(0.00461)	(0.00497)	(0.00482)	(0.00478)
LTV_{it-1}	-1.979**			
	(0.931)			
$DSTI_{it-1}$		0.156		
		(0.344)		
$MaPP\_Change_{it-1}$			-0.550*	
			(0.313)	
$MaPP\_Cum_{it-1}$				-0.590**
				(0.272)
Constant	6.315	6.073	6.537	6.562
	(5.195)	(5.537)	(5.476)	(5.412)

Observations	180	180	180	180
R-squared	0.603	0.574	0.581	0.584
Number of countries	18	18	18	18

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Tables 11,12 and 13 are based on estimations using equation (5), to better understand the one-year delayed effects of macroprudential measures on a subgroup of the dataset that excludes from the analysis the beginning of the great financial crisis, and its aftermath effects (2008-2011). I will analyze the results obtained comparing them to the results obtained in the previous robustness tables.

Regarding the LTV measure, the lagged effect on housing prices increases in magnitude from -0.70% in table 8, to -2.38%, remaining statistically insignificant, note that table 5 exhibited a lagged LTV coefficient of -4.15%, almost two percentage points higher than in table 11, exhibiting that the baseline subset might be influenced by crisis dynamics rather than real effects of macroprudential policy. Rent prices increase slightly from 1.53% in table 9, to 1.67%. When comparing to the lagged model in table 6, there is a substantial jump from the initial 0.38% effect. However, the HCOB rate effect remains negatively stable and statistically significant, going from -1.32% in table 10, to -1.98%, signaling that HCOB rate is consistent in all models, the baseline and the robustness.

The DSTI ratio maintains a steady effect on housing prices when comparing table 11 and 8, once lagged, the DSTI coefficient presents a positive and statistical significant effect of 1.40%, but when comparing to the lagged model in table 5, it is visible that the subprime crisis influences the effects of DSTI on housing prices, the result aligns better to my argumentation that the DSTI influences lower income households access to credit the most, potentially increasing the average housing price index.

Regarding rent prices, the impact of the financial crisis becomes even more evident. Table 12 shows that the lagged DSTI ratio presents a positive but statistically insignificant coefficient of 0.42%, this result is contrary to the lagged DSTI effects on the baseline

sample, showing a coefficient of -1.78%. Has in the LTV case, the HCOB rate seems consistent as well across models.

MaPP variables present differences when we compare section 5.1 and section 5.3. MaPP Change has a statistically insignificant effect on housing prices (-1.35%), rent prices (-0.58%) and the HCOB rate (-0.39%) in section 5.1. However, when the crisis years were excluded, the lagged effect of MaPP Change presents a lower negative coefficient for housing prices (-0.16%) and for rent prices the coefficient turns positive, increasing to (0.70%), notably the HCOB rate remained close and statistically significant from the baseline results, with coefficient -0.55%.

Similarly, "MaPP Cum" exhibits a positive but statistically insignificant coefficient of 0.40% on housing prices, exhibiting a contrary effect from the previous negative relationship presented in section 5.1, and a shift from a negative effect of -0.71% in section 5.1, for a positive effect of 0.50% for rent prices. However, the HCOB remained statistically significant and with stable negative results across the baseline and robustness model, with a new effect of -0.59%.

6. Conclusion

This paper draws two substantive policy conclusions. The first is that macroprudential policy, especially LTV caps, are a powerful tool in limiting housing price growth. My results show that LTV limits reduce the real housing price index by roughly 4.1%. This relationship reflects the effectiveness of LTV to reduce excessive credit, which directly influences the demand for housing. Moreover, the use of macroprudential policy can be an interesting choice for policymakers seeking to stabilize housing prices, while also decreasing excessive leverage, bank exposures and excessive indebted borrowers, while also considering possible social disparities of these effects.

On that note, my analysis shows that MaPP is not only effective in reducing housing prices (mainly via the implementation of LTV caps), but also relevant in reducing affordability constraints for households. These effects are more pronounced and statistically viable for the LTV.

A key reason for this lies in the different nature of LTV and DSTI, since an LTV tightening implies the credit restriction for every borrower seeking to get a loan, as it is applied to the value of the loan rather than the level of the borrower's income. At the same time, DSTI disproportionally affects those with a higher debt service-to-income ratio, mainly lower-income households. Hence, in terms of housing prices and affordability, DSTI demonstrates a weaker contractionary effect and might even lead to an increase in prices and lower affordability, since DSTI caps might not decrease demand for medium to high hand housing supply, pushing average house prices up rather than down.

My results also suggest that macroprudential policy is not the best strategy if the goal is to stabilize the rental market. Rent prices do not directly depend on credit, being more influenced by rental dynamics, such as supply and demand of rental properties, changes in fiscal policy via taxes or housing policy. This indirect link between macroprudential policy and rent prices could explain the lack of statistical significance for all macroprudential tools studied.

This analysis carries important policy implications, especially given the growing use of macroprudential policy. First, LTV ratio is a key tool to control house price growth, being effective in reducing excessive credit, leading to an overall decrease in housing demand, and consequently prices. Policymakers should prioritize LTV limits during periods of house price acceleration, to mitigate speculative dynamics and systemic risk.

Second, DSTI as was discussed before, does not appear to have the same controlling power as LTV. Hence, if the objective is to smooth housing appreciation, the use of DSTI as a sole measure is not optimal, being better targeted for safeguarding households' solvency, and systemic risk, rather than market price stability.

Third, LTV ratios, and the broader MaPP indices are also effective in reducing the HCOB rate, strengthening the case for using LTV caps, not only as a financial tool, but also as a supportive policy for housing affordability.

Finally, targeted and timely macroprudential implementation is important. The broader use of macroprudential policy ("MaPP Change" and "MaPP Cum"), suggest that the combined use of MaPP measures, is not effective in controlling the house price index, nor the rent price index. A targeted choice of measures is needed, if the end goal is to

control housing cycles. Furthermore, the timing of implementation is also important, my empirical results show that MaPP effects have greater impact when a lag structure is introduced, suggesting that tools should be implemented preemptively, and not reactively.

Although useful, my thesis still lacks some important unexplored topics that could be investigated in future research, such as exploring more deeply and with a stronger dataset whether MaPP affects inequality through the wealth accumulation channel across different income quintiles. It would also be valuable to study the effects of macroprudential policy on rent prices, controlling for fiscal policy, using an intra-country panel, that enables easier access to policy and supply data.

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8. Appendix

Appendix 1. Data and sources

Variable	Code	Description	Sources
Housing Cost Overburden Rate	hcob	Percentage of households that spend more than 40% of their disposable income on housing-related expenditure	OECD
Real House Price Rate	house price	Index of transaction prices of residential properties, both newly built and existing. 2015=100%	OECD
Real Rent Price Rate	rent price	Evolution of rent prices, with base year 2015=100%	OECD
GDP per capita growth rate	gdp pc growth	GDP per capita is the sum of gross value added by all resident producers in the economy plus any product taxes (less subsidies) not included in the valuation of output, divided by mid-year population.	World Bank
Gross disposable income per capita of households and NPISH	gdi per capita	Final consumption expenditure and savings.	Eurostat
Population growth rate	pop growth	The rate of growth of the population.	World Bank
Unemployment rate	unemp rate	Unemployment rate is the share of the labor force without work.	World Bank
Interbank rate	interbank r	The interest charged on short-term loans made between financial institutions.	OECD
Permits issued for dwellings	build permit	A building permit is the final authorization to start work on a building project, unit of measure in thousands.	Eurostat
Investment in dwellings (%GDP)	inv dwelling	Gross investment in dwellings as a percentage of GDP.	Eurostat
Domestic credit to private sector by banks (% of GDP)	credit gdp	Domestic credit to private sector by banks refers to financial resources provided to the private sector, such as through loans, purchases of non-equity securities, and trade credits.	World Bank
Loan-to-value	ltv chg	Year on year change of loan-to-value policies over time, where the implementation of a policy equals +1, and the end of the policy equals -1	Alam et al. (2019) IMF
Debt service-to-income	dsti chg	Year on year change of debt service-to-income policies over time, where the implementation of a policy equals +1, and the end of the policy equals -1	Alam et al. (2019) IMF
Macroprudential index	Mapp chg and Cum	Year on year change and accumulation of 17 macroprudential tools.	Alam et al. (2019) IMF