Assessing the Effectiveness of the Portuguese Borrower-based Measure in the Covid-19 Context*

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ABSTRACT

Based on the macroeconomic projections from Banco de Portugal and using an integrated micro-macro model developed by Gross and Población (2017), this paper makes a first attempt at gauging the impact of the Covid-19 pandemic on Portuguese households and banks. To this end, we examine how the borrower-based measure, which was put into place in 2018, may have been successful in lessening the negative economic effects of the pandemic on households' debt-servicing capacities and thereby on the banking system. We find that the borrower-based measure, defined as an LTV ratio cap of 90%, a shocked DSTI ratio cap of 50%, and a maturity cap for mortgage loans of 40 years, leads to (i) a reduction in households' loss rate (LR), caused by both a decrease in households' probability of default (PD) and loss given default (LGD), and (ii) an increase in the capital ratio of the banking system, compared with a scenario where these limits are not in place. We also find positive effects of introducing a shocked DSTI ratio cap, calculated according to the Portuguese borrower-based measure, as it further (i) decreases the risk parameters of the borrowers and (ii) increases the capital ratio of banks.

Keywords: Macroprudential policy; Central bank; Covid-19.
JEL Codes: G01; G51; G21

I. Introduction

The Covid-19 pandemic has deeply affected the Portuguese economy. A large number of businesses had to close down during several lockdown periods. Despite different support measures put into place by the Portuguese government (moratoria on loans, government-backed loans, lay-offs, etc.), not all businesses were able to survive the crisis, which has potentially led to a reduction in some households' income and an increase in the unemployment rate. Once the moratoria expire, it will become clear which households

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that hold mortgage debt will be able to start servicing this debt again. This is an important question not only in terms of household debt sustainability, but also concerning the banking sector as this might lead to a renewed increase in non-performing loans, also depending on further measures that may be implemented in the meantime.

Based on the macroeconomic projections from Banco de Portugal and using an integrated micro-macro model developed by Gross and Población (2017), this paper will make a first attempt at gauging the potential impact of the Covid-19 pandemic on Portuguese households and banks. To this end, we will examine if the borrower-based measure, which was put into place in 2018, has been successful in dampening the negative economic effects of the pandemic on households' debt-servicing capacity and, thereby on the banking system. We do this by comparing the respective results with a scenario where the measure is not in place.

The Portuguese borrower-based measure was put into place in 2018 as a reaction to easing credit standards, coupled with high levels of indebtedness and low saving rates of Portuguese households. Therefore, Banco de Portugal, as the Portuguese macroprudential authority, has adopted measures that target new loans for households, including mortgages as well as consumer credit. These measures were issued on 1 February 2018 in the form of a recommendation, which sets limits to some of the credit criteria used by financial institutions when assessing the creditworthiness of borrowers. They target the Loan-to-Value (LTV) ratio, the Debt-Service-to-Income (DSTI) ratio, in addition to the maturity of new loans and regular interest and capital payments. The main aim of this measure is to prevent credit institutions and financial companies from taking on excessive risk when granting credit to households. Ultimately, this should lead to a more resilient financial sector as well as affordable access to finance for borrowers (Leal & Lima, 2018).

The recommendation is a macroprudential measure that directly targets the borrower by potentially restricting the amount of credit available. This is achieved by tightening the borrowing constraints for certain groups of borrowers and contrasts with measures that are applied at the level of the bank (so-called capital-based measures), which promote an increase in capital requirements. Both macroprudential measures have the ultimate aim of improving the resilience of financial institutions. While capital-based measures raise the resilience of institutions in an immediate and direct manner, borrower-based measures improve the resilience of institutions indirectly and over the medium term by improving the risk level of new credit, which results from the enhanced resilience of borrowers.

This resilience of borrowers is especially important in challenging economic environments that are characterized by high levels of uncertainty. The Covid-19 pandemic is an example of such a challenge. The containment measures, which most countries across the globe implemented to safeguard public health, resulted in a synchronized global sudden halt in economic activity. This makes the global Covid-19 crisis unique, as it negatively impacted both supply and demand (Boissay & Rungcharoenkitkul, 2020).

In this paper, we assess the effectiveness of the aforementioned borrower-based measure in the context of the Covid-19 pandemic. For this purpose, we conduct a counterfactual analysis that looks at the effectiveness of the measure. In particular, we look at its effect on the loss rate (LR) of borrowers (households) as well as the LR's respective impact, via potential credit-related losses, on the capital/resilience of credit institutions.

Borrowers' loss rates are estimated in a scenario in which the measure is in place versus a scenario in which it is not, using an integrated micro-macro model as developed by Gross and Población (2017) and applied to Slovakia by Jurča et al. (2020). The effectiveness is analyzed considering each limit separately as well as all limits jointly. Additionally, we assess the importance of a DSTI ratio with interest rate and income shocks, as envisaged in the Portuguese borrower-based measure, in comparison with a DSTI ratio without shocks. The shocks refer to the way the numerator and the denominator are constructed.[1] In the Portuguese case, the numerator of the ratio takes the impact of an interest rate increase, depending on the loan's original maturity and the interest rate regime into account. The denominator includes a reduction in borrowers' income of at least 20% as of the age of 70, given that a material decrease is expected in the transition from working life to retirement. These shocks align with the European Banking Authority's Guidelines on loan origination and monitoring.[2]

This paper contributes to a growing number of studies that aim to assess the effectiveness of borrower-based measures targeted at households. Overall, these studies point to a positive effect of borrower-based measures on financial stability and social welfare.

The main contributions of our paper to the empirical literature are twofold. Firstly, this paper focuses on the borrower-based measure applied to Portugal, which comprises country-specific LTV, DSTI and maturity limits. Secondly, to the best of our knowledge, this is the first paper to analyze the effectiveness of these types of measures in the context of the Covid-19 pandemic.

Our results point to a reduction in households' LRs due to imposing the borrower-based measure, caused by both a decrease in households' PDs and LGDs. The joint effect of the three caps is a reduction of the LR by 0.046 p.p.

The results also show the benefits of introducing a shocked DSTI ratio cap, as carried out in the Portuguese borrower-based measure. Without shocks to the DSTI ratio, the LR would decrease by 0.039 p.p., 0.005 p.p. less than with the DSTI ratio shocks.

The model also points to a positive impact of the borrower-based measure on the capital ratio of the banking system. The introduction of the macroprudential measure (with shocks to the DSTI ratio) leads to an increase in the capital ratio of the banking system by 0.74 p.p. Both the numerator and denominator of the capital ratio contribute to that scenario. The introduction of the measure results in a reduction of credit and interest income losses, which increases capital. Moreover, it leads to a reduction in the risk weights for mortgage loans and a reduction in lending to families with higher risk profiles, given that the credit lending criteria become more restrictive, which decreases

[1] See Appendix 2 for more details.
[2] For more information, see EBA's Final Report on the Guidelines on loan origination and monitoring.

risk-weighted assets. The latter effect is particularly strong. Without the shocks to the DSTI ratio, the capital ratio of the banking system would increase by 0.63 p.p., 0.11 p.p. less than with a shocked DSTI ratio.

II. Literature Review

The increasing importance of borrower-based measures in the macroprudential toolkit has been followed by a growing number of studies that examine the effectiveness of this type of instrument. The literature on the effectiveness of borrower-based measures can be divided into two strands. The first comprises studies that estimate the impact of the introduction of borrower-based measures on aggregate macroeconomic and financial variables, exploring cross-country data. The second strand of analysis uses micro-level data for country-specific studies.

One of the most common borrower-based macroprudential policies targeting the housing sector is the adoption of LTV ratio limits to housing loans. The countercyclical nature of the LTV ratio is shown by a number of studies based on Dynamic Stochastic General Equilibrium (DSGE) models. Lambertini et al. (2013) show that countercyclical LTV ratio limits that respond to credit growth are more effective in stabilizing credit over the cycle than interest-rate rules because the former do not increase inflation volatility. Additionally, by tightening leverage and domestic borrowing limits during boom periods and relaxing the limits during recessionary periods, this type of measure helps borrowers to smooth consumption over time (Mendicino and Punzi, 2014). Using a DSGE model, Gelain et al. (2012) show that DSTI ratio limits can be more effective than an LTV ratio in curbing house price growth and household debt volatility.

There are several papers that analyze borrower-based measures from a cross-country perspective. One of the earliest is by Almeida et al. (2006). It examines the relationship between the level of the LTV ratio, house prices and demand for new mortgage lending in the presence of an income shock. Using a sample of 26 countries, they find that house prices and new mortgage lending are more sensitive to aggregate income shocks in countries with higher LTV ratio limits. Lim et al. (2011), using data from a group of 49 countries to assess the effectiveness of macroprudential measures, also suggest that limits to the LTV ratio and the DSTI ratio may help lessen the procyclicality of credit.

Other empirical cross-country studies also highlight the countercyclical nature of some borrower-based measures. Cerutti et al. (2017), using a sample of 119 countries over the 2000–2013 period, conclude that the introduction of limits to the LTV and Debt-to-Income (DTI) ratios are associated with reductions in the real growth rates of credit and house prices. However, the effectiveness is more visible when growth rates are very high, as the limits become less countercyclical during busts. Gross and Población (2017), using an integrated micro-macro model and data from the Household Finance and Consumption Survey (HFCS) of 4 European countries, find that limits to the LTV and DSTI ratios may reduce households' risk, measured by the probability of default (PD) and loss given default (LGD), when a shock occurs, thus having a positive effect on banks' capital. Additionally, comparing the efficacy of LTV versus DSTI, the results suggest that DSTI ratio caps are more effective in containing household risk.

Another strand of the literature uses micro-level data for country-specific studies. Asian-Pacific countries have extensive experience with borrower-based measures applied to households. Therefore, some interesting results have been gleaned from several ex-post studies. Igan and Kang (2011) use survey data on the housing and mortgage decisions of households in South Korea and examine the impact of LTV and DTI ratio limits on house price dynamics, residential real estate market activity, and household leverage. They find that transaction activity decreases significantly in the short-term following the tightening of LTV and DTI ratio limits. Furthermore, expected house price increases become more muted after the introduction of an LTV ratio limit, and plans to buy a house are more likely to be postponed, especially in the case of households that already own a house. The authors do not find an impact of the regulatory tightening on households' debt levels and growth rates of mortgage loans. Wong et al (2011) analyze the effects of the LTV ratio on Hong Kong's property market. Using the coefficients of a cross-country model (13 economies), they simulate the impact of shocks to property prices in Hong Kong. Their results suggest that an LTV is effective in reducing systemic risk arising from the boom-and-bust cycle of property markets. The transmission channels behind these results are developed in Wong et al. (2014). They conclude that the effect of the LTV ratio on borrowers' leverage is responsible for strengthening the resilience of banks to property price shocks.

Ireland introduced an LTV ratio limit in 2015 in order to curb house price inflation. Duffy et al. (2016) use a structural model to simulate the implementation of the measure with respect to a scenario where the measure is not in place. They find the measure to be effective in reducing house prices. However, it also leads to a decrease in the demand for new houses and a relatively muted supply-side response due to the financial crisis of 2007/2008 and the following sovereign debt crisis. Acharya et al. (2022) assess potential side effects resulting from the implementation of the Irish limits. They do this by combining supervisory loan-level data on residential mortgages and house price data and examine the impact of the introduction of LTV and loan-to-income (LTI) ratio limits on residential mortgages in Ireland. Following the introduction of the LTV and LTI ratio limits, banks reallocated mortgage credit from low-income to high-income households and from counties where borrowers are closer to the lending limits to counties where borrowers are farther away from the lending limits. However, this led to an increase in banks' risk-taking in both credit to firms and security holdings, the two largest classes not targeted by the regulation.

Gabarro et al. (2019) examine the effects of the LTV ratio limit introduced in the Netherlands in 2011 on households' leverage, liquidity and default. Using a database that combines information from income, wealth-tax records and property ownership for the entire Dutch population, they find that the introduction of the LTV ratio limit has been effective in reducing households' leverage and mortgage debt servicing costs, taking into account that households have responded to the introduction of the policy by taking out smaller loans. These results are accompanied by a reduction in mortgage default. The effects are more pronounced for households in lower wealth percentiles and those with fewer liquid assets. De Araujo et al. (2020) use credit register and employment register data from Brazil to explore the effects of an LTV ratio limit for housing loans on contract

terms and borrower behavior. They show that borrowers affected by the regulation pay higher interest rates, borrow loans with shorter maturities and lower amounts. Moreover, these borrowers purchase cheaper houses and are therefore less likely to default.

Following the methodology by Gross and Población (2017), Jurča et al. (2020), using data from the HFCS applied to Slovakia, conclude that borrower-based measures can improve household and bank resilience to macroeconomic downturns, in particular when several limits (LTV, DTI and DSTI ratios) are in place.

Despite the overall benefits of imposing an LTV ratio, there is some evidence of negative side effects. Tzur-Ilan (2019) uses loan-level data from the Bank of Israel to explore the costs and benefits of the "strict" LTV ratio limit adopted in 2012 on housing choices and credit conditions. The author finds that although it reduces borrowers' leverage, the adoption of the macroprudential measure has pushed the constrained borrowers to purchase cheaper and lower quality assets, which are farther from the city center and in less desirable neighborhoods. Furthermore, the policy change has been associated with higher interest rates, which may be related to the fact that households bought riskier assets and increased unsecured credit. Therefore, the paper emphasizes that macroprudential policies that focus on the stability of the financial system can have undesirable implications at the micro level.

III. Data and Methodology

This section gives a brief overview of the data used in this paper. It then continues to describe the different modules of the integrated micro-macro model developed by Gross and Población (2017).

A. Data

The model employed in this paper requires micro as well as macro data, as detailed in Gross and Población (2017). At the micro level, we use the Eurosystem's Household Finance and Consumption Survey (HFCS). The HFCS collects information on the finances and consumption of households in 22 (mainly Euro Area) countries. It contains information at the household level (e.g. assets and liabilities, and savings and consumption) in addition to at the level of the household members (e.g. employment status, labor income and sociodemographic information). The use of the different variables at their respective level of aggregation will become clear throughout the description of the different modules. Table 1 gives an overview of the variables being used in this paper.

Our paper focuses on the Portuguese part of the survey, the ISFF (*Inquérito à Situação Financeira das Famílias*) for the year 2017, i.e. the most recent available survey wave. The 2017 wave contains data collected from 5,924 valid household interviews (15,079 household members), which corresponds to a response rate of 85%, the highest

of all participating countries.[3] For more information on this survey wave, see Costa et al. (2020).

As this paper focuses on the effects of the borrower-based measure in Portugal, we restrict our sample to borrowing households only. This reduces the sample size to 2,749 households or 8,114 household members.[4]

At the macro level, we collect data for six variables at a quarterly frequency for the period 2005Q1 – 2020Q4 that feed into the VAR model in module 1. These variables are: unemployment rate (seasonally adjusted), nominal compensation per employee, short-term interest rate (3 months), stock price index (Dow Jones Euro Stoxx 50), nominal residential property price index and nominal domestic credit from financial institutions to the private sector. In the context of the Covid-19 pandemic, we also use the 3-year March 2021 economic projections of Banco de Portugal, from 2021Q1 to 2023Q4. These macro projections are characterized by the onset of the pandemic in Portugal in early 2021, which led to the introduction of containment measures. Consequently, this resulted in a sharp fall in economic activity.

Furthermore, the model requires additional model parameters, the so-called metadata, which are needed for calibration purposes. These include the average duration of unemployment for the whole working population, an average implicit tax rate on labor, and a so-called net replacement rate, which is the share of previous net income that a person receives in terms of benefits when unemployed. Table 2 gives an overview of all macro and metadata variables used in this paper.

B. Methodology

The integrated micro-macro model used in this analysis, which comprises six modules, estimates three risk parameters for households: Probability of Default, Loss Given Default and the Loss Rate. These can be calculated with or without imposing limits to the LTV and DSTI ratios and to maturity, thus making it possible to measure the impact of their implementation. In the first stage, risk parameters, calculated on the basis of micro data, are affected by developments in macroeconomic and financial variables (unemployment rate, residential property prices, stock price index, income per employee – including wages, premia, income in kind paid by employers to employees – and credit to the non-financial private sector) – the so-called 1st round effects. The developments in the macroeconomic and financial variables are based on the March 2021 economic projections of Banco de Portugal. [5] These define the evolution of micro data from the

[3] The survey is mandatory in Portugal for the selected households, thus explaining the high response rate.

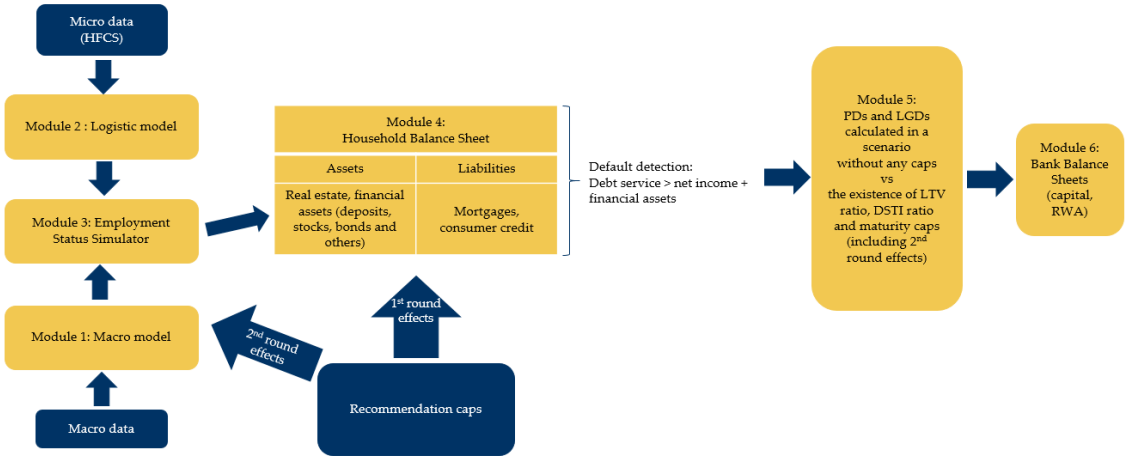
[4] This is due to missing values in some relevant variables of the HFCS. Using the same wave of the HFCS for Slovakia and applying the same basic model setup, Jurča et al. Jurča, P., Klacso, J., Tereanu, E., Forletta, M., & Gross, M. (2020). The effectiveness of borrower-based macroprudential measures: a quantitative analysis for Slovakia. , arrive at a final sample of 92 borrowing households.

[5] Only the unemployment rate is published in the economic projections of the Economic Bulletin of Banco de Portugal. The remaining variables are not publicly available. The projection for the stock price index is not calculated by Banco de Portugal. We calculate it by using the March 2021 economic projections of Banco de Portugal for the remaining variables and the historical dependencies between them obtained in the VAR.

balance sheet of each household (assets and liabilities). In the second stage, the shock to credit demand, caused by imposing limits on credit standards, influences macroeconomic and financial variables, which then in turn have an impact on the risk parameters calculated in the first stage – the so-called 2nd round effects. Figure 1 illustrates the basic structure of the model, showing the different modules and their respective interlinkages.

Module 1 estimates the evolution of macroeconomic and financial variables, such as the unemployment rate, credit granted to the non-financial private sector, the three-month interest rate, residential real estate market prices, compensation per employee and the evolution of the stock index. We start by estimating the VAR model with the six macroeconomic and financial variables previously mentioned to capture the dependencies between them. Based on the estimated model, we generate 1,000 3-year stochastic forward simulations consistent with the historical dependencies estimated in the VAR.

Figure 1
Structure of the integrated micro-macro model
Note: This figure depicts the model structure with its different modules.



Then, we use the 3-year March 2021 economic projections of Banco de Portugal, from 2021Q1 to 2023Q4, to re-centre the stochastic forward simulations around these economic projections (i.e., around Covid-19 pandemic macro data). For each of the six macroeconomic and financial variables, denoted by the index i, and for each quarter, denoted by the index t, we calculate the deviation ($shift_{i,t}$) between the economic projections of Banco de Portugal ($economic\ projections_{i,t}$) and the mean of the 1,000 stochastic forward simulations obtained from the VAR ($stochastic\ forward\ simulation_{i,t,z}$), for each i and t, where z denotes the number of simulations. This allows introducing uncertainty around the Covid-19 macroeconomic scenario.

$$shift_{i,t} = economic\ projections_{i,t} - mean(stochastic\ forward\ simulations_{i,t,z}) \quad (1)$$

Then, the re-centred forward simulations for each macro and financial variable are given by:

$$recentred\ forward\ simulations_{i,t,z} = stochastic\ forward\ simulations_{i,t,z} + shift_{i,t} \quad (2)$$

Module 2 calculates the probability of an individual being unemployed according to their socio-demographic characteristics, such as age, gender, marital status, level of education and country of birth (Portugal or foreign), using a binary logit model. For this purpose, only employed, self-employed and unemployed household members are included, whereas students and retirees are excluded. Therefore, the probability of each household member being unemployed is based on the following logistic regression:

$$y_t^k = \alpha + \beta_1 x_1^k + \beta_2 x_2^k + \cdots + \beta_j x_j^k + \varepsilon_t^k \quad (3)$$

where $y_t^k = 1$ if the household member is unemployed at time t and 0 otherwise. x_j^k stands for age, marital status, level of education, gender, and country of birth of each household member k. The results of the regression are provided in Table 3 of Appendix B.

Module 3 calibrates the level of the probability of being unemployed based on the results from module 2. However, they are adjusted such that the aggregate unemployment rate resulting from the micro-level estimates matches the simulated forward path of the unemployment rate from the macro module (module 1). This is carried out by adjusting the unemployment status of randomly chosen household members at the micro level until the unemployment rate obtained from the micro module matches the unemployment rate from the macro module.

In module 4, households' LRs are calculated. The criterion for a given household to default is insufficient income and assets to meet the instalments associated with the respective level of indebtedness. To this end, we first need to define liquid assets and how they evolve over time. Liquid assets are composed of cash and cash equivalents (C) as well as bonds (B) and stocks (S). The rationale for including these types of assets is that such a buffer might be drawn down in case a household's periodic income does not suffice to cover periodic expenses, including debt repayment.

Liquid assets can therefore be written as:

$$LiqA_t^k = C_t^k + B_t^k + S_t^k \quad (4)$$

The periodic change of liquid assets is determined as follows:

$$\Delta LiqA_t^k = \Delta B_t^k + \Delta S_t^k - \min\left(L_t^k, EXP_t^k\right) + \begin{cases} INC_{n1,t}^{G,k}(1-r)(1-l^e)\ if\ employed \\ U_{n2,t}^{N,k}\,(1-r)(1-l^u)\ if\ unemployed \end{cases} \quad (5)$$

The evolution of the micro variables is driven by the projections for the macroeconomic and financial variables. The outstanding amount of loans (L_t^k) decreases with the periodic debt repayment (EXP_t^k) until the value of the loans reaches zero, meaning all debt has been repaid.

Income $INC_{n1,t}^{G,k}$ and unemployment benefit $U_{n2,t}^{N,k}$ (depending on whether a household member is employed or unemployed) are subject to a deduction regarding the expenses to cover the costs of living (l) and are net of tax expenses (r). Additionally, the model also considers the interest, dividends and valuation of assets such as bonds, stocks and investment fund units, as well as rents from real estate assets other than those intended for own and permanent residence, and interest from deposits. Income and other assets will evolve according to the projection for macroeconomic and financial variables according to the projections in module 1.

Each household defaults if liquid assets become negative ($LiqA_{t-1}^{k} + \Delta LiqA_{t}^{k} < 0$) during any period of the projected horizon. Once a household defaults, it is not allowed to recover and resume its debt repayment by assumption, even though we consider a recovery rate at the macro level, as explained in module 6. The probability of default for each period is therefore computed as the number of defaults over the number of households.

In parallel, LGD is computed for households defaulting, taking into account the projections for the value of the loan collateral based on the estimated market prices for residential real estate in module 1. This module takes the retirees into account that have formerly been excluded in module 2.

In module 5, the LR estimated in module 4 is being recalculated, this time where there are limits to the LTV and DSTI ratios and to maturity, thus excluding credit that does not comply with these three limits considered individually as well as jointly (first-order effects). It is assumed that these limits were imposed in 2017, i.e., before the macroprudential limits actually entered into force (July 2018). In line with Gross and Población (2017), we assume that those households that breached the caps did not receive any amount of credit. In this scenario, there is a reduction in credit to the non-financial private sector (NFPS), which in turn will negatively influence developments in the unemployment rate at the micro and macro level (modules 1 and 3), ultimately leading to a deterioration in households' LR (second-order effects).

Therefore, the net benefit of the macroprudential measure is a result of the direct effects from the reduction of credit to higher-risk borrowers on the reduction of LRs (first-order effects), less indirect effects. These result from the potential increase in LRs, caused by the impact of the credit reduction on the other macroeconomic variables, in particular on the unemployment rate (affecting the PD) and the evolution of prices in the residential real estate market (affecting the LGD) (second-order effects). Using the impulse-responses of the macro-financial variables to a 1 p.p. shock to NFPS credit growth, the module adjusts the simulated macro paths from module 1 based on the scaled shock to lending. It then re-computes the LRs implied by the borrower-based measure limits considered individually as well as jointly, thereby accounting for the macro-economic feedback of the policy measures.

Finally, module 6 estimates the impact of the macroprudential measure on the banking system's average total capital ratio. This results either from the effect on the numerator (own funds), through the flow of credit losses, or from the impact on the denominator, through the new amount of credit in default net of impairments, which has a different risk weight.

The flow of provisions is computed as $Stock\ of\ Provisions_{\ t} - Stock\ of\ Provisions_{\ t-1}$, the stock of provisions being equal to $LGD_t \times NPL_t$. In turn, the NPL_t is defined as the NPL_{t-1} net of write-offs and cures plus the new defaulted credit as follows: $NPL_t = NPL_{t-1}\,(1 - w_t - c_t\,) + PD \times (L_t - NPL_{t-1})$, where L_t are gross loans and $L_t - NPL_t$ is assumed to equal the exposure at default EAD_t. For the purpose of this paper, we assume that the write-off parameter *w* for NPLs equals zero. *c* stands for cures, i.e., the migration of loans from non-performing back to performing status. Even though cures are not considered at the micro level (an assumption that is embedded in module 5), we have carried out an adjustment at the macro level based on historical values of cures regarding mortgage loans of the largest banks of the Portuguese banking system. Finally, the impact on the Total Capital (TC) ratio is computed as $[\,TC_{baseline} - Flow\ of\ Provision_t + Interest\ Income_t]/[RWA_{baseline} + RWA_t - RWA_{t-1}]$ where the $TC_{baseline}$ and $RWA_{baseline}$ are the total capital and the risk-weighted assets in the period t-1, respectively. To compute the impact on RWA, it is necessary to take into account the proportion in the Portuguese case of the portfolio of credit for house purchase that is subject to the internal ratings method and the one whose minimum capital requirements are computed using the standard method. All computations are carried out twice, once with the measure in place and then without the measure.

In view of the original model developed by Gross and Población (2017), some adaptations were made, namely: (i) calculation of the DSTI ratio according to the Portuguese macroprudential recommendation, i.e. with a shock to the income of the borrower(s), considering a reduction in income in the case of a borrower aged 70 and over, and with a shock to the debt service, considering the impact of an interest rate increase in the case of variable and mixed interest rate agreements, and (ii) inclusion of limits to the maturity of loans granted for house purchase.

While the Portuguese borrower-based measure is broad, this paper focuses on the LTV ratio cap set for mortgage credit for own and permanent residences (90%). Further limits that target mortgage credit for purposes other than own and permanent residences (80%), mortgage credit for purchasing immovable property held by credit institutions, and property financial leasing agreements (100%) are beyond the scope of this analysis. The same holds true for the original maturity limit for new consumer credit agreements. However, we calculate the DSTI ratio of households by taking all of the borrowers' loans, including consumer credit, into account.

III. Results

We compute the individual and the combined effect of the limits of the borrower-based measure on the households' LRs. The borrower-based measure is defined here as an LTV ratio cap of 90%, a shocked DSTI ratio cap of 50%, and a maturity cap for mortgage loans of 40 years.

Furthermore, we analyze the effect of imposing a DSTI ratio cap, calculated according to the Portuguese borrower-based measure, with shocks to the numerator (payments for household debt) and denominator (household income). Finally, we link the effect on households' LRs to the capital ratio of the banking system.

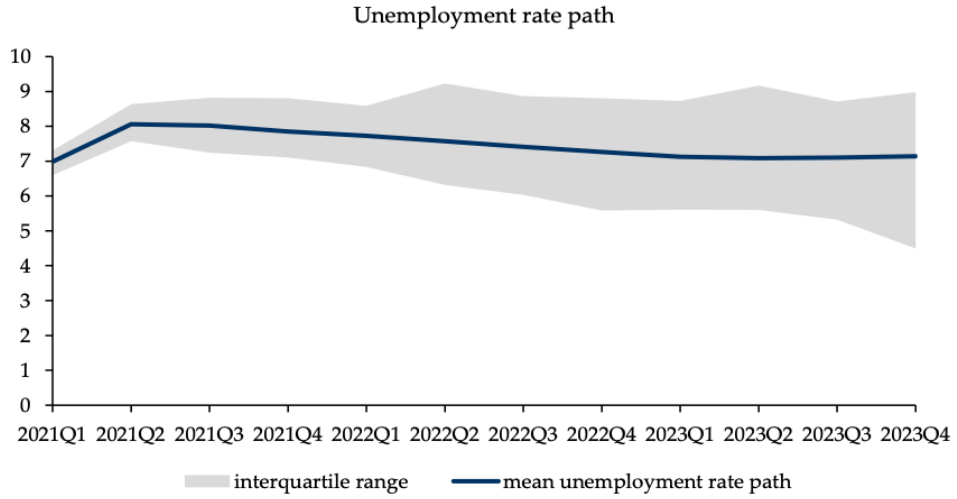
The objective of using the Covid-19 scenario is to quantify the expected increase in the resilience of households and reduction in bank mortgage portfolio losses resulting from implementing a combination of borrower-based macroprudential measures.

When we run the integrated micro-macro model, the unemployment rate path has a forecast horizon of 3 years and is based on the VAR model, re-centred around the March 2021 projections by Banco de Portugal (Figure 2). Unemployment is expected to increase until the second quarter of 2021, before entering onto a downward path until the end of the projection horizon. At the end of this horizon, the unemployment rate is expected to be higher than its 2019 value, although still standing considerably below the levels observed during the 2011-13 crisis.

Figure 2

Unemployment rate path| In percent

Note: This figure outlines the projection of the unemployment rate based on 1,000 macroeconomic simulations until 2023 Q4. The solid line represents the mean of the simulations for the unemployment rate and the shaded area depicts the interquartile range of the simulations.



The results, based on an average of the 1,000 macroeconomic simulations re-centred around the Covid-19 scenario, point to a reduction in households' LRs with the borrower-based measure in place. The joint effect of the three caps, in the context of the Covid-19 pandemic, is a reduction in the LR by 0.046 p.p., after taking the 2nd round effects into account (Figure 3).

The results also show the benefits of introducing a shocked DSTI ratio cap, calculated according to the Portuguese borrower-based measure. Without shocks to the DSTI ratio, the LR would decrease by 0.039 p.p., 0.005 p.p. less than with DSTI ratio shocks (Figure 4).

Imposing the LTV ratio, shocked DSTI ratio and maturity limits separately, after taking the 2nd round effects into account, we also find that the DSTI ratio cap with shocks is the one that reduces the borrowers' LR the most. The LTV ratio cap decreases the LR by 0.025 p.p. The DSTI ratio cap (with shocks) reduces the LR by 0.046 p.p. The maturity cap decreases the LR by 0.011 p.p. The DSTI ratio cap (without shocks) reduces the LR by 0.03 p.p.

The model also suggests a positive impact of the borrower-based measure on the capital ratio of the banking system in the context of the Covid-19 pandemic.

Figure 3
Change in the LR after the 2nd round effects | In percentage points

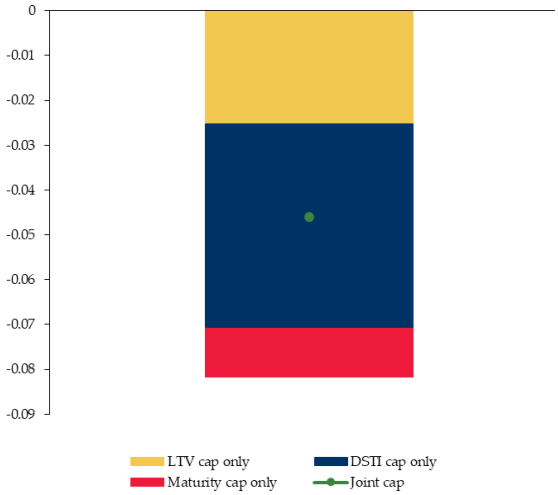
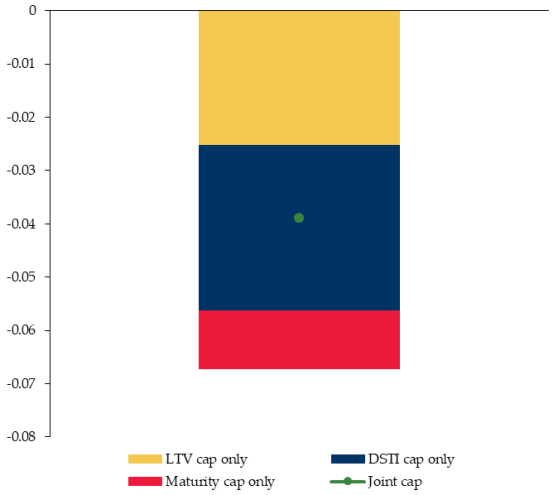


Figure 4
Change in the LR after the 2nd round effects without DSTI shocks | In percentage points

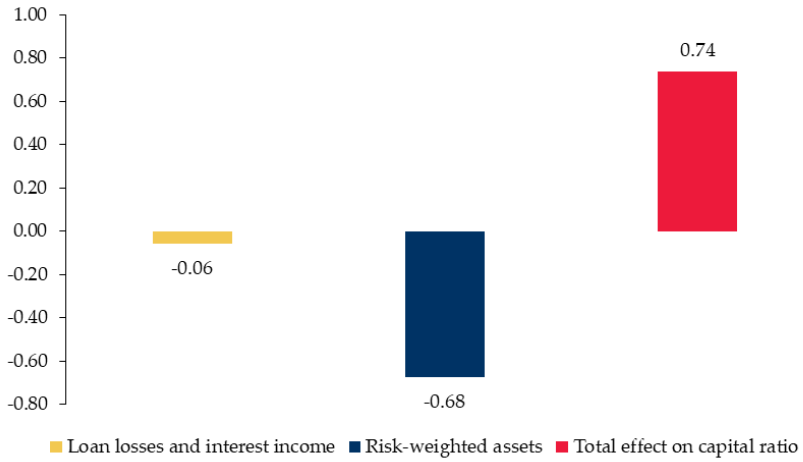


Note: Figure 3 shows the impact of each limit (LTV, DSTI with a shock to the interest rate and to the borrower´s income and maturity) as well as of a borrower-based measure combining the three limits (joint cap) on the projected loss rate. Figure 4 outlines the impact of each limit (LTV, DSTI without shock and maturity) as well as of a borrower-based measure combining the three limits (joint cap) on the projected loss rate.

The introduction of the macroprudential measure leads to an increase in the capital ratio of the banking system by 0.74 p.p. (Figure 5) amounts to 1.16 billion euros in the case of the largest Portuguese banks. Both the numerator and the denominator of the capital ratio contribute to this. This result is aligned with the study carried out by Gross and Población, 2017 for a pooled sample containing Austria, Belgium, Germany and Switzerland (0.9 p.p. of impact) and somewhat higher than the ones obtained by Jurča et al., 2020 for Slovakia (0.2 p.p).

Figure 5
3-year cumulative change in risk weighted capital ratios | In percentage points

Note: Figure 5 depicts the impact of the borrower-based measure (combining limits on LTV, DSTI comprising a shock in interest rate and borrower´s income and maturity) on banks´ capital ratio split into impact on loan losses and interest income and on risk-weighted assets.

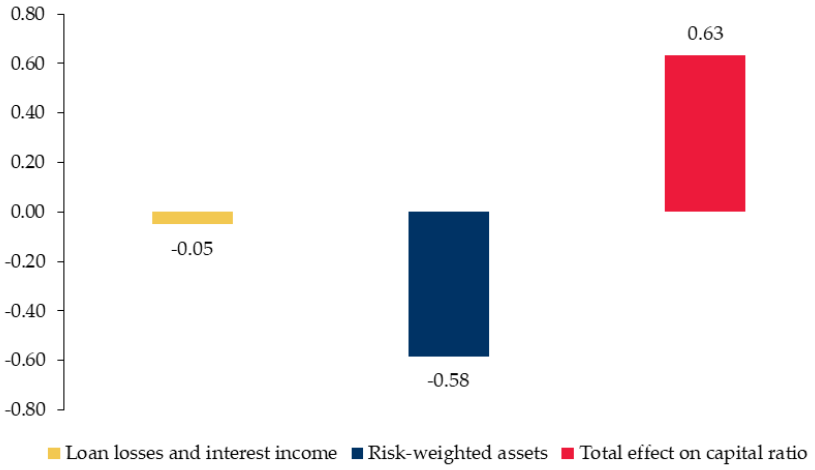


The introduction of the measure results in a reduction of credit and interest income losses, which increases banks' capital. Moreover, it leads to a reduction in the risk weights for mortgage loans and a reduction of lending to households with higher risk, given that the credit lending criteria become more restrictive, which decreases risk-weighted assets. The latter effect is particularly strong.

The results also show that without the shocks to the DSTI ratio, the capital ratio would increase by 0.63 p.p., 0.11 p.p. less than with DSTI ratio shocks (Figure 6).

Figure 6
3-year cumulative change in risk weighted capital ratios without DSTI shocked | In percentage points

Note: Figure 6 depicts the impact of the borrower-based measure (combining limits on LTV, DSTI without any shock and maturity) on banks´ capital ratio split into impact on loan losses and interest income and on risk-weighted assets.



IV. Conclusions

This paper aims at assessing the effectiveness of the Portuguese borrower-based measure in the context of the Covid-19 pandemic, following Gross and Población's (2017) methodology. The Portuguese measure comprises caps to the LTV and DSTI ratios as well as a cap to maturity.

Using an integrated micro-macro approach, we conduct a counterfactual analysis that looks at the effectiveness of the Portuguese borrower-based measure during the recent pandemic. The question we wanted to address was twofold. First, can the measure mitigate the riskiness of households in terms of their LRs? Second, what are its effects on the Portuguese banking system via potential credit-related losses?

Using data from the HFCS, our results can be summarized as detailed below.

First, we find evidence of a reduction in the riskiness of households, which is due to imposing the borrower-based measure. The joint effect of the three caps is a reduction of the LR by 0.046 p.p.

Furthermore, the integrated micro-macro model suggests a positive impact of the borrower-based measure on the capital ratio of the banking system of 0.74 p.p., in the context of the Covid-19 pandemic.

The results also show that considering a DSTI ratio with interest rate and income shocks, as envisaged in the Portuguese borrower-based measure, is effective as it further decreases the risk parameters of households and further increases the capital ratio of credit institutions.

Our analysis is a first step in assessing the effectiveness of the Portuguese borrower-based measure in the context of this severe economic shock. Although the micro-level data used refer to the year 2017, the integrated micro-macro approach enables us to re-center our results around the pandemic macro data, which allows for a cautious first assessment of the measure in a scenario of severe economic stress.

Summing up, our results suggest that the Portuguese borrower-based measure is indeed successful in increasing the resilience of households as well as of the banking system. However, given that our analysis is based on forecasts and simulations, due to the lack of more recent data on the Covid-19 pandemic, results should still be considered as preliminary, and more research will be needed once new data becomes available.

Conflicts of Interest: The authors declare no conflict of interest.

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APPENDIX A

Variables used in the model

Table 1: Micro variables from the HFCS used in the model.

Category	Variable	Variable name
Household-level, asset side	DA1110	Current value of household's main residence
	DA2103	Current market value of bonds
	DA2105	Current market value of stocks
	DA2100	Total financial assets
Household-level, liability side	DL1100	Outstanding balance of mortgage debt
Household-level, liability side	DL1200	Outstanding balance of other, non-mortgage debt
Household-level, flows	DL2100	Monthly payments to repay outstanding mortgages
Household-level, flows	DL2200	Monthly payments to repay non-collateralized debt
Household-level, flows	DI2000	Total household gross income
Household member-level, flows	PG0110	Annual gross employment income
	PG0210	Annual gross self-employment income
	PG0310	Annual gross income from public pensions
	PG0410	Annual gross income from occupational and private pension plans
	PG0510	Annual gross unemployment benefit
Other household member-level	PE0100a	Labour status
	PA0100	Marital status
	PA0200	Level of education
	RA0300	Age
	RA0200	Gender
	SA0100	Residence indicator
	ID	Household member ID
Other household-level	HB0700	Initial year of mortgage
	HB0800	Initial value of the house
	HB140x	Mortgage debt at origination
	HB160x	Original maturity of mortgage loan
	IniLTV	Initial LTV, calculated as sum (HB140X)/(HB0800)
	CurrDSTI	Current DSTI, calculated as (12*DL2100+12*DL2200)/DI2000
	SA0010	Household ID

Table 2: Macro variables used in the model.

Variable	Source
Unemployment rate (seasonally adjusted)	INE
Long-term interest rates (10-year benchmark government bond yields)	Banco de Portugal
Stock price index	ECB Statistical Data Warehouse
Nominal compensation per employee	INE
Residential property price indices	INE
Nominal GDP	INE
GDP deflator	INE
Short-term interest rates (3-month money market interest rates)	Banco de Portugal
Domestic credit from financial institutions to the private sector	Banco de Portugal
Nominal loan interest rates	Banco de Portugal
Unemployment rate anchor point for 2017	Haver Analytics
Short-term interest rate level anchor point for 2017	Haver Analytics
Annual house price growth in 2017	ECB Statistical Data Warehouse
Annual stock price growth in 2017	Haver Analytics
Annual compensation per employee growth in 2017	ECB Statistical Data Warehouse
Deposit rate in 2017, annual average	ECB Statistical Data Warehouse
Annual mortgage interest rate on OB	ECB Statistical Data Warehouse
Estimated annual expected return on mortgages	-
Average duration of unemployment in quarters	OECD
Consumption expenditure rate for employed household members; HM population median	HFCS
Consumption expenditure rate for unemployed household members; HM population median	HFCS
Income tax	OECD
Tax on unemployment benefit	-
Net of tax unemployment benefit over previous income gross of tax	Segurança Social
Mortgage PD anchor point for 2017	EBA Risk Dashboard
Mortgage LGD anchor point for 2017	EBA Risk Dashboard
Cure rate	Banco de Portugal
Ratio of total household new business flows during 2015-17 (36 months) to total NFPS lending stock as at end-2017; divided by 12 to obtain a quarterly measure	ECB BSI
Ceiling on monthly gross unemployment benefit flow in EUR	Segurança Social

APPENDIX B

Logistic model for unemployment status

The logistic model for the unemployment status of the household members considers the following explanatory variables: (i) marital status, equal to 1 if the household member is married, 0 otherwise, (ii) education, equal to 1 if the household member has a university degree, 0 otherwise, (iii) gender, equal to 1 if the household member is female, 0 if male, (iv) foreign, equal to 1 if household member is foreign, 0 otherwise, and (v) age of the household member.

Marital status has a negative sign, suggesting that being married decreases the probability of being unemployed. Holding a university degree decreases the probability of being unemployed. Gender, foreign (if your country of birth is not Portugal) and age are not statistically significant.

Table 3: Logistic model estimates.

Note: The table reports the coefficient estimates (p-values in parenthesis) from a logistic regression whose dependent variable equals 1 for household members that are unemployed and 0 for those that are employed. AUROC denotes the estimate of the area under the receiver operating curve.

Independent variables	Coefficient estimates (p-values in parenthesis)
Intercept	2.7309 (0.00)
Marital status	-0.7667 (0.00)
Education	-0.9467 (0.00)
Gender	0.1599 (0.25)
Foreign	0.0315 (0.80)
Age	0.0026 (0.42)
Observations	7,319
AUROC	0.62
Gini	0.28

APPENDIX C

Overview of the Portuguese Borrower-Based Measure

Banco de Portugal, as the designated Portuguese macroprudential authority, announced the macroprudential measure on 1 February 2018, which covers all new loans to households taken out from 1 July 2018 onwards. The period of five months between the announcement and the implementation was given to allow financial institutions to implement the necessary operational adaptions required to comply with the new requirements. The measure applies to all entities authorized to grant credit in Portugal, which comprise financial companies that have their head office in Portugal as well as branches on Portuguese territory from foreign financial institutions.

The macroprudential measure takes the legal form of a recommendation that follows the “comply-or-explain” principle. Despite the potential flexibility that this measure allows for, banks have broadly accepted the limits laid down in the recommendation,

given the overall consensus with respect to the benefits of this borrower-based measure for financial stability. Consequently, the Portuguese financial system's most relevant financial institutions swiftly converged to the limits defined for the LTV ratio, for the DSTI ratio and for the maturity.[6]

When designing the scope of this measure, Banco de Portugal decided to exclude loans intended to prevent or address default situations, considering the ongoing high level of non-performing loans on the balance sheets of Portuguese banks at that time. The recommendation is also not applicable to credit agreements with an amount equal to or lower than the equivalent of ten times the guaranteed monthly minimum wage. Finally, the recommendation excludes overdraft facilities and other credit with no defined repayment schedule (including credit cards and credit lines), given the difficulty of applying some of the measures envisaged in the recommendation to these credit agreements.

The macroprudential recommendation defines limits to the LTV ratio, the DSTI ratio, and the maturity of the loan, and it requires regular payments of principal and interest that should be applied to new loans secured by immovable property, credit secured by a mortgage or an equivalent guarantee, and consumer credit (Table 4).

Table 4: Summary of the Macroprudential Measure.

LTV limits (Recommendation A)	• LTV ≤ 90% - New credit secured by residential immovable property for the purchase or construction of own and permanent residence. • LTV ≤ 80% - New credit secured by residential immovable property or credit secured by a mortgage or equivalent guarantee for other purposes than own and permanent residence. • LTV ≤ 100% - New credit secured by residential immovable property and credit secured by a mortgage or equivalent guarantee for purchasing immovable property held by the institutions themselves and for property financial leasing agreements. The value of the property pledged as collateral is given by calculating the minimum between the purchasing price and the appraisal value.
DSTI limits (Recommendation B)	DSTI ≤ 50%, with the following exceptions on the total amount of credit granted by each institution in each year: • up to 10%: DSTI ≤ 60%; and • up to 5%: no DSTI limit. For the calculation of the DSTI, monthly instalments of new loans are assumed constant over the entire period of the loan. For variable and mixed interest rate loans, the impact of an interest rate increase should be considered. The DSTI should also take into account the impact of a reduction in the borrower's income if the borrower's age during the term of the loan contract is above 70, except if the borrower is already retired at the time of the creditworthiness assessment.

[6] For more details concerning the convergence of the Portuguese banking system to the limits defined in the macroprudential recommendation, please see the three Progress Reports already published on Banco de Portugal´s website: (i) May 2019 Progress Report, (ii) March 2020 Progress Report, (iii) March 2021 Progress Report.

Maturity limits (Recommendation C)	For new loans secured by residential immovable property or credit secured by a mortgage or equivalent guarantee: • Maturity ≤ 40 years. • Average maturity of new loans should gradually converge to 30 years until the end of 2022. For new consumer loans: • Maturity of new personal credit ≤ 7 years. • Maturity of new personal credit for education, healthcare, renewable energy, provided that these purposes are duly evidenced, ≤ 10 years. • Maturity of new car credit ≤ 10 years. The definitions of personal credit and car credit correspond to those provided for in Instruction No 14/2013 of Banco de Portugal.