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Content

Editor's note[1]

Pedro Duarte Neves

April 2021

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1. This issue of *Banco de Portugal Economic Studies* includes three studies. The first addresses the estimation of cyclically adjusted fiscal balances for the analysis of the fiscal policy stance. The ensuing studies focus on financial stability issues: one assesses the adequacy of the interest rates on new loans to non-financial corporations, taking into account a broad pool of costs (credit risk, funding cost, operational costs and the cost of capital); the third study examines the short-term effects of the Macroprudential Recommendation of the Banco de Portugal, adopted in July 2018, on aggregate variables.

2. In order to frame the first study, the Banco de Portugal's longstanding tradition in the use of fiscal policy stance indicators is worthy of mention. The economic and financial analysis of the 1977 Annual Report of the Banco de Portugal reads as follows:[2] *"Due to the method according to which deficits and surpluses were calculated (...), they do not accurately gauge the true expansionary or contractionary effect of fiscal policy. (...) As such, for the fiscal balance to be used to correctly assess the nature of fiscal policy, it must be calculated excluding endogenous components. This means that the direction and expansionary or contractionary degree of the policy can only be analysed by using a balance that separates deliberate fiscal changes from automatic changes. To this end, (...) changes in the standardised fiscal balance are presented (...), which are calculated as the difference between changes in fiscal revenue obtained as a result of discretionary changes in taxes and changes in expenditure on goods and services and current transfers.* To conclude: *The change in the standardised balance, where positive, indicates that the fiscal policy implemented in 1977 was clearly contractionary, but not as markedly as might have been inferred from the analysis of changes in the actual balance."*

These excerpts from the 1977 report clearly demonstrate the need, consistently perceived by the Banco de Portugal, at least since then,[3]to use fiscal policy stance indicators that identify the factors behind actual balances. Examples of this are the

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1. The analyses, opinions and conclusions expressed in this editorial are entirely those of the editor and do not necessarily coincide with those of Banco de Portugal or the Eurosystem.

2. Quotations are shown in italics, for readability purposes. The words 'deficits' and 'superavits' appeared in italics in the original text in Portuguese, as was common for foreign language expressions.

3. The excerpt presented here is the first reference found by the editor on the use of fiscal policy stance indicators by the Banco de Portugal.

operation of automatic stabilisers, discretionary fiscal policy measures and temporary effects on balances.

Since then, the Banco de Portugal's staff members have carried out several studies on this topic, which are briefly presented below. Centeno (1994)[4] presented fiscal policy stance indicators inspired by methodologies then used by the International Monetary Fund, the Organisation for Economic Co-operation and Development and the European Commission. Neves and Sarmento (2001)[5] proposed a new approach, inspired by the methodology being developed for a project involving the national central banks of EU Member States and the European Central Bank. Braz (2006)[6] further explored the latter study, in the context of ongoing work at the European System of Central Banks (ESCB). Finally, Braz, Campos and Sazedj (2019)[7] applied the most recent ESCB methodology to calculate structural fiscal balances, i.e. adjusted for the effects of the business cycle and temporary, non-recurring measures.[8]

One of the most important dimensions of these exercises is the fiscal semi-elasticity, measuring the sensitivity of fiscal balances to the business cycle, defined as the fiscal balance change, in percentage points of GDP, as a result of a 1 percentage point change in the output gap. It is therefore interesting to look back on the figures presented in these studies:[9] Centeno (1994) produced a figure of 0.52; Neves and Sarmento (2001) estimated a central figure of 0.50; Braz (2006) obtained the same value (0.50); finally, Braz, Campos and Sazedj (2019) presented a figure of 0.54 for the semi-elasticity (0.49 for the concomitant output gap). It should be noted that these studies covered a variety of time periods. Most research carried out by international bodies has also converged towards values very close to these and, as such, the use of 0.5 for the fiscal semi-elasticity is one of the most commonly used 'rules of thumb' in the analysis of fiscal policy.[10]

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4. See "Política orçamental: Indicadores e análise", Centeno, M., *Quarterly Bulletin*, Banco de Portugal, Vol. 16, No 1, March 1994.

5. See "The use of cyclically adjusted balances at Banco de Portugal", Neves, P.D. and Sarmento, L.M., *Economic Bulletin*, Banco de Portugal, September 2001.

6. See "The calculation of cyclically adjusted balances at Banco de Portugal: an update", Braz, C., *Economic Bulletin*, Banco de Portugal, winter 2006.

7. See "The new ESCB methodology for the calculation of cyclically adjusted budget balances: an application to the Portuguese case", Braz, C., Campos, M.M. and Sazedj, S., *Banco de Portugal Economic Studies*, Banco de Portugal, April 2019.

8. Consequently, differences in the value of the structural balance may result not only from methodologies adjusting for the effect of the business cycle but also the identification of temporary, non-recurring measures.

9. This text only presents the central figures obtained for semi-elasticity, given that some of the aforementioned research allowed for it to vary in tandem with the composition of aggregate demand or over time, given the lags in some fiscal revenue.

10. Naturally, there are several reasons that prevent this value from constituting an appropriate rule in a number of cases. However, for the purpose of this note, no further scrutiny is warranted.

3. The opening study in this publication, prepared by Duarte, Maria and Sazedj, revisits important points associated with the calculation of structural fiscal balances. In particular, the authors analyse the effect of different measures to identify the business cycle, more specifically those used by major international bodies to calculate that fiscal indicator.

The study illustrates the care that should be taken when interpreting cyclically adjusted indicators, given that the different methodologies to estimate the business cycle produce quantitatively different values for structural balances. For the period 1999-2018, the authors obtain a mean amplitude between the different estimates for the structural balance at 1.5 p.p. With regard to the annual changes in this balance, changes tend to widely converge towards a similar trend: this means that for the methodologies reviewed in the study changes tend to be, over two consecutive years, prevalently simultaneously positive, approximately null, or simultaneously negative. The average amplitude of the respective annual changes stood at 0.3 p.p. This type of consideration has led the Banco de Portugal to focus more prominently on changes in cyclically adjusted fiscal balances when analysing fiscal policy.[11]

One of the reasons behind the stronger emphasis placed on changes in structural balances in the most recent period[12] relates to their role under the current European fiscal rules. Their compliance is determined on the basis of the figures calculated by the European Commission, at the time of assessment. Notably, the limitations associated with the use of structural balances in the EU budgetary surveillance mechanism were gradually recognised and led to several adjustments to the Stability and Growth Pact and other one-off legislation. In particular, a two-pillar approach was favoured, with the introduction of the expenditure rule, where both pillars were assessed by means of an overall assessment: the 'freezing principle' to guarantee the predictability of the ex-post assessment of fiscal requirements and the 'constrained judgement' principle, which allows the European Commission, in its assessment, to depart from estimates of the output gap under the commonly agreed methodology.[13]

In any case, this study – due to the fact that it highlights the inherent difficulties of rigorously estimating the structural balance as well as the sensitivity of estimates to the sample period[14] – contributes to the reflection on the role that cyclically adjusted fiscal indicators can play in future European budgetary rules, which are currently under

11. Evidently, this is solely the editor's assessment.

12. The concept of structural balance was introduced in European budgetary rules following the 2005 reform of the Stability and Growth Pact.

13. For an informative read, see "Vade Mecum on the Stability and Growth Pact – 2019 edition", Economic and Financial Affairs, *Institutional Papers*, No 101, 2 April 2019.

14. In addition to the aforementioned difficulties, the study also shows that estimates of potential output are conditioned by the information used and, as such, are naturally revised as soon as new information is incorporated.

review. Against this background, the words of the Commission in its communication[15] of 3 March 2021 should be recalled: *When the recovery takes hold, the Commission intends to relaunch the public debate on the economic governance framework. The Commission's review of February 2020 identified well-recognised challenges with the fiscal framework and its implementation.*

4. Low profitability has been repeatedly presented in the ECB's *Financial Stability Review*[16] as a major vulnerability – if not the most significant of all – of the European banking system. This assessment, which was already apparent prior to the COVID-19 pandemic crisis, reflects a number of structural factors. As a result, in the May 2020 issue of the Financial Stability Review it is concluded that the return on equity (RoE) of euro area significant institutions[17] was a little below 5.5% in December 2019 and that, for 80% of these institutions, the RoE was below 8% – a threshold which is typically deemed necessary to offset the costs of investing in the sector – despite the relatively long period of economic recovery observed until then in several European countries. In this context, the Single Supervisory Mechanism identified the assessment of supervised banks' business models as a supervisory priority for 2020 and 2021.

The second study in this publication, prepared by Mateus and Pinheiro, expands on an innovative approach to assess whether, between September 2018 and December 2019, the conditions for granting new loans to non-financial corporations – which correspond to around 16% of their stock and approximately 5% of the banking sector's total assets – make it possible to restore the cost of equity (CoE) of 8%.

The findings of the study are mixed. Therefore, for the most recent period, i.e. the second half of 2019, the findings indicate that the RoE on these new loans made it possible, overall, to cover the 8% CoE. However, for the initial part of the sample and for a number of specific segments (sectoral and maturities), this was not the case. This finding does not vary from what has been determined for the European banking system,[18] with an average return on equity relatively close to that seen in Portugal.

