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The Link between Financial Stability, Macroprudential Policy and Heterogeneity in the Euro Area[1] (2)

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THE LINK BETWEEN FINANCIAL STABILITY, MACROPRUDENTIAL POLICY AND HETEROGENEITY IN THE EURO AREA (2)
This thesis establishes the link between financial stability, macroprudential policy, and heterogeneity in the euro area by positing first that the underlying heterogeneity in $t-2$, to the extent that it is proxied by the cumulative sum of percentage point deviation of inflation index of countries from the euro area level with the base year 2003, impacts the application of macroprudential policy in $t-1$, represented by the average loan-to-value (LTV) limits. In turn, the resulting heterogeneous calibration of macroprudential policy entails different financial stability outcomes in t, which are captured by the growth rate of real household credit. This relationship is formalised by the instrumental variable fixed effects model, while the data run from 2003 to 2019. In that way, this framework addresses not only the endogeneity problem present in the policy-outcome set-up, but also builds upon and provides insight into the conceptual foundation of this model, which is the real interest rate transmission mechanism: Countries with higher cumulative sums of inflation deviation will systemically experience lower real interest rates, i.e. more favourable borrowing conditions. Macroprudential tightening in the form of lower LTV limits follows, especially in light of the parallel force of expansionary (un)conventional monetary policy during this time frame. Finally, those countries experience a decrease in real household credit growth, the financial stability indicator.

JEL F30, G15, G21

4 Empirical Part: The Link between Financial Stability, Macroprudential Policy and Heterogeneity in the Euro Area

This chapter introduces the analysis which formalises the link between financial stability, macroprudential policy, and heterogeneity in euro area, to the extent that these concepts are captured by variables employed. The first section looks at descriptive data overview. The second section introduces main results from the quarterly specification. Finally, the last section presents robustness tests.

4.1 Descriptive Data Overview

In order to gain an idea of the dataset properties, let us first have a look at basic data statistics and some visualisations.

In the table 4.1 is the summary statistics of the main quarterly specification.

The quarterly specification has 1,292 observations since there are 19 euro area countries, and the data runs for 17 years, from 2003 until 2019, each year consisting of four quarters. However, some observations are fewer because of lags, which decreases the number of observations to 1,273 in case of one lag, and 1,254 in case of two lags, or, in a similar way, growth rates. In the case of household loans, however, there is some missing data: for Cyprus, the data start on November 2005, for Estonia, on January 2008, for Latvia, on September 2010, for Lithuania, on June 2004, for Malta, on January 2005, for Slovakia, on January 2006, and for Slovenia, on January 2004.

The highest growth of real household loans was 37.6%, which occurred in Greece in the second quarter of 2010. For reference, the corresponding LTV ratio cap is 100%. The lowest growth of real household loans was -28.9%, which occurred in Cyprus in the third quarter of 2018 with

[1] This paper is based on a master's thesis with the same title, which was prepared under the supervision of Univ. Prof. Dr. Guido Schäfer, Vienna University of Economics and Business.

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Table 4.1: Summary Statistics

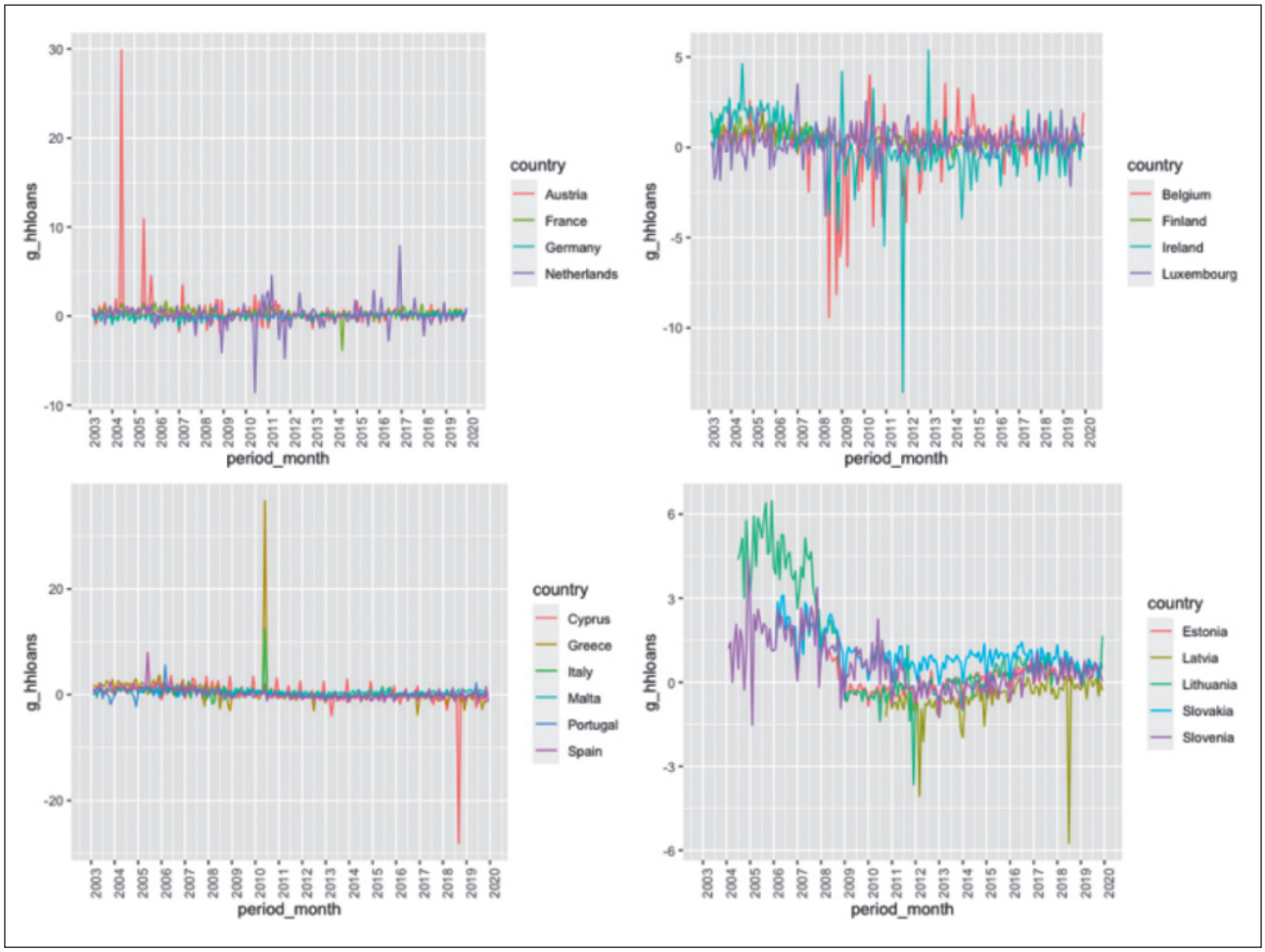
	N	Mean	SD	Min	Max
country_num	1,292	10.00	5.48	1.00	19.00
g_hhloans	1,183	0.94	3.12	-28.89	37.59
ltv_lag	1,273	97.77	7.51	75.00	110.00
cumsum_inflation_inx_dev_lagtwo	1,254	152.25	347.68	-285.89	2,466.76
inflation_rates_lagtwo	1,254	2.00	2.00	-3.87	17.53
interest_rate_lagtwo	1,254	1.25	1.29	0.00	4.25
interest_rate_lag	1,273	1.27	1.29	0.00	4.25
g_gdp_lag	1,273	0.53	1.58	-12.86	23.38
mpp_sum_lag	1,273	0.20	0.73	-3.00	5.00

the corresponding LTV ratio cap of 75%. Figure 4.1 illustrates the growth rates of real household loans for groups of euro area countries.

In the period from January 2003 to December 2019, LTV ratio caps ranged from 110% to 75%. Visualisation 4.2 illustrates their path in time for groups of euro area countries.

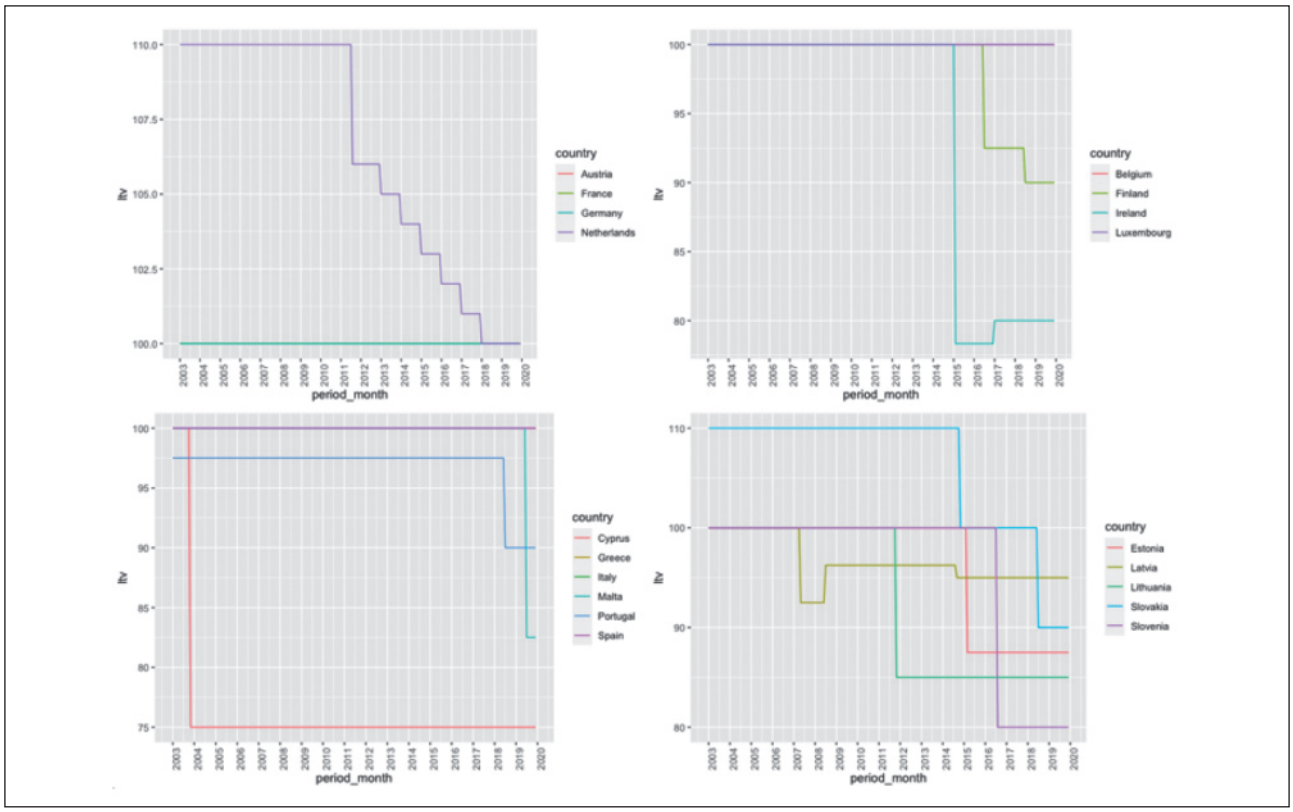
Let us contrast charts 4.2 of LTV ratio limits with those depicting the cumulative sum of inflation deviation of countries from euro area levels in Figure 4.3. Then we can make a descriptive observation that countries, which experienced most tightening in LTV ratio cap on average, were also the countries which saw the highest levels of inflation deviation

Figure 4.1: Growth rates of real household loans, in %



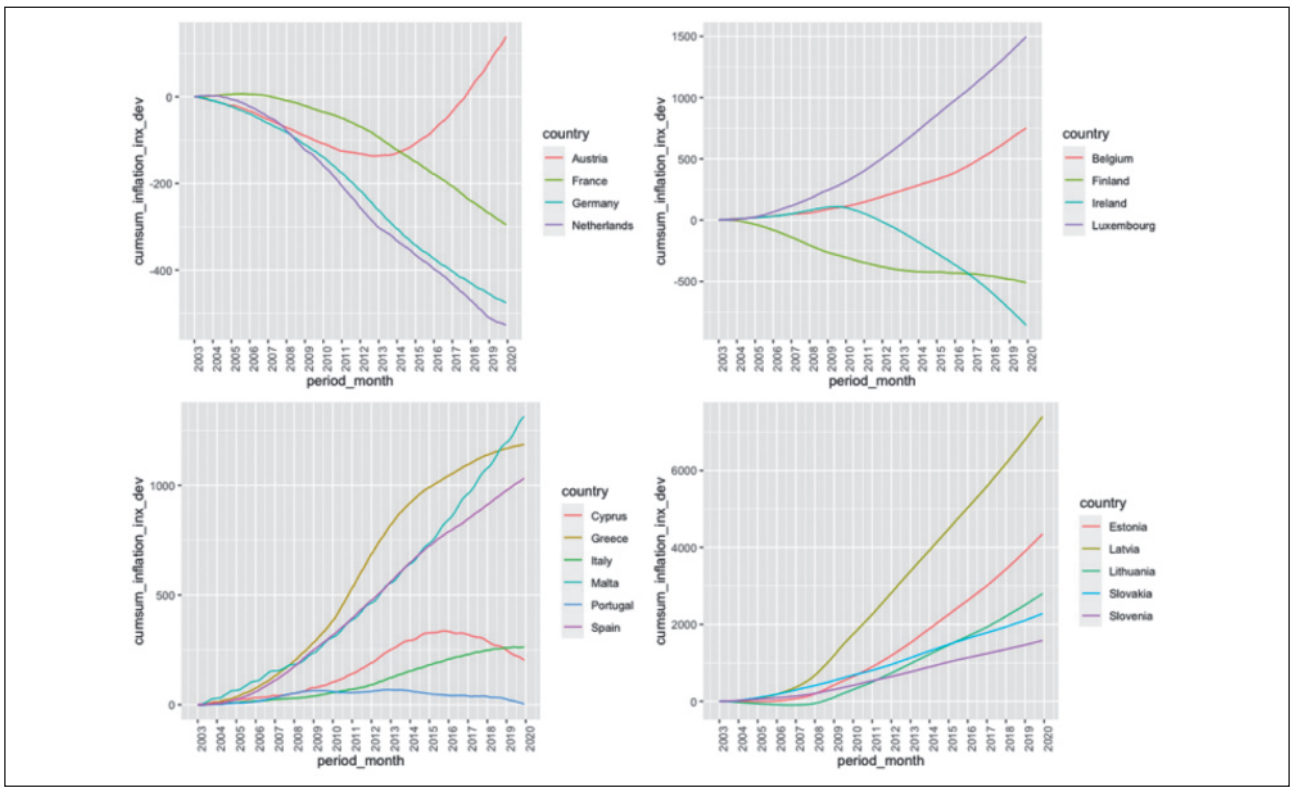
Source: ECB, own calculations.
Notes: Depicted is monthly frequency.

Figure 4.2: Average LTV ratio limits, in %



Source: IMF iMaPP database (Alam et al., 2019), own calculations.
Notes: Depicted is monthly frequency.

Figure 4.3: Inflation index deviation of countries from euro area levels, in cumulative sum of percentage point deviation



Source: ECB, own calculations.
Notes: Depicted is monthly frequency. Note that absolute numbers (measured by percentage points) in the cumulative sum variable are of monthly basis and while they create a similar path in ordinal fashion, they differ in absolute terms for monthly, quarterly and yearly model specification.

Figure 4.4: Inflation rates, in %

Source: ECB, own calculations.
Notes: Depicted is monthly frequency.

Figure 4.5: Inflation rate deviation, in percentage point

Source: ECB, own calculations.
Notes: Depicted is monthly frequency.

build-up over the years (bottom-right country group in Figures 4.2 and 4.3, respectively).
Furthermore, Figure 4.4 shows inflation rates for euro area countries. The highest inflation rate in the period from 2003 to 2019 was recorded in Latvia in the second quarter of 2008. Countries, which tend to have the highest inflation rates (at least until approximately 2010), are then the country group located in the bottom-right (Figure 4.4).
Let us have a look at a further measure (Figure 4.5), which gauges the deviation of countries' inflation rates from euro area average at each specific year, over time. The trend is visible: Inflation rates of all country groups converged to the euro area average, i.e. the distance across countries, on average, is closer to zero. However, Figure 4.5 illustrates that that was achieved through inflation rates of countries in top-left increasing over time, whereas inflation rates of countries in bottom-left and right decreasing over time.
It is to be noted that the latter deflationary dynamics were one of the consequences of the austerity measures in response to the sovereign debt crisis, implemented by the troika from 2010 until 2014 (Karanasos, Koutroumpis, Karavias, Kartsaklas, & Arakelian, 2016). Other consequences, specifically for the Greek economy, included deep recession and high unemployment rates[8] (Karanasos, Koutroumpis, Htgioannides, Karanassou, & Sala, 2017). Finally, it is visible that the top-left group finishes off with an average deviation of above zero, meaning that country inflation rates in recent periods exceed euro area average, whereas countries in bottom-left experience an average deviation of below zero, meaning that in closing years, country inflation rates tend to be lower than the euro area average.

4.2 Results

This section introduces and explains the results from the first and second stage of the IV regression. Table 4.2 summarises the results of the main model specification. The first column exhibits the results of the first stage, while the second column depicts the second stage.
The first stage unveils the following: The coefficient of $cumsum\_inflation\_inx\_dev\_lagtwo$ is statistically significant at 1% and has a negative sign, which indicates that a 1 percentage point increase in $cumsum\_inflation\_inx\_dev\_lagtwo$ on average leads to a 0.0063772 percentage point decrease in

Table 4.2: Instrumental Variable Fixed-Effects Results

	Stage1	Stage2
	ltv_lag	g_hhloans
ltv_lag		0.171*
		(0.051)
		[0.0873]
cumsum_inflation_inx_dev_lagtwo	-0.00638***	
	(0.000)	
	[0.000729]	
inflation_rates_lagtwo	-0.0903	
	(0.300)	
	[0.0871]	
interest_rate_lagtwo	0.652	1.531***
	(0.152)	(0.000)
	[0.454]	[0.347]
interest_rate_lag	0.181	-0.886**
	(0.689)	(0.011)
	[0.452]	[0.347]
g_gdp_lag	-0.304***	0.142**
	(0.000)	(0.030)
	[0.0783]	[0.0652]
mpp_sum_lag	-0.595***	0.319**
	(0.000)	(0.015)
	[0.153]	[0.132]
Constant	98.29***	-16.60**
	(0.000)	(0.050)
	[0.248]	[8.462]
Observations	1,145	1,145
R-squaredwithin	0.21	0.11
JointF-testfor	169.64	7.67

Notes: p-values in parentheses; standard errors in brackets.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

ltv_lag, ceteris paribus[9]. That implies that higher levels of built-up inflation deviation from euro area average are, on average, associated with lower levels of LTV, i.e., countries with systematically higher levels of inflation since 2003 have observed tighter financial stability measures in household lending.

Furthermore, the coefficient of mpp_sum_lag is statistically significant at 1%. This means that a 1 unit increase in mpp_sum_lag is on average associated with a 0.5950201 percentage point decrease in in ltv_lag, ceteris paribus, suggesting that macroprudential tools of various nature are aimed at similar policy direction contemporaneously, i.e. in this case, tightening, and are therefore not signalling contrasting messages to economic agents. Last, the coefficient of g_gdp_lag is statistically significant at 1%, implying that a 1 percentage point contemporaneous increase in real economic growth rate is

[8] The unemployment rate was 25.5% in 2015, and youth unemployment rate was 52.4% in 2014.

[9] Note that the range of $cumsum\_inflation\_inx\_dev$ is much larger than that of ltv.

on average associated with a 0.3040327 percentage point decrease in in ltv_lag, ceteris paribus. This might be an indication of preventive macroprudential policy-making, i.e., as the economy does better, within the same quarter, policy is set so that loan-taking is less available in order to stem potentially excessive household debt.
The coefficient of the second exogenous instrument $inflation\_rates\_lagtwo$ is not statistically significant. The source of that is arguably the randomness of specific values of inflation in each quarter, amplified by the longevity of the sample, wherein countries whose inflation build-up is higher experience below euro area average quarterly inflation rates toward the end of the sample, while countries whose inflation build-up is lower tend to experience the opposite (consult exhibits 4.3 and 4.5).
Going further, the second column of table 4.2 exhibits the second stage results. Notably, the coefficient of ltv_lag is statistically significant at 10% and has a positive sign, and thus, a 1 percentage point increase in ltv_lag on average leads to 0.1707425 percentage point increase in $g\_hhloans$, ceteris paribus. This implies that a tightening in LTV ratio cap in previous quarter, to the extent that the level of which can be predicted by exogenous variation in inflation build-up heterogeneity, leads to a decrease in the growth rate of real household loans in current quarter, thereby providing the evidence of the effectiveness of borrower-based measures at pursuing financial stability goals.

Further, the coefficient of $interest\_rate\_lag$ is positive at 5% and negative, meaning that a 1 percentage point increase in $interest\_rate\_lag$ leads to, on average, 0.8863843 percentage point decrease in $g\_hhloans$, ceteris paribus. In other words, the tighter the monetary policy in the previous quarter, the lower the growth rate of real household loans. This means that monetary policy is effective at influencing financial stability goals, and provides evidence of expansionary monetary policy, led by the ECB in the last decade to pursue economic recovery, interfering with financial stability objectives.
Furthermore, the coefficient of g_gdp_lag is statistically significant at 5% and positive, meaning that a 1 percentage point increase in the growth rate of real economic growth leads to, on average, 0.1417818 percentage point increase in the growth rate of real household loans. This indicates that as the economy does well, households tend to take more credit.
Next, the coefficient of $interest\_rate\_lagtwo$ is statistically significant at 1% and positive, meaning that a 1 percentage point increase in the nominal interest rate two quarters ago is on average associated with a 1.531217 percentage point increase in the growth rate of real household credit, ceteris paribus[10]. Finally, the coefficient of mpp_sum_lag is statistically significant at 5% and positive, meaning that a 1 unit increase in the composite macroprudential policy measure a quarter ago is on average associated with 0.3192786 percentage point increase in the growth rate of real household credit, ceteris paribus. This inconsistent result can be attributed to the correlation between $ltv\_lagandmpp\_sum\_lag$ variable, evidence of which was reported in the first stage of regression, and thus create problems of multicollinearity. Additionally, it is worth acknowledging that this is only a very crude specification of policies, while the LTV ratio limit alone is more specific. However, the composite macroprudential policy measure remains included so as to control for other macroprudential policy measure with potential influence on household debt growth.

4.3 Robustness Tests

This part presents tests that were performed to verify the robustness of the results. First, pertaining to the main quarterly specification, two tests were run which typically accompany the IV regression, a test of relevance and a test of endogeneity, to assess the validity of instruments and justify the IV methodology use. Further, the issue of structural breaks is examined. The last section presents the yearly model, where the period base is extended to a longer time period, in order to capture any potential policy effect that materialised over a longer period base.

4.3.1 Test of Relevance and Test of Endogeneity

This section reports the results of two tests, test of relevance and test of endogeneity, which were performed to verify the validity of the instrument use. For instruments to be considered valid, both conditions of relevance and exogeneity need to be fulfilled. The former is verified by the test of relevance, whereas the latter is supported by a theoretical argument. The test of exogeneity verifies whether the independent variable is endogenous, i.e., whether the IV estimation is necessary at all.
First, the test of relevance asks whether the instrument *z* is sufficiently correlated with the endogenous *x* variable, i.e., whether it explains enough of its variation. In the opposite case, weak correlation can lead to high standard errors, bias or inconsistency of estimators (Schmidheiny, 2016). Relevance can easily be tested in the first stage of 2SLS regression through a simple t-test (in case of one instrument)

[10] Consult the discussion on this point in the Yearly Model 4.3.3 and Figure 4.6.

or F-test (in case of more instruments) on the coefficient of z, whereby the zero hypothesis H_0 is that the coefficients of all instruments are equal to 0 in the first stage, i.e., in our case, γ_1 & $\gamma_2 = 0$. The rule of thumb is that F-statistic must exceed the threshold of 10 for instrumental variables to be considered sufficiently correlated.

The reported coefficients and results of the test are below[11]. Since the F-statistic is 34.63, we can therefore conclude that the endogenous regressor ltv_lag is sufficiently correlated with the combination of instruments $cumsum\_inflation\_inx\_dev\_lagtwo$ and $inflation\_rates\_lagtwo$.

[11] Note that this regression includes fixed-effects, but excludes the application of the IV. Also note that both instruments, $cumsum\_inflation\_inx\_dev\_lagtwo$ and $inflation\_rates\_lagtwo$, are statistically significant at 1% and negative.

Table 4.3: Relevance Test

	ltv_lag
cumsum_inflation_inx_dev_lagtwo	-0.00418***
	(0.000)
	[0.000508]
inflation_rates_lagtwo	-0.229***
	(0.001)
	[0.0710]
interest_rate_lagtwo	0.598
	(0.178)
	[0.444]
interest_rate_lag	0.382
	(0.389)
	[0.443]
g_gdp_lag	-0.210***
	(0.005)
	[0.0751]
mpp_sum_lag	-0.606***
	(0.000)
	[0.152]
Constant	97.94***
	(0.000)
	[0.233]
Observations	1,254
R-squared within	0.20
JointF-testfor fixed effects	183.57

Notes: p-values in parentheses; standard errors in brackets.
* p<0.10, ** p<0.05, *** p<0.01

$$H_0 : \gamma_1 \,\&\, \gamma_2 = 0$$
$$H_1 : \gamma_1 \,\&\, \gamma_2 \neq 0$$
$$F(2,1229) = 34.63$$
$$Prob > F = 0.0000$$

Next, since the simple OLS estimator is more efficient than the IV estimator, the test of endogeneity verifies whether IV estimation is necessary at all, i.e. whether the error term is correlated with x variable and $Cov(x, u) \neq 0$ holds. Note that the IV estimator has a smaller bias than the OLS estimator if equation 4.1 holds, thus relating the concepts of instrument exogeneity, instrument relevance, and *x* variable endogeneity.

$$\frac{Corr(z, u)}{Corr(z, x)} < Corr(x, u) \qquad (4.1)$$

Let us now perform the test of endogeneity. The first stage of the test necessitates the endogenous variable x is regressed on all instruments and included exogenous variables, yielding residuals, which then in the second stage are plugged as additional regressor into the structural regression. Estimating the regression then and testing for significance of the residuals' coefficient gives an idea of the

Table 4.4: Endogeneity Test

	g_hhloans
ltv_lag	0.217**
	(0.046)
	[0.109]
ltv_lag_residuals	-0.190*
	(0.082)
	[0.109]
interest_rate_lagtwo	1.353***
	(0.000)
	[0.365]
interest_rate_lag	-0.757**
	(0.034)
	[0.357]
g_gdp_lag	0.202***
	(0.005)
	[0.0717]
mpp_sum_lag	0.283**
	(0.022)
	[0.124]
Constant	-21.11**
	(0.045)
	[10.50]
Observations	1,145
R-squared	0.14
F-test	29.94

Notes: p-values in parentheses; standard errors in brackets.
* p<0.10, ** p<0.05, *** p<0.01

degree of endogeneity in the removed variation of variable x. In other words, since residuals capture the variation in ltv_lag that is potentially correlated with the error term of the structural equation, significance of its coefficient is indicative of the problem of endogeneity.

Table 4.4 reports the results of the regression[12], showing that the residuals coefficient of ltv_lag is significant at 10% and has the wrong, negative sign, pertaining to attenuation bias. This indicates that the residuals of ltv_lag and the error term of the structural equation are correlated, since potentially endogenous variation bears an effect on the outcome variable $g\_hhloans$. Hence, there was endogeneity present in the set-up, and so, the use of the IV FE estimation is justified.

4.3.2 Structural Breaks

There exist considerable grounds to argue that the use of macroprudential measures, such as the LTV ratio cap, had conceptually altered in the period followed by the 2008 global financial crisis, which brought focus on using these measures as tools to pursue financial stability in macro terms (Cabral et al., 2019; Danielsson et al., 2015; Schäfer, 2020). Then, the period from 2003 to 2019 is subject to structural breaks, which if analytically not accommodated, could undermine the validity of results. But before cutting the series to only consider the period from 2010, which is the safest approach to eliminate the bias arising from structural breaks, let us first perform the following exercise: Since only in the case of Latvia and Cyprus the level of the LTV ratio cap had been altered before 2010, let us first drop them to see if the results changed significantly. There are grounds to argue that if this "trick" produces conceptually similar results to the main model, there is no need to split the sample in 2010, which would otherwise be necessary to allow for conceptually different uses of LTV ratio cap as a macroprudential policy tool by policymakers pre- and post-2010. Below are the results without Latvia and Cyprus.

We can see that, conceptually, results are similar, in that all levels of significance and directions of effects remain identical. Most significantly, in the first stage, the coefficient of $cumsum\_inflation\_inx\_dev\_lagtwo$ continues to indicate that the higher the inflation build-up in the previous quarter, the lower the LTV ratio cap in the following; and in the second, the coefficient of ltv_lag continues to demonstrate that the tighter the LTV ratio cap in the previous quarter, the lower the growth rate of real household loans

Table 4.5: Structural Breaks

	Stage 1	Stage 2
	ltv_lag	g_hhloans
ltv_lag		0.283***
		(0.000)
		[0.0766]
cumsum_inflation_inx_dev_lagtwo	-0.00879***	
	(0.000)	
	[0.000890]	
inflation_rates_lagtwo	-0.133	
	(0.160)	
	[0.0946]	
interest_rate_lagtwo	0.691	1.527***
	(0.150)	(0.000)
	[0.480]	[0.362]
interest_rate_lag	0.138	-1.062***
	(0.773)	(0.003)
	[0.478]	[0.363]
g_gdp_lag	-0.308***	0.208***
	(0.000)	(0.002)
	[0.0824]	[0.0667]
mpp_sum_lag	-0.585***	0.330**
	(0.000)	(0.014)
	[0.162]	[0.134]
Constant	99.58***	-27.66***
	(0.000)	(0.000)
	[0.259]	[7.514]
Observations	1,056	1,056
R-squared within	0.24	0.04
Joint F-test for fixed effects	52.21	7.63

Notes: p-values in parentheses; standard errors in brackets.
* p<0.10, ** p<0.05, *** p<0.01

in the following. The latter is true at an even higher significance level, 1% in place of 5% previously, and higher absolute effect, 0.2834362 in place of 0.1707425 previously.

4.3.3 The Yearly Model

Since the policy effect may not be fully materialised after just a quarter, and thus not fully captured in the quarterly main specification, the yearly model extends the period base to a year. Table 4.6 reports the results of the yearly model.

Table 4.6 reveals that the levels of significance and directions of effect remain conceptually parallel to the quarterly analysis. It is to be noted that since these effects are yearly estimates, coefficients tend to be larger in absolute terms. Most importantly, the mechanism of higher cumulative sum of inflation deviation in year $t - 2$ tran-

[12] Note that here, simple OLS is employed. If fixed-effects are applied, the residuals coefficient becomes insignificant, since this method already addresses the problem of endogeneity to some extent.

Table 4.6: The Yearly Model

	Stage 1	Stage 2
	ltv_lag	*g_hhloans*
ltv_lag		2.087***
		(0.009)
		[0.801]
cumsum_inflation_inx_dev_lagtwo	-0.0249***	
	(0.001)	
	[0.00719]	
inflation_rates_lagtwo	0.128	
	(0.537)	
	[0.207]	
interest_rate_lagtwo	0.690*	2.061*
	(0.087)	(0.094)
	[0.402]	[1.229]
interest_rate_lag	-0.0580	1.373
	(0.871)	(0.177)
	[0.357]	[1.017]
g_gdp_lag	-0.349***	0.453
	(0.000)	(0.187)
	[0.0775]	[0.343]
mpp_sum_lag	-0.426**	2.299***
	(0.026)	(0.001)
	[0.191]	[0.703]
Constant	98.97***	-206.0***
	(0.000)	(0.009)
	[0.610]	[78.42]
Observations	245	245
R-squared within	0.28	.
Joint F-test for fixed effects	38.17	2.75

Notes: p-values in parentheses; standard errors in brackets.
* p<0.10, ** p<0.05, *** p<0.01

slating to lower LTV ratio cap in year $t-1$ on average, which in turns lowers the growth rate of real household loans in year *t*, is present. This is evidenced by the following: First, in the first stage, the coefficient of $cumsum\_inflation\_inx\_dev\_lagtwo$ is statistically significant at 1% and has a negative sign, which indicates that a 1 percentage point increase in $cumsum\_inflation\_inx\_dev\_lagtwo$ on average leads to a 0.0249127 percentage point decrease in ltv_lag, ceteris paribus. Second, in the second stage, the coefficient of ltv_lag is statistically significant at 1% and has a positive sign, and thus, a 1 percentage point increase in ltv_lag on average leads to 2.087318 percentage point increase in $g\_hhloans$, ceteris paribus.

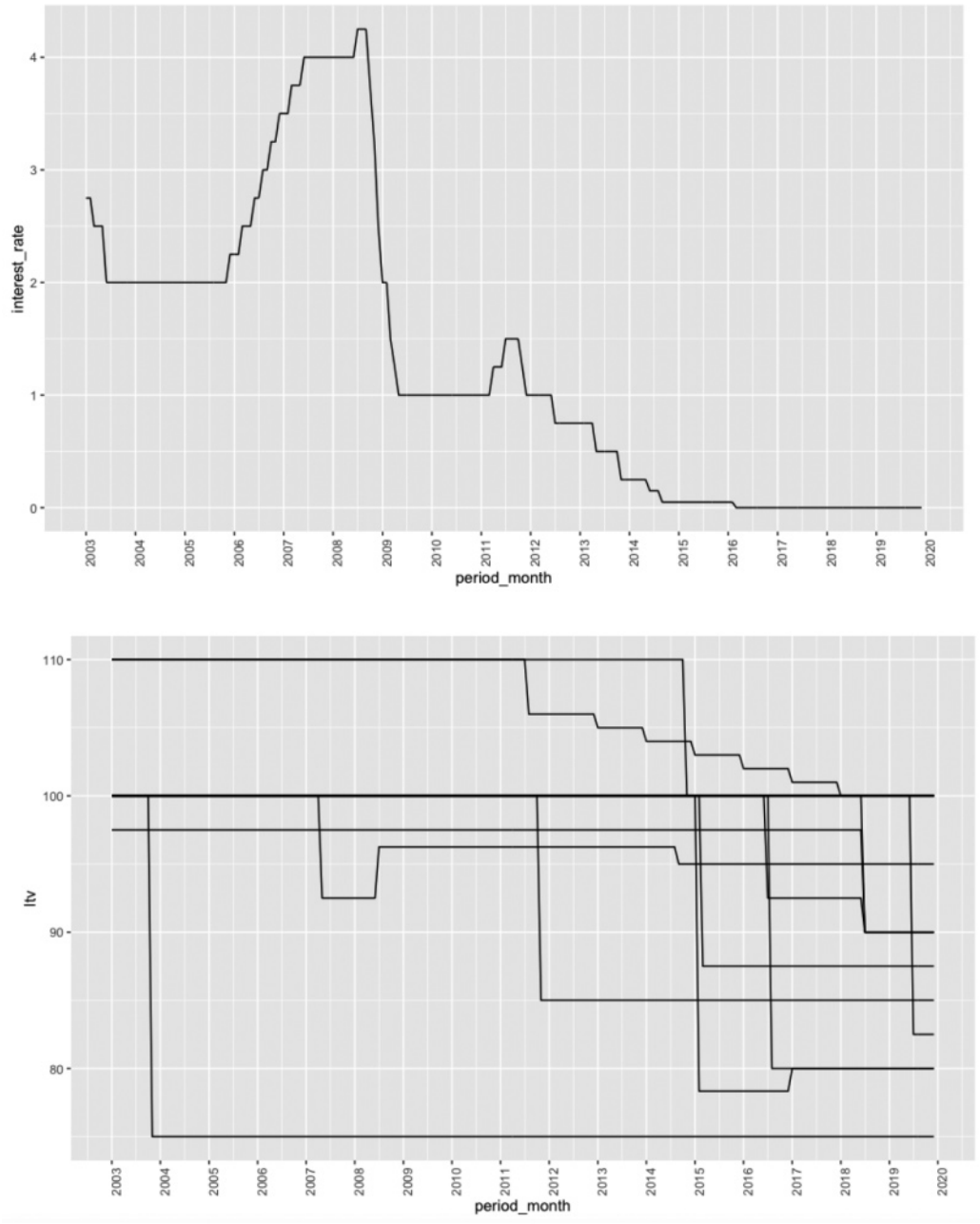
Furthermore, the signs on the coefficients on controls remain largely similar. In the first stage, the coefficient of mpp_sum_lag is statistically significant at 5%, which means that a 1 unit increase in mpp_sum_lag is on average associated with 0.4261308 percentage point decrease in ltv_lag, ceteris paribus, suggesting also in the yearly specification that macroprudential tools reflect tightening or easing collectively. The coefficient of g_gdp_lag is statistically significant at 1%, implying that a 1 percentage point contemporaneous increase in real economic growth rate is on average associated with 0.3489176 percentage point decrease in ltv_lag, ceteris paribus. As suggested in the quarterly results analysis, this might be an indication of preventive macroprudential policy-making.

Interestingly, in the first stage, the coefficient of $interest\_rate\_lagtwo$ becomes statistically significant at 10% in the yearly vis-à-vis quarterly analysis. Then, a 1 percentage point increase in $interest\_rate\_lagtwo$ in the previous year leads to, on average, a 0.6898965 percentage point increase in ltv_lag, ceteris paribus. This means that the looser the monetary policy in the previous year, the tighter the macroprudential policy in the following year. This result arguably stems from the fact that as monetary policy continuously loosened over the period from mid-2008 to 2019, macroprudential policy attempted to regulate its subsequent adverse effect on financial stability. Figure 4.6 testifies to this observation.

Next, the coefficient on the second exogenous instrument $inflation\_rates\_lagtwo$ remains not statistically significant also in the yearly specification. As outlined in the quarterly analysis, the source of that is arguably the randomness of specific values of inflation in each quarter, as well as potential shift in inflation rate levels in country groups that occurred following the euro debt crisis (consult exhibits 4.4 and 4.5).

Next, in the second stage, the coefficient of $interest\_rate\_lagtwo$ is statistically significant at 10% and positive, meaning that a 1 percentage point increase in nominal interest rate two years ago is on average associated with 2.060841 percentage point increase in the growth rate of real household credit, ceteris paribus. This result might stem from the first stage and thus be explained via the following: As the euro area interest rate continued to loosen throughout the period between mid-2008 and 2019, LTV ratio caps kept on tightening. This relationship is captured by the statistical significance and positive coefficient between $interest\_rate\_lagtwo$ and ltv_lag in the first regression stage, and explained by the adverse interplay of the two sets of policies between regulating economic and financial outcomes during that period. Then naturally, as LTV ratio caps experienced tightening, $g\_hhloans$ tended to decrease. Therefore, the

Figure 4.6: Euro area interest rate (top) and average LTV ratio limits across euro area countries (bottom), in %



Source: Deutsche Bundesbank and IMF iMaPP database (Alam et al., 2019), own calculations.
Notes: Depicted is monthly frequency.

positive relationship between $interest\_rate\_lagtwo$ and $g\_hhloans$ is a consequence of an indirect effect of $ltv\frown lag$. So, the time component is of essence here as the effect plays out through not only monetary policy and financial stability, but also macroprudential policy. Figure 4.6 depicts this monetary policy and macroprudential policy interplay.

Finally, coefficient of mpp_sum_lag is statistically significant at 1% and positive, meaning that a 1 unit increase in the composite macroprudential policy measure a year ago is on average associated with a 2.298905 percentage point increase in the growth rate of real household credit, ceteris paribus. As outlined in the quarterly analysis, this inconsistent result can be attributed to multicollinearity, as well as to the crude variable design. Overall, the results of the yearly specification coincide with those of the quarterly, which reinforces the validity of the results found in the main specification.

5 Conclusion

This part connects the hypotheses in Introduction to the findings in the Empirical Part. Let us remember the hypotheses:

1. Heterogeneity in the euro area, to the extent that it is captured by systemic build-up of inflation differences, influences heterogeneous outcomes in the application of macroprudential policy measures, specifically, different levels of LTV ratio caps. Specifically, the higher the inflation build-up over the years, the lower the LTV ratio cap.
2. Macroprudential policy has the capacity to influence financial stability outcomes. Specifically, the tighter, i.e. lower, the LTV ratio cap, the more sustained, i.e. lower, the growth rate of real household credit.

The first stage of the IV FE regression confirms the first hypothesis: Via this set-up, it is visible that macroprudential policy, to the extent that it is represented by a borrower-based measure of LTV ratio limit, can be predicted by the underlying heterogeneity, to the extent that it is predicted by the systemic build-up of inflation deviation differences. Further, the former then has the capacity to influence financial stability outcomes, provided that they are captured by the growth rate of real household loans. This is evidenced by the second stage of the IV FE regression. Therefore, this study supports both hypotheses.

It is to be noted that the scope for further studies is to introduce more financial stability variables to increase robustness, which in this analysis was restricted to fulfill the exclusion restriction. Nonetheless, the implications of this study are the following: In the context of monetary union, heterogeneity in economic conditions (such as different systematically divergent inflation) can translate to heterogeneity in financial outcomes (such as different financial stability outcomes). As financial stability is addressed by macroprudential policy, macroprudential policy can, to an extent, be predicted by the underlying heterogeneity.

However, macroprudential policy alone cannot address imbalances – these have to further be addressed by fiscal policy, and markets ought to be further defragmented by the completion of the banking union and the formation of the capital markets union. Moreover, as monetary policy normalises, as announced by Lagarde (2022), its capacity to address economic conditions heterogeneously will diminish. One truth remains: It is unlikely that the euro area will face no problems if it becomes more harmonised – however, if it does not, it is certain to struggle more.

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