When analysing pricing conditions in credit operations, both in Portugal and in Europe, several background aspects, which are not always easy to capture, should be taken into account.[19] For instance, in the case of Portugal, the analysis presented in this study does not take into consideration any operational cost-cutting programmes among banks. However, it estimates that a 15% cut in operational costs would make it

15. "Communication from the Commission to the Council. One year since the outbreak of COVID-19: fiscal policy response", 3 March 2021.

16. See, for instance, the November 2019 and May 2020 issues.

17. Institutions under direct supervision of the Single Supervisory Mechanism as a whole.

18. See, for instance, *Trends and risks in credit underwriting standards in the Single Supervisory Mechanism. Main findings from the credit underwriting data collection 2019*, European Central Bank

19. Ibid.

possible to generate an 8% return on equity, on average and for the period under review. Moreover, due to the absence of granular information, this analysis – or similar analyses on the European banking system – cannot capture all the specific pricing conditions (bank fees, cross-selling, cross-subsidisation). Aside from these limitations, following up on lending conditions is a priority for the mission to safeguard financial stability in Europe.

5. The last study in this publication focuses on the Recommendation on new credit agreements for consumers, introduced by the Banco de Portugal in July 2018 in its capacity as macroprudential authority. The Recommendation[20] is aimed at fostering the adoption of prudent lending criteria and, as such, at boosting institutions' resilience and borrowers' access to sustainable financing, minimising default risk.

As a result of this Recommendation, the Banco de Portugal has documented[21] an improvement in borrowers' risk profile and convergence towards the limits set out in the Recommendation. The Bank has also concluded that the introduction of the Recommendation has enhanced the banking system's resilience by reducing borrowers' probability of default and minimising institutions' losses in the case of default and due to the ensuing positive impact on the capital of financial institutions. While monitoring compliance with this Recommendation, the Banco de Portugal has used highly comprehensive individual information and, more recently, an aggregate micro-macro model.

The study prepared by Abreu and Passinhas uses a completely different approach to assess the short-term effects of the Banco de Portugal's Macroprudential Recommendation. On the basis of Bayesian Vector Autoregression (BVAR) models, a counterfactual scenario is unfolded, outlining how the economy would have evolved if this measure had not been implemented. Its findings indicate that the Banco de Portugal's macroprudential measure is likely to have contributed to a reduction in new loans to households both for house purchase and consumption purposes. Moreover, the study concludes that this effect is statistically significant four months after the introduction of the measure, only to become more marked from then onwards. Therefore, and although its aim was not to affect all lending to households, the measure appears to have helped contain growth in new loans to the sector.

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20. The Recommendation introduced four measures, in particular: (i) limits to the loan-to-value ratio, i.e. the ratio of the total amount of the loan to the minimum between the appraisal value and the purchase value of the immovable property pledged as collateral; (ii) limits to the debt service-to-income ratio, i.e. the ratio of the total amount of monthly instalments of a borrower's total debt to their net monthly income, whose calculation considers interest rate rises and income reductions, in the latter case when the borrower is aged 70 and over upon expiry of the agreement; (iii) limits to the maturity of loans; and (iv) regular interest and principal payment requirements.

21. See *Macroprudential Recommendation on new credit agreements for consumers – progress report*, Banco de Portugal, May 2019, March 2020 and March 2021.

Non-technical summary

April 2021

Cyclical outputs and structural budget balances

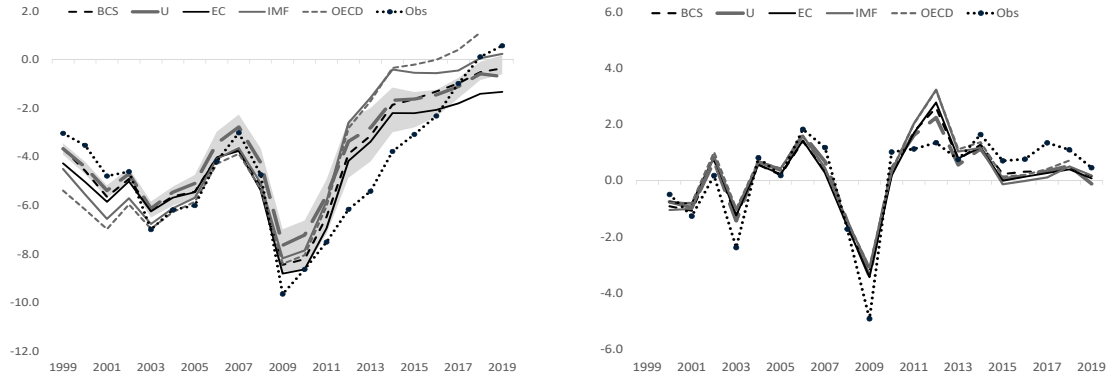
Cláudia Duarte, José R. Maria and Sharmin Sazedj

Structural budget balances are intertwined with cyclical outputs and lie at the heart of most fiscal surveillance assessments. By removing the business cycle impact from the published headline budget balances, in addition to the effects of temporary measures, they emerge as natural policy variables that should provide valuable indications about the underlying fiscal position of an economy. In this study, we rely on alternative estimates of cyclical outputs to document the impact on estimates of structural balances and on fiscal assessments.

We compute Portuguese structural balances using different business cycle indicators, which we take on equal footing, while keeping the methodology and the remaining information set unchanged. Five different indicators are considered, including those released by the European Commission (EC), the International Monetary Fund (IMF), and the Organisation for Economic Co-operation and Development (OECD). As shown in Figure 1, alternative cyclical indicators lead to structural balances that have similar features, to some extent, though important discrepancies arise. Discrepancies are particularly striking when the evaluation is focused on structural balance levels, as depicted in Figure 1a. The average amplitude across estimates reaches 1.5 percentage points (p.p.) over 1999-2018. Similarities are clearer when we analyse the changes in structural balances, as depicted in Figure 1b. The average amplitude drops to 0.3 p.p. In both cases, however, comparisons with selected benchmark levels and benchmark adjustments, namely a reference level of 0.25% and a reference change of 0.5 p.p., lead to fiscal assessments that are model-dependent, for instance over 2017-19.

The cyclical output's unobserved nature makes the computation of structural balances inherently challenging and conditioned by model and parameter uncertainty. We show how structural balances are revised over time, as new observations become available. By incorporating new information in the estimation of cyclical indicators, not only end-of-sample revisions take place, but also historical revisions. We provide a stylised example on how much these revisions get amplified under unexpected shocks, such as a major economic downturn.

In the European Union fiscal framework, the rules designed to ensure sound public finances have relied heavily on structural balances. Against the background of ongoing discussions on the appropriateness of the rules, the framework has been revised several times to broaden the fiscal assessment scope. We do not dwell into the functioning of these rules, nor into the commonly agreed methodology of the EC for the purpose of



(A) Levels (B) Changes

FIGURE 1: Structural balances

Sources: Banco de Portugal, EC, IMF, OECD and authors' calculations.
Notes: Structural balances are in percentage of potential output and observed data, which correspond to headline values free of temporary measures, in percentage of GDP (identified by "Obs"). Changes in structural balances are in p.p. "BCS" and "U" identify the results obtained with the models taken, respectively, from Braz, C., M. M. Campos, and S. Sazedj (2019). "The new ESCB methodology for the calculation of cyclically adjusted budget balances: an application to the Portuguese case" Banco de Portugal Economic Studies; and from Duarte, C., J. R. Maria, and S. Sazedj (2020). "Trends and cycles under changing economic conditions." Economic Modelling, 92(C), 126–146. The grey area corresponds to alternative outcomes of the U model along a 5th-95th percentile range of possible outcomes drawn from the posterior distribution.

fiscal surveillance. Notwithstanding, our analysis sheds some light on the importance of both model and real-time uncertainty, which can be significantly reduced when selected benchmarks are set in terms of changes. Yet, the proximity across results should not be taken as identical matches, as small differences can be enough to cast doubts on the validity of fiscal assessments based on point-specific benchmarks.

Cyclical outputs and structural budget balances

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Abstract
Structural budget balances are intertwined with cyclical outputs and lie at the heart of most fiscal surveillance assessments. Failure to comply with adequate goals is largely feared as a step forward towards a foretold unstable environment. We show that alternative cyclical indicators, including those suggested by pivotal international institutions, provide an evaluation of the Portuguese case that has both converging features and important discrepancies. Discrepancies are particularly striking when the evalutation is focused on structural balance levels—with an average amplitude across estimates of 1.5 percentage points over 1999-2018—, whereas similarities are clearer when based on the changes in structural balances—with an average amplitude dropping to 0.3 percentage points. We also highlight significant revisions in the European Commission estimates and find that comparisons with selected benchmarks lead to model-dependent assessments. (JEL: E32, E62, H62)

1. Introduction

Macroeconomic time series are often seen as the result of a long-run trend temporarily disturbed by short-run cycles. Government budget balances are no exception. If assisted by an informed distinction between permanent and temporary influences, policymakers can more easily set adequate spending levels and tax rates to cope, for instance, with medium-term sustainability concerns. Structural balances emerge herein as a natural policy variable, by aiming to gauge the underlying fiscal position.

Structural budget balances are unsurprisingly at the heart of most fiscal surveillance assessments. Failure to comply with the desirable goals is feared as a step towards tighter scrutiny, carrying along losses in discretionary power and higher market pressures. Structural balances are, however, also at the heart of an intense debate. Their estimates result from removing the cyclical component from headline balances, and therefore should remain unchanged if automatic stabilizers explain all movements in the latter. Soaring headline deficits in crisis times, as tax revenues recede and government

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transfers increase (*e.g.* unemployment benefits), can be safely ignored if the structural balance remains at adequate levels. Likewise, cyclical surpluses in expansion periods are not necessarily interpreted as fiscal tightening and consolidation. In short, cyclical outputs and structural balances depend on the filtering processes that identify trends and cycles in observed variables. How much do structural balances change if one uses alternative cyclical indicators? To what extent is the comparison with selected benchmarks affected? These are key questions that we wish to discuss in this article.

Both the levels and changes in structural balances provide information content, among other monitoring data, that policymakers use to infer whether a particular country offers a sound fiscal position. The debate over such practice has both political and academic dimensions: a wrong assessment of the true fiscal position of a particular country can give rise to misplaced policy options; an unreliable cyclical estimate—emphasized, for instance, by Orphanides and van Norden (2002)—poses a challenge that the empirical literature wishes to overcome.

The cyclical component can be subject to several estimation procedures, including univariate and multivariate filters, possibly linked to Phillips curves with wage or price developments. Our goal herein is to focus solely on the marginal impact of cyclical indicators on the budget balance. To achieve this objective we assess the outcome of five different indicators, namely those proposed by the European Commission (EC), International Monetary Fund (IMF), and Organisation for Economic Co-operation and Development (OECD), and also those suggested by Braz, Campos, and Sazedj (2019), used in the context of the European System of Central Banks (ESCB) projection exercises—henceforth the "BCS model"—, and Duarte, Maria, and Sazedj (2020)—henceforth the "U model". By using a unique GDP time series over 1999-2019, we can easily recover all implicit potential output estimates.[1] We focus exclusively on the Portuguese case.

We ensure that the only variable driving our results is the output gap—the cyclical indicator. Given that the structural balance corresponds to the published headline budget figures excluding temporary measures and the cyclical component, we rely on a unique time series classified *a priori* as capturing all temporary revenues and expenditures, in line with the ESCB definition. The formula used to estimate structural balances is kept unchanged throughout all experiments.

Finally, we retrieve historical vintages of EC databases to address concerns over the uncertainty of potential output estimates when the information set expands. Herein we are focused on extracting the real-time business cycle contribution to both the level and changes of headline balances, as end-of-period biases can be particularly problematic. For example, unexpected crises can bring about downward revisions of historical levels in the pre-crisis period, when the economy was growing, as a result of the filtering process that decomposes observed data into trends and cycles.[2]

[1] We make no distinction between potential, trend or low-frequency component of output.

[2] A comparison between the cases of Portugal, Germany, France, Italy, Spain, and Greece can be found in Christofzik *et al.* (2018). See Tooze (2019) or Darvas (2019) for a recent critique of the filtering process.

Our results show that structural balance levels do seem to extract long-run trends of headline budget balances, with all models featuring common qualitative outcomes. For instance, business cycle contributions are always positive in the beginning of the sample and negative during the financial or sovereign debt crisis of the 2000s. A closer inspection reveals, however, important time-varying differences across models, namely in terms of sign and amplitude. For instance, the U model brings along a larger structural balance over 2007-08 resulting from a close to zero, but negative, business cycle contribution to the headline budget balance, in contrast to the remaining models.[3] The amplitude across databases, measured by the difference between maximum and minimum structural balances, in percentage of potential output estimates, reaches 1.5 percentage points (p.p.) over 1999-2018. The recent past is an example of how such differences translate into opposite assessments regarding deviations from selected benchmarks.

In contrast with the previous assessment, results based on the changes in the structural balance are relatively similar across models. The impact of cyclical output has largely the same sign, or is close to nil, and amplitudes bring along no systematic conflict—an outcome suggesting that policymakers would have similar information sets no matter their preferred output gap series. The amplitude across databases stands at 0.3 p.p. over 1999-2018. The benefits of changing the focus to changes, from levels, has already been highlighted in the literature (Task Force of the Monetary Policy Committee of the European System of Central Banks 2012; Buti *et al.* 2019; Duarte *et al.* 2020). This proximity should not be taken, erroneously, by identical matches, as the small differences can be enough to cast doubts on the validity of fiscal assessments based on point-specific benchmarks.

Finally, an inspection of the historical vintages of the EC database confirms the difficulties of assessing the business cycle contribution in real time. Previous conclusions still hold: results are irregular when evaluated on the levels, and less so on the changes. As the information set expands, our results show smaller revisions in potential growth than output gaps, as the latter are associated with current and past level shifts in potential output. Nevertheless, we report important revisions in growth rates at the end of the sample, particularly for 2018, possibly linked to backward effects of the pandemic crisis, *i.e.* by considering a sample that already includes data from 2020. This has consequences on our ex-post assessment when we compare the results with benchmark objectives.

The article is organized as follows. We start by clarifying the computational method and the role of both structural balance levels and changes in the European fiscal surveillance framework, before proceeding to estimate alternative contributions of cyclical outputs to the headline budget balance, obtained by considering different trend-cycle decompositions. The subsequent section reports our inspection of the historical vintages of the EC estimates, and the last section presents some concluding remarks.

[3] Blanchard and Portugal (2017) also suggest a negative output gap over 2007-08.

2. Institutional and operational environments

The main objective of fiscal surveillance is to ensure sound public finances. Assessing the fiscal policy stance underlying a sequence of government budgets requires a separation between the outcome of discretionary or permanent policy actions, which take the form of fiscal consolidation or expansion processes, and the outcome of other factors, such as special one-off impacts or cyclical developments. For this purpose, fiscal experts and international institutions, namely the IMF, OECD or the EC, rely extensively on structural balances.[4]

2.1. Fiscal surveillance framework

The EU fiscal surveillance framework, which is the one institutionally relevant for Portugal, is classified as a rules-based process (European Commission 2014, 2020), featuring nevertheless a constrained discretion approach that some authors consider adequate, in general, to deal with the unavoidable uncertainty surrounding cyclical output and structural balances (Buti *et al.* 2019; Roeger *et al.* 2019; Hristov *et al.* 2017). Other authors and institutions suggest that the current system is too complex, with many exceptions, that it suffers from credibility losses and transparency issues (Bundesbank 2017; European Fiscal Board 2019; Kamps and Leiner-Killinger 2019), or is in need of new rules, some of them still relying on potential output indicators (Carnot 2014; Andrle *et al.* 2015; Feld *et al.* 2018; Christofzik *et al.* 2018; Gaspar 2020).

We will not address this debate and do not intend to go into a deep assessment over the current state of affairs, nor dwell into the functioning of the Stability and Growth Pact (SGP). Instead, we wish to focus solely on the role of structural balances – levels and changes – in the current framework.

The current set of European rules has been evolving since its inception. The simple benchmark of 3% of Gross Domestic Product (GDP) for the headline deficit proved insufficient to create adequate incentives, in particular for improving the soundness of public finances during favourable economic conditions, and to avoid the implementation of temporary measures just to comply with the benchmark. In this context, the SGP was amended for the first time in 2005, introducing the concept of "structural balances" explicitly.

After the inclusion of the set of laws known as the Six-pack, the Fiscal Compact and the Two-pack, other changes were introduced to the framework, including the expenditure benchmark, to reduce the role played by the output gap.[5] Nonetheless, in its current version, the SGP still relies heavily on structural balances, both under its "preventive arm" and the "corrective arm".

[4]The IMF assesses structural balances regularly in the *World Economic Outlook* releases. The OECD publishes their estimates in the *Economic Outlook Issues* and reports in-depth policy analysis in the biennial *Government at a Glance* publication (see, for example, OECD (2019)).

[5]See European Fiscal Board (2019).

Under the preventive arm countries have to meet a Medium Term Objective (MTO), which is set in terms of a structural balance level.[6] If a Member State fails to achieve this goal, the required corrective policy measures are conditional on country-specific factors. As part of the overall assessment, a minimum fiscal adjustment is set in terms of annual change in the structural balance, and is therefore dependent on the change in the output gap.

Under the corrective arm of the SGP, *i.e.* when Member States present excessive deficits, changes in the structural balance also play a key role in setting the pace for fiscal consolidation (European Commission 2019).[7] When Excessive Deficit Procedures (EDP) are triggered, recommendations are addressed to Member States to bring the headline deficit below 3% according to a specific time frame and targets, both in terms of headline deficits and fiscal effort, *i.e.* the change in the structural balance.

2.2. *Operational environment*

The structural balance is an unobserved variable that needs to be estimated. As in the case of many latent variables, for instance potential output, the empirical literature offers no unique or uncontroversial estimation procedure, although most international institutions converged to relatively similar approaches, namely to use expert judgement to identify special one-off impacts on government budget balances, and to use low-frequency estimates of output to extract the business cycle impact.

Herein we will follow the ESCB methodology, where the structural balance at year t, presumably free from revenue and expenditure business cycle dependencies, is given by the formula

$$\frac{\bar{B}_t}{\bar{Y}_t} = \frac{B_t - TM_t}{Y_t} - \varepsilon\, \hat{Y}_t \tag{1}$$

where $\bar{B}_t/\bar{Y}_t$ is the unobserved structural balance, B_t is the headline budget balance, TM_t is the net effect resulting from temporary measures, Y_t is output, $\hat{Y}_t$ is the cyclical indicator, and $\varepsilon > 0$ is a constant semi-elasticity. All variables are expressed in nominal terms, and bars identify low-frequency estimates, which we also indistinguishably take as "potential" levels, *e.g.* $\bar{Y}_t$ is the nominal potential output (computed with the real estimate and the actual GDP deflator). All time series in equation (1) are officially published by national statistical institutes, except real potential output.[8]

[6] An MTO is a country-specific target that takes into account the need to achieve sustainable debt levels, while allowing for the role of automatic stabilizers without breaching the 3% reference value for the headline deficit.

[7] Member-states risk facing the rules of the corrective arm when the headline deficit breaches the 3% reference value or the debt level is above 60% and is not approaching the reference value at a satisfactory pace, where the annual debt reduction target corresponds to one twentieth of the debt in excess of the threshold. The debt criterion is breached when the reduction falls short of this target over three years. The current regulation also contains discretionary leeway to consider the breach exceptional.

[8] See Braz *et al.* (2019) and Mourre *et al.* (2014) for a more detailed description of the ESCB and EC methodologies, respectively. As Mourre *et al.* (2013) recalls, equation (1) is a linear first order approximation

The aggregate approach behind equation (1) establishes that structural balance ratios are defined as a residual: it is the level that remains after the influences of actual temporary measures and the output gap are removed from the headline budget balance ratio B_t/Y_t. Note that TM_t/Y_t is an observed variable expressed in percentage of nominal GDP. Temporary revenues and expenditure congregated in TM_t have one-off impacts at year t and no permanent effects and therefore, by design, no influence on low-frequency budget balance developments. The criteria to define these impacts vary across institutions and herein we use temporary estimates as defined by the ESCB.

The sole unobserved time series in equation (1) is the economy-wide cyclical indicator $\hat{Y}_t$, which we use extensively by considering $\hat{Y}_t \equiv (Y_t - \bar{Y}_t)/\bar{Y}_t$, *i.e.* a variable measuring the deviation of total output from its trend estimate. The presence of this cyclical component is meant to capture the impact of automatic stabilizers—the effect of the business cycle on the headline budget balance.

In the analysis that follows we rely on cyclical indicators produced by the EC, IMF and OECD models, as well as those suggested by Braz, Campos, and Sazedj (2019), used in the context of the ESCB projection exercises (the BCS model), and Duarte, Maria, and Sazedj (2020)—parametrized with posterior median estimates (the U model). All estimates intend to capture the maximum level of output that the economy can produce without jeopardizing price stability, *i.e.* an overall supply measure from which actual output can deviate. Potential output computed by the EC, OECD, BCS and U models are based on Cobb-Douglas production functions with constant returns to scale, featuring two factor inputs—labour and capital—, and a measure of total factor productivity. IMF estimates are computed by country desk experts following no uniform method. For industrialized countries, the estimation usually also relies on a production function, however, public details regarding the method applied to Portugal are not available.[9]

The semi-elasticity of the budget balance to the output gap ε is derived from the difference between revenue and expenditure semi-elasticities, which are weighted averages of the semi-elasticity of each revenue and expenditure component. Each of these former elasticities is obtained by multiplying an elasticity—meant to capture the sensibility of these items to changes in their macroeconomic bases—and the elasticity of the latter relative to the output gap. Herein we take the ESCB estimate and set $\varepsilon = 0.5$.[10]

Solving equation (1) for B_t/Y_t, namely

$$\frac{B_t}{Y_t} = \frac{\bar{B}_t}{\bar{Y}_t} + \frac{TM_t}{Y_t} + \varepsilon \frac{Y_t - \bar{Y}_t}{\bar{Y}_t} \tag{2}$$

allows us to clarify that the contribution of the business cycle for the headline balance in levels is given by $\varepsilon \frac{Y_t - \bar{Y}_t}{\bar{Y}_t}$, and in changes by $\varepsilon \Delta \frac{Y_t - \bar{Y}_t}{\bar{Y}_t}$, where the operator Δ identifies

of a more precise but cumbersome expression measuring the difference between cyclically-adjusted revenues and expenditures.

[9] The EC, BCS and U models are briefly presented in Appendix A

[10] It should be noted that some approaches, including the ESCB, rely on a second semi-elasticity intended to capture lagged effects on current estimates. We abstract from this complexity as our qualitative results remain unchanged.

a variation between two consecutive time periods. Positive/nil/negative output gaps generate positive/nil/negative contributions to the headline ratio.

3. Cyclical outputs and structural budget balances

After highlighting the importance of structural balances in the European fiscal surveillance framework, we now focus on the Portuguese case. Temporary measures, GDP and the semi-elasticity are identical across all estimates, and thus differences between alternative levels stem solely from business cycle indicators.

Our sample spans the period 1999-2019 whenever the database vintage was produced in 2020. In the case of the OECD, we use a vintage produced during 2019 and therefore the associated sample ends in 2018. Average values using all databases span 1999-2018.[11]

3.1. Impact on the level

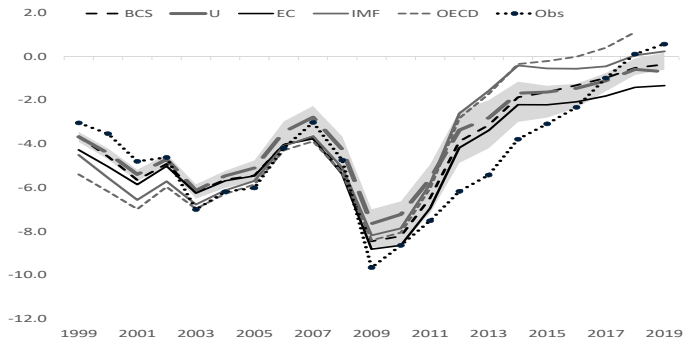
Figure 1a reports structural balances, according to equation (1), superimposed against published headline data excluding temporary measures. Figure 1b isolates the business cycle contribution, as clarified in equation (2). All unobserved times series fulfil to some extent the expected role of long-run trend estimates, around which observed data oscillates. In addition, all models share some identical features, for instance positive contributions in the beginning of the sample, or large negative impacts in the first part of the 2010s. Results also show, nevertheless, striking time-varying differences, not only in terms of sign but also in term of amplitude. For instance, the U model suggests close but below zero output gaps during 2007-08, implying a negative contribution of the business cycle to the headline balance, not echoed by the remaining models. In 2017-18, IMF and OECD indicators suggest a negative or nil impact of the business cycle on the headline budget balance, in contrast with the remaining estimates.

In terms of amplitude, the difference between the maximum and minimum point estimates across databases, in percentage of potential output estimates, reaches 1.5 p.p. between 1999-2018. The amplitude stood close to 1.2 p.p. until 2007-08, and increased to almost 2.0 p.p. in 2013-14, before receding to 1.5 p.p. during the last part of the sample. Excluding the IMF and the OECD, the maximum amplitude was reached in 2010 (1.4 p.p.), and stood around 1.0 p.p. in 2019.

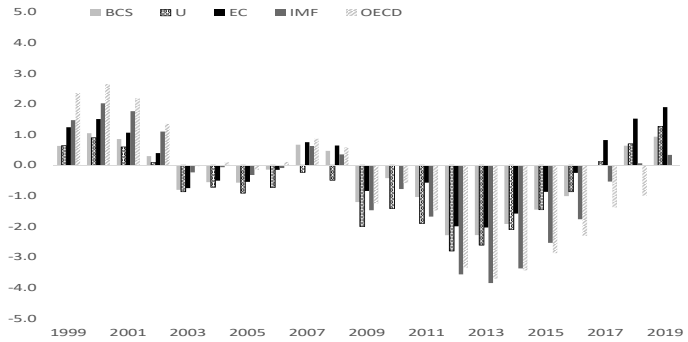
Discrepancies against EC estimates reach their highest level during the international financial crisis in the case of the U model and thereafter in the case of the IMF and OECD data. The BCS model depicts the smallest deviations, yet with an increasing trend in the recent past.

The dispersion of structural balance point estimates reported in Figure 1a and 1b suggests primarily that model uncertainty should not be ignored. However, unobserved

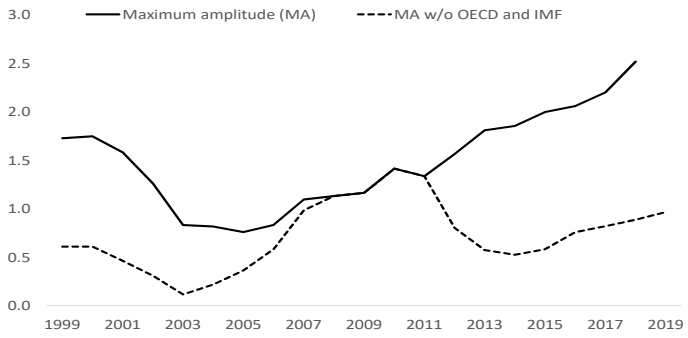
[11] The EC, IMF and OECD data was retrieved from the Annual macro-economic database (AMECO), World Economic Outlook, and Economic Outlook, respectively. All databases are available from the authors upon request.



(A) Headline and structural balances | Levels



(B) Business cycle contribution | Levels



(C) Amplitude | Levels

FIGURE 1: The impact of cyclical output on structural balances

Sources: Banco de Portugal, EC, IMF, OECD and authors' calculations.

Notes: Structural balances are in percentage of potential output and observed data, which correspond to headline values free of temporary measures, in percentage of GDP (identified by "Obs"). The EC, BCS and *U* models are briefly presented in Appendix A. The grey area corresponds to alternative outcomes of the *U* model along a 5th-95th percentile range of possible outcomes drawn from the posterior distribution. The maximum amplitude (MA) corresponds to the difference between maximum and minimum datapoints. The reference "w/o OECD and IMF" indicates the results obtained when excluding OECD and IMF databases.

variables are also associated with other sources of uncertainty, among them parameter and data uncertainty, including not only the variables underlying equation (1) and those used in each model, but also the sample period that is subject to the filtering process that

decomposes observed data into trends and cycles.[12] Although this feature is well known in the literature, most models are only used to produce one set of point estimates. Herein we use the *U* model to follow another route and consider alternative values along a 5th-95th percentile range of possible outcomes drawn from the posterior distribution. This range is depicted as the grey area in Figure 1a. The area encompasses most of the remaining point estimates, as most lie within or very close to this region since 1999. However, this is not always the case, which indicates the presence of clear differences in terms of data generation processes. For instance, IMF and OECD figures lie outside this area on several occasions, as well as the EC in recent years.

3.2. Impact on the change

Figures 2a and 2b depict the same set of information as Figures 1a and 1b, but now in terms of changes between two consecutive years. In sharp contrast with the previous assessment, results are now relatively similar across databases, *i.e.* the impact of cyclical output on changes in the structural balances have the same sign, or are close to nil, and amplitudes have no systematic decouplings. All business cycle contributions are also highly correlated with the real growth rate of GDP, also reported in Figure 2b.[13]

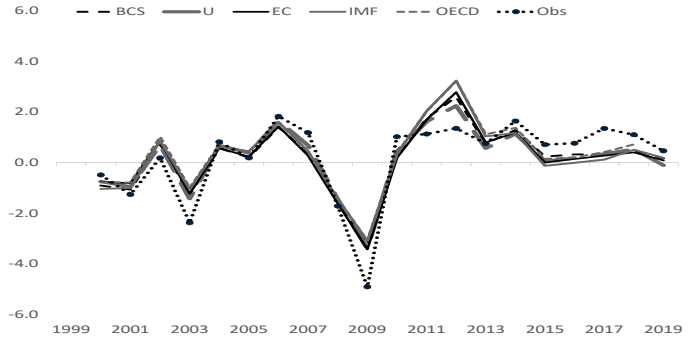
In terms of amplitude, the difference between the maximum and minimum point estimates across databases stood close to 0.3 p.p. over 1999–2018, increased temporarily to 1 p.p. in 2012, and stood at 0.3 p.p. in 2018. Excluding the IMF or the OCDE results in marginal differences.

Similarities in term of changes in structural balances are grounded on similar potential output growth estimates, suggesting on this dimension a noticeable reduction in model uncertainty. This decrease extends to other sources of uncertainty, as shown in the case of the *U* model by Duarte *et al.* (2020), who robustly confirm that potential output growth is much less uncertain than potential output levels. Furthermore, note that uncertainty around level estimates is irrelevant if the possible range of output gaps is symmetric around a focal point. Although this is not the case of the *U* model, the qualitative value added of including these figures is negligible and therefore omitted.

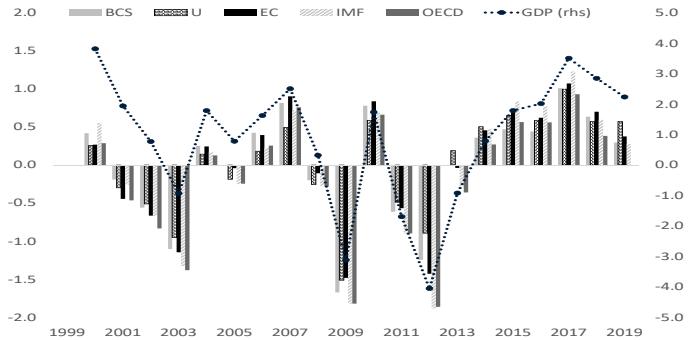
The proximity across models should not be taken, erroneously, by identical matches. The years 2012 and 2013 are, for instance, clear exceptions. In 2012, the IMF and OECD models feature the highest cyclical output impact, and in 2013 we detect the largest difference across models: the *U* model signals a positive business cycle contribution, the IMF a negative contribution, and the BCS and EC a close to nil impact.

[12] See Duarte *et al.* (2020) for an evaluation of the uncertainty surrounding the *U* model. It should also be noted that the EC established a "constrained judgement" approach, which includes expert judgement, to cope with large degrees of uncertainty surrounding output gap estimates. On this issue, see Hristov *et al.* (2017) and Roeger *et al.* (2019).

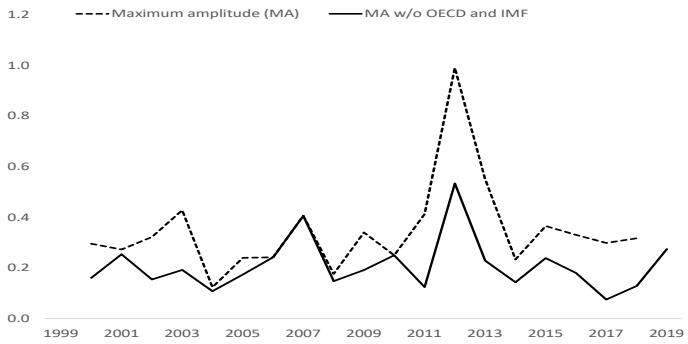
[13] The correlation coefficient is above 0.8 over 1999-2018 in all cases.



(A) Headline and structural balances | Changes



(B) Business cycle contribution | Changes



(C) Amplitude | Changes

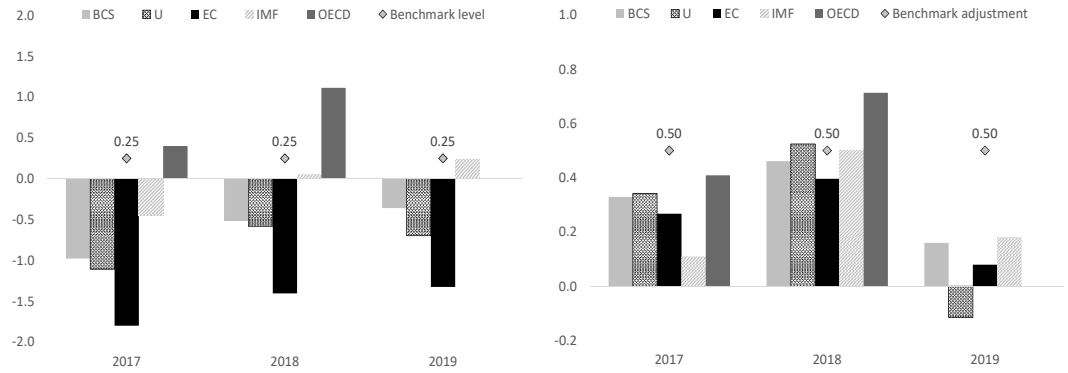
FIGURE 2: The impact of cyclical output on the change in structural balances

Sources: Banco de Portugal, EC, IMF, OECD and authors' calculations.

Notes: All data is in p.p., except "GDP (rhs)", which is in percentage. This series corresponds to real growth rate and is measured on the right-hand scale (rhs). The maximum amplitude (MA) corresponds to the difference between maximum and minimum datapoints. For further information, see notes of Figure 1.

3.3. Comparison with selected benchmarks

This subsection assesses to what extent the previously identified discrepancies and similarities affect the comparison with selected benchmarks. This implies moving away from the EU criteria, given that compliance with the relevant institutional rules is solely assessed against figures produced by the commonly agreed methodology of the European Commission. Figure 3 reports our results.



(A) Structural balance (B) Changes in the structural balance

FIGURE 3: Comparison with selected benchmarks

Sources: Banco de Portugal, EC, IMF, OECD and authors' calculations.

Notes: Structural balance levels are in percentage and their changes in p.p. We selected a "Benchmark level" of 0.25% and a benchmark change of 0.5 p.p. (identified by "Benchmark adjustment"), which intends to capture, respectively, plausible levels and minimum required changes during normal times.

We focus on the 2017-19 period, after the EDP was abrogated and Portugal entered the preventive arm of the pact. For illustrative purposes, we selected a structural balance benchmark of 0.25% and an annual adjustment benchmark of 0.5 p.p.[14]

Figure 3a confronts the structural balances levels with the selected benchmark level. It illustrates that the differences across models could lead to different assessments with regard to the distance from the benchmark. Indeed, OECD figures suggest that Portugal had already reached the benchmark in 2017, while according to the IMF estimate it was only reached in 2019. In contrast, the remaining estimates suggest that a distance of 0.6 to 1.6 p.p remains in 2019.

Changes in the structural balances are depicted in Figure 3b. All estimates point to a shortfall in 2017 and 2019, considering the benchmark adjustment, suggesting that the differences in the underlying cycle indicators do not play a major role. The exception is 2018, where the BCS and EC estimates fall short of the benchmark adjustment, in contrast with the remaining results.

In short, comparisons with our selected benchmarks lead to a model-dependent assessment, which suggests the presence of important model-uncertainty effects.[15]

[14] Although our selected benchmarks intend to map plausible estimates for an MTO and a minimum adjustment required during normal times under the European fiscal surveillance framework, our goal is solely to evaluate how alternative output gaps impact on the comparison with these benchmarks. We are neither reproducing the published figures from the institutions, nor considering the exact recommendations that were made at the time.

[15] Results are qualitatively identical if we were to qualify the deviations as significant, since 2017, namely when their magnitude surpasses 0.5 p.p. in a given year, or 0.25 p.p. on average over two consecutive years. Results are available from the authors upon request.

4. Revisions in structural balances

Cyclical outputs are subject to revisions, and therefore structural balances are subject to revisions. Even if one uses the same model, it is well known that potential output estimates may change as new observations become available, or as new out-of-sample projections are modified, if those are included in data-filtering processes. The new information set may have an impact not only on the last unobserved data point of the sample, but also on historical estimates.

Until now we have focused on impacts of alternative cyclical outputs on the determination of structural balances. In this section we abstract from model uncertainty and focus on uncertainty surrounding real-time estimates.

We initiate this section by providing a stylised example of what might occur under unexpected shocks, and later retrieve EC output gap vintages to illustrate their impact on structural balance estimates.[16]

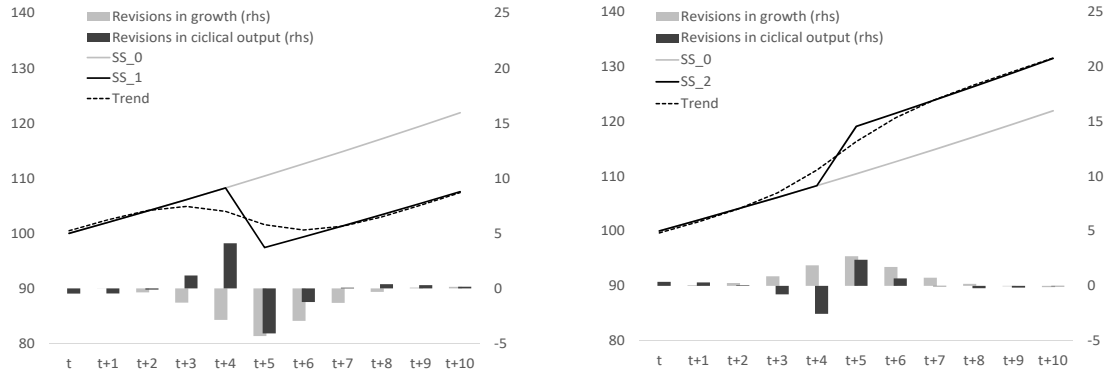
4.1. A stylised example

Figure 4 report highly stylized and simple examples that may clarify the possible impact of an unexpected crisis, or, in contrast, an unexpected expansion period on the revisions of structural balances. Suppose that the economy is growing along a balanced-growth path of 2% per period (identified by the straight line SS_0), actual and trend output grow at the same rate, the output gap is nil, and for simplicity headline and structural balances are stable at a nil value. In such state of the world, with no shocks, note that the contribution of cyclical output to government budget balances remains nil at all times. Assume now that a negative/positive shock occurs at a particular time period, say $t+5$, after which the economy jumps back to the same expansion rate of 2% (identified as SS_1). By design, the shock is temporary on the growth rates and permanent on the level. Under the unexpected crisis scenario, the output level at $t+10$ is already close to the one recorded before the crisis at $t+4$, but there is a permanent loss close to 10% against the level that would have prevailed if no crisis had existed.

Under the assumption that potential output is given by the slow-moving output level that changes from the initial to the new steady-state path, *i.e.* towards SS_1, from SS_0, then one might expect to have an evolution similar to the one given by the dotted line. Herein we used an Hodrick-Prescott filter but other options would give the same qualitative outcome (*e.g.* a centered moving average).

Figures 4a and 4b show that during the unexpected crisis/expansion periods registered at $t+5$, both the trend growth and output gap move in the same direction, as reported by the bars, but note that before the shock their revisions have opposite signs. For instance, in the crisis scenario depicted in Figure 4a both are revised downwards

[16]Real-time estimates found herein focus solely on alternative output gap data, as in previous sections, and therefore do not account for all changes that occurred during our sample period, including GDP revisions or methodological revisions. Note also that the EC does not re-evaluate their historical assessments, as new output gap data is released. All EC vintages are available from the authors upon request.



(A) Unexpected crisis (B) Unexpected expansion

FIGURE 4: Output gap and potential output growth revisions

Source: Authors' calculations.

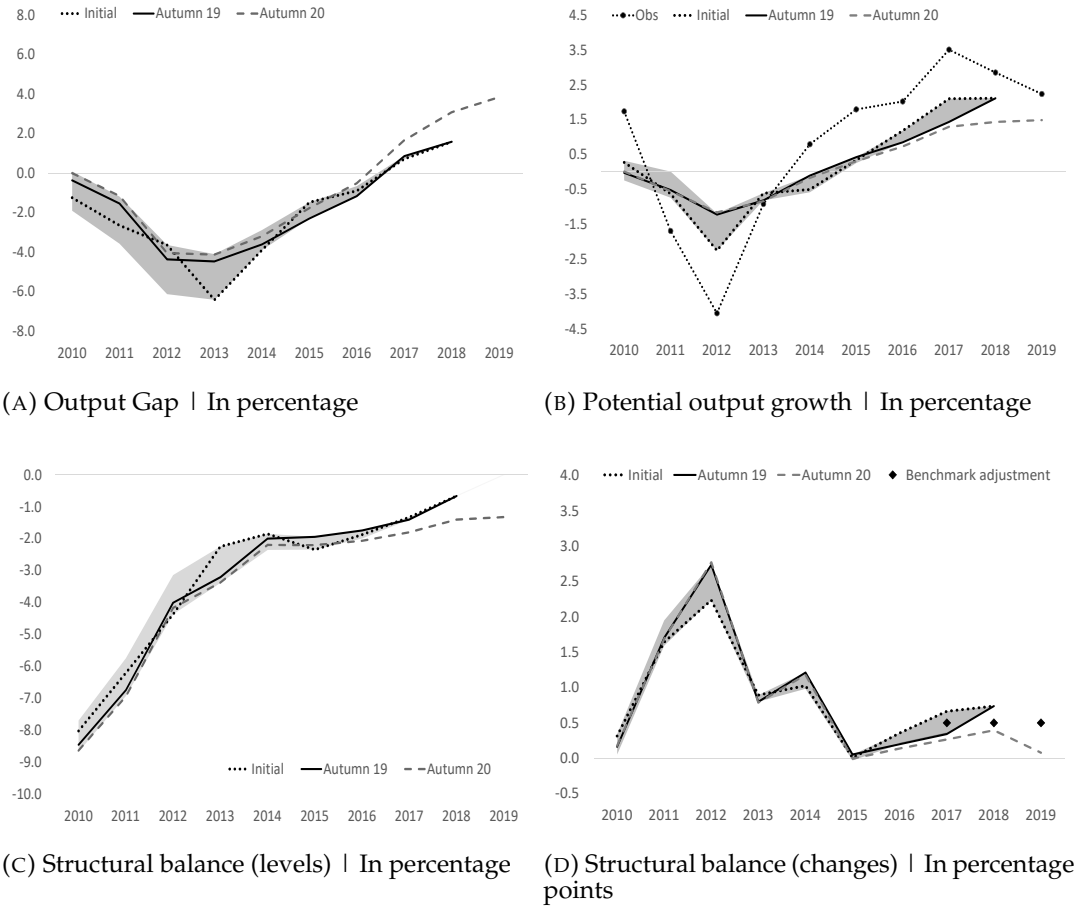
Notes: Revisions in growth (*i.e.* potential output growth) and in cyclical output (*i.e.* the output gap) are measured in p.p. in the right-hand scale (rhs). In Figure 4a output falls by 10% and in Figure 4b there is an expansion of 10% at $t+5$. Initial and final steady-state trends are identified with SS_0 and SS_1, respectively.

at $t+5$, but before the crisis the growth rate is revised downwards and the output gap upwards. This brings along a change in the assessment. Before the crisis, at $t+4$, the contribution of the business cycle to the headline budget balance is suddenly revised from nil to positive, and therefore the structural balance is revised downwards. The opposite effect occurs in Figure 4b.

4.2. The EC case

Figure 5 reports revisions in potential output and structural balances. The upper row, namely Figures 5a and 5b, reports output gaps and potential output revisions, whereas the lower row, namely Figures 5c and 5d, map these data points into structural balance estimates, both in terms of levels and changes. To reduce the end-of-period bias, all estimates for year t are retrieved from the publication of year $t+1$, and therefore already incorporate information available at that period. For instance, initial output gap estimates for 2010 refer to the values published in Autumn 2011. By the same token, the growth rate of potential at year t, $t-1$, etc, is computed with the output gaps of t, $t-1$, $t-2$, etc, published at $t+1$. We include not only the initial and most recent estimates, but also a shaded area highlighting the range of published outcomes until the Autumn 2019 publication.

A comparison between the initial and Autumn 2019 publications reveals considerable output gap revisions in several years, reaching magnitudes of 2 p.p. The shaded area shows that revisions until 2018, when the area is non-existent by design, do not always move in the same direction, *i.e.*, the revisions that take place after the initial estimate do not necessarily approximate it to the most recent figure. When we consider the Autumn publication of 2020, the output gap is substantially revised upwards before 2018. One possible explanation may be linked to the effects reported in Figure 4a. The



(A) Output Gap | In percentage

(B) Potential output growth | In percentage

(C) Structural balance (levels) | In percentage

(D) Structural balance (changes) | In percentage points

FIGURE 5: Revisions in potential output and structural balances

Sources: Banco de Portugal, EC and authors' calculations.

Notes: All data is based on Autumn publications. The shaded area corresponds to the range of estimates for year t, where the initial estimate refers to autumn of year $t+1$ and the most recent to Autumn 2020. Figure 5d also features our "Benchmark adjustment" of 0.50 p.p. (as in Figure 3b). The growth rate of real GDP is identified in Figure 5b as "Obs".

results released in Autumn 2020 are obtained from a sample that already includes data associated with the pandemic crisis, which is a large negative shock.

Revisions in growth rates are of a much lower order of magnitude. In general, all estimates depict a low-frequency movement around actual GDP growth, also reported in Figure 5b. The difference between the maximum and minimum growth rates over 1999-2018 stands at 0.5 p.p., reaching the highest level in 2012 (close to 1.0 p.p.). When we consider the Autumn publication of 2020, we detected a downward revision that reaches 0.7 p.p. in 2018—again, in line with the stylised example of Figure 4a.

Structural balance revisions have amplitudes conditioned by the use of equation (1), namely the semi-elasticity $\varepsilon = 0.5$. Thus, changes of 2 p.p. in the output gap correspond to changes of around 1 p.p. in structural balances, and therefore lower revisions in growth rates of potential output implies lower revisions on structural balance changes. The average revision in changes over 2010-18 stood at 0.23 p.p., and the highest reached 0.51 p.p. in 2012, against a background where vintages, since 2010, often do not move the estimated data in the same direction.

	Mean absolute revisions									
Elapsed time	$t-1$	$t-2$	$t-3$	$t-4$	$t-5$	$t-6$	$t-7$	$t-8$	$t-9$	$t-10$ [t]
Levels	0.51	0.42	0.44	0.38	0.30	0.19	0.14	0.13	0.17	0.21
Changes	0.22	0.13	0.10	0.13	0.14	0.11	0.12	0.10	0.09	0.05 [b]

TABLE 1. Structural balances: levels and changes

Sources: Banco de Portugal, EC and authors' calculations.

Notes: All data is based on Autumn publications. Mean absolute revisions are in p.p. and are computed with 9 observations.

Comparisons with selected benchmarks, however, cannot always be assessed in a stable manner, as clarified by Figure 5d. In some particular cases the evaluation depends on the data vintage. Note that the Autumn 2020 publication brought along a downward revision of the structural balance of 2018. Moreover, this estimate is below our selected benchmark adjustment of 0.5 p.p., in contrast with the previous assessment.

Finally, Table 1 reports mean absolute revisions *vis-à-vis* the Autumn 2020 publication, both of the level of structural balances and of the change. For instance, $t-k$ mean values collect all $t-k$ revisions published in year t, starting in the Autumn 2011 publication, where $k = 1, 2, ..., 10$. Considering changes, mean values are relatively small—below 0.2 p.p after $t-1$ and close to 0.1 p.p thereafter. Mean revisions for levels are higher, reaching 0.51 p.p at $t-1$, and only falling below 0.2 p.p after $t-6$.

5. Concluding remarks

We reported similarities and discrepancies in cyclical output impacts on structural balances over 1999-2019. Differences are solely originated by alternative cyclical indicators. The similarities, particularly in the changes of structural balances, imply that an assessment of the Portuguese fiscal policy stance would lead to broadly similar conclusions across models.

The discrepancies, particularity striking when focusing on the levels of structural balances, may cast doubts on their usefulness, especially if not properly taken into account by policymakers. Unsurprisingly, if the output gap is subject to high uncertainty, especially in real time, it is only natural to expect that fiscal rules relying on this unobserved variable would inherit, to some extent, identical characteristics. The conflicting signals reinforce the need for a more encompassing analysis because comparisons with point-specific benchmarks—even when measured by changes in structural balances—lead to model-dependent assessments.

In spite of the challenges, potential output and structural balances are valuable indicators in policymakers' toolkit. Assessing the low-frequency characteristics of the economy is crucial to promote adequate policies envisaging sustainable growth and a sound fiscal position.

Appendix: Brief overview of potential output estimation methods

The estimation of potential output shares some characteristics across the EC, OECD, BSP and U models. All use Cobb-Douglas production functions with labour, capital and total factor productivity (TFP), and all set the potential capital stock equal to actual values, which implies that all models only require the estimation of labour and TFP potential levels. All models use the capital stock of the whole economy, except the OECD, which excludes housing.

The EC model (Havik *et al.* 2014)
The labour input is computed as the product of actual working age population and the trend components of average hours worked (per worker) and participation rates (computed with an Hodrick-Prescott (HP) filter), as well as a measure of the Non-Augmenting Wage Inflation Rate of Unemployment (NAWRU) measure. The NAWRU is estimated by maximum likelihood techniques within a Phillips curve that ensures a convergence towards a structural unemployment indicator (obtained from a panel regression on several labour market indicators). Trend TFP is obtained through Bayesian methods using a model that explores a relationship between cyclical components and capacity utilization.

The OECD model (Chalaux and Guillemette 2019)
The labour input takes into account trend working age population and labour force, obtained by HP filters, and featuring a component that accounts for the gap between national accounts (NA) and Labour Force Survey (LFS) employment levels. The authors prefer the concept of "labour efficiency", instead of TFP, obtained as a residual. The trend unemployment rate is estimated with a Kalman filter within a Phillips curve specification.

The BCS model (Braz *et al.* 2019)
The labour input is computed as the product of actual working age population, HP-filtered series of the participation rate, average hours per worker, and an adjustment term that takes into account the gap between NA and LFS levels, as well as NAWRU estimates that are in line with the proposal of Duarte *et al.* (2020). Trend TFP is computed as the HP-filtered Solow residual.

The U model (Duarte *et al.* 2020)
The model uses reduced-form theoretical equations that are jointly estimated with Bayesian techniques. The output gap is linked to the unemployment gap through Okun's law, and wage and price equations establish links with labour and product markets. The trend component of labour results from a measure of the NAWRU and the labour force (measured in hours). TFP is endogenously determined within the model, closing the link between output and prices.

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Non-technical summary

April 2021

Bank pricing of corporate loans

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From the end of the sovereign debt crisis to the end of 2019, bank credit to Portuguese firms fell, spreads on new loans decreased and banks reported an increase in competition. Banks' profitability, while increasing to levels close to those observed in euro area banks, remained below its historical long term average.

The combination of these dynamics raises concerns that banks were underpricing loans. In a bid to remain competitive, banks may have offered loan spreads below the level needed to compensate banks' equity holders for bearing risk. Underpriced loans can lead to fragilities in the financial system and pose a risk to financial stability. Banks originating underpriced loans are less able to build up capital by accumulating profits, are less attractive to outside investors, and are more likely to make losses if credit risk increases suddenly.

We assess whether the spreads on firm loans are sufficient to cover loans' expected credit losses, operating costs and capital costs. The analysis covers loans originated between September 2018 and December 2019 by the largest banks operating in Portugal.

Results suggest that banks' equity holders are earning a return higher than an estimated cost of equity of 8 percent in the short-run. In the medium to long-run, however, loans are underpriced. Banks' equity holders stand to earn a return lower than the cost of equity, especially if banks keep on originating loans as in the sample period. Underpricing in the medium to long-run is reduced if we take into account only the subsample of loans originated during 2019 (Figure 1).

Results also show that loan underpricing is linked to the underpricing of loans with maturity longer than a year, loans to the construction, real estate, and transportation and storage sectors, and loans to high credit risk borrowers. Loans to other borrowers are generally overpriced.

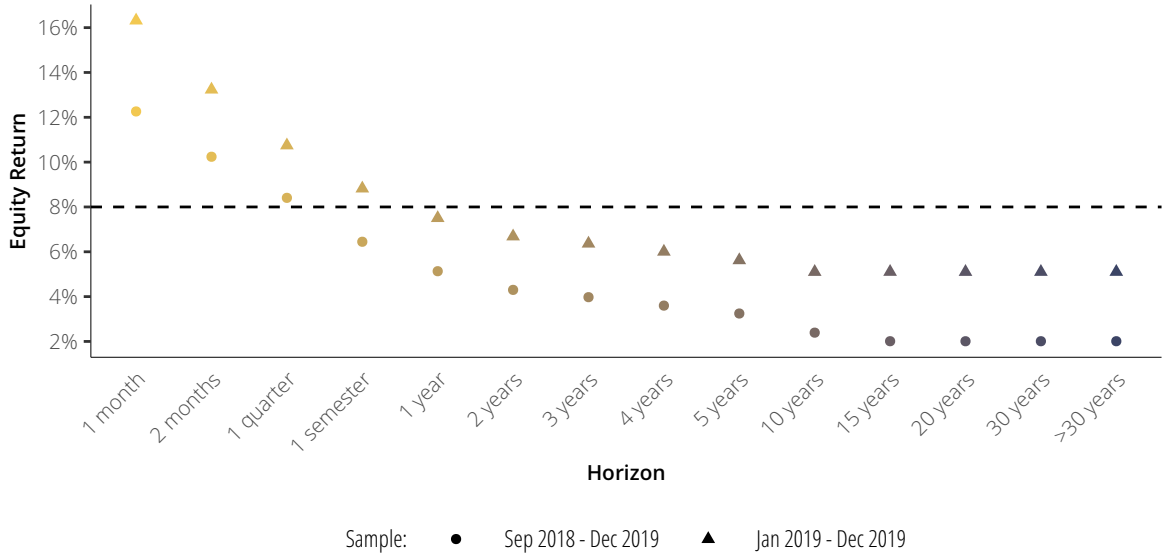

FIGURE 1: Average equity holders' return on new loans at different horizons.

Source: Banco de Portugal.
Notes: This figure shows average equity holders' returns generated at different holding horizons. Each point in the figure should be interpreted as the return banks' equity holders are expected to earn on new firm loans over a specific horizon – eg. 1 month, 2 months, 10 years –, if banks keep on originating loans as they did during the sample period. The figure has two series: One using loans originated between September 2018 and December 2019 and another using loans originated between January and December 2019.

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Abstract
We analyze the pricing of firm loans originated by the largest banks operating in Portugal between September 2018 and December 2019. On average loans are overpriced in the short-run and underpriced in the long-run. Underpricing is lower in the subsample of loans originated in 2019. Loans with maturity longer than a year, loans to the construction, real estate, and transportation and storage sectors, and loans to high credit risk borrowers are on average underpriced. Loans to other borrowers are generally overpriced. Borrowers and sectors with underpriced loans are potential sources of fragility in the financial sector, especially in the medium to long-run. (JEL: G12, G21)

1. Introduction

From the end of the sovereign debt crisis to the end of 2019, bank credit to Portuguese firms fell and banks reported an increase in competition. Spreads on new loans decreased and bank profitability, while improving during this period, remained lower than its historical long term average. The combination of these dynamics raises concerns that banks were underpricing loans. In a bid to remain competitive, banks may have offered loan spreads lower than the level needed to compensate banks' equity holders for bearing risk. Underpriced loans can lead to fragilities in the financial system and pose a risk to financial stability. Banks originating underpriced loans are less able to build up capital by accumulating profits, are less attractive to outside investors, and are more likely to make losses if credit risk increases suddenly.

In this article we assess the pricing of firm loans. We analyze whether the net interest and fee income of loans to Portuguese firms is sufficient to cover loans' expected credit losses, operating costs, and capital costs. We then analyze the borrower and loan characteristics driving the differences in the pricing of firm loans.

We contribute to the literature on loan pricing with a new methodology. We compute the spreads that banks should charge based on loan, borrower, and bank characteristics,

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and compare them with observed spreads. This comparison allows us to determine whether loans are under, over, or fairly priced.

We assess loan pricing with a granular analysis of loans originated between September 2018 and December 2019. We compute the risk-adjusted return of each loan net of capital costs. The risk-adjusted return of each loan accounts for the loan's net interest and fee income, expected credit losses, and operating fees. The loan's capital costs accounts for the loan's contribution to a bank's capital. We estimate the risk-adjusted return and the loan's capital costs using loan, borrower, and bank data.

Results on the pricing of loans originated in 2018 and 2019 are mixed. On average loans are overpriced by 11 basis points if we focus on short-run loan returns. In the long-run, however, loans are underpriced by 29 basis points. While the absolute level of underpricing is seemingly small, it has a sizable effect on shareholders' return. An average underpricing of 29 basis points reduces shareholders' return on corporate loans by 6 percentage points compared to a setting with no underpricing. The underpricing we find when focusing on the long-run returns seemingly decreases over time. In the sample of loans originated in 2019, loan underpricing reduces to 7 basis points on average and the corresponding shareholders' return on corporate loans reduces only by 2.9 percentage points compared to a setting with no underpricing.

We find further evidence of over and underpricing when we analyze mispricing across different loan and borrower characteristics. First, loans with maturity longer than a year are generally underpriced. If banks keep on originating loans as in the sample period firm loan portfolios are unlikely to adequately compensate banks' equity holders in the medium to long-run. Second, loans to firms operating in the construction, real estate, and transportation and storage sectors are underpriced. To the extent that underpriced loans yield lower returns than fairly priced loans, this result highlights these sectors as potential sources of fragility to the financial system. It also raises questions about the strength of the recovery of these sectors from the 2008-2012 crisis. Third, loans to low credit quality firms are underpriced. They represent 17.7 percent of all loans originated between September 2018 and December 2019. This result suggests that the borrowers of some of these loans have a weak financial standing and are possibly more sensitive to a negative shock than similar borrowers with fairly priced loans. Lastly, and in contrast with these results, we find that loans to high credit quality borrowers, and loans to the manufacturing and to the wholesale and retail sectors are overpriced.

The overall effect on bank profitability of the mispricing that this article documents, is likely limited. The loans in the sample we analyze represent at most 16 percent of banks' stock of credit to firms and 5 percent of banks' total assets. We also note that the low equity returns on new firm loans that Portuguese banks are expected to earn in the medium to long-run is in line with the low profitability that euro area banks are experiencing since the financial crisis. Between 2008 and 2019, the yearly equity returns of euro area banks was never higher than 6 percent.

The existing literature on loan pricing of which Barbosa and Ribeiro (2007), Santos (2011), Antunes and Martinho (2012), Santos (2013), Gambacorta and Mistrulli (2014), Santos and Winton (2019) and Banco de Portugal (2016, 2017) are a few examples,

is mostly focused on explaining the cross-section variation in observed spreads. The methods used in the literature can determine whether certain loan, borrower, and bank characteristics matter for loan pricing but, in contrast with the method we use, they cannot determine whether a particular level of observed spread is sufficient to compensate banks' shareholders for their costs.

The next section describes the methodology and the data. Results from our granular analysis are in section 3. Section 4 concludes.

2. Risk-adjusted return net of capital cost

2.1. Method

We assess whether specific firm loans are mispriced by computing the risk-adjusted return of each loan net of the loan's capital cost. The risk-adjusted return net of capital cost is the sum of the loan's net interest and fee income minus the loan's expected loss rate, operating costs, and capital costs:

$$r = Net\,Interest\,Income - E\left[Loss\right] + Fees - Operating\,Costs - Capital\,Cost$$

The capital cost is the cost of equity of the bank originating the loan multiplied by the loan's contribution to the bank's capital, $Capital\,Cost = Cost\,of\,Equity \times Capital$.

The risk-adjusted return net of capital cost is the excess return earned by the shareholders of the bank originating the loan. It represents what is left to shareholders after paying all costs including the capital cost associated with the loan. The capital cost is the risk premium for bearing the part of the loan's default risk that is not diversified by the bank's portfolio. If the excess return is zero then shareholders are exactly compensated for the costs of originating and servicing the loan – the operating costs –, and for the costs of bearing default risk – the expected losses and the capital cost. Loans are underpriced if the risk-adjusted return net of capital cost is negative.

The risk-adjusted return net of capital cost is closely related to a metric practitioners use for banks' capital budgeting and for loan pricing. This metric is called risk-adjusted return on capital, or RAROC. We follow the description of RAROC in Saunders and Allen (2010), adjusted to partly address the shortfalls identified in Froot and Stein (1998). Following Froot and Stein (1998) we compute a loan's capital to reflect only the credit risk that cannot be hedged by the bank's portfolio.

In what follows we briefly describe how we compute each component of the risk-adjusted return net of capital cost. Details are available upon request. In the remainder of this article we will use the expressions 'risk-adjusted return net of capital cost' and 'excess return' interchangeably.

2.1.1. Net interest income

A loan's net interest income is the value that, once added to a cost of funds rate, discounts the sum of the loan's cash-flows to zero. The net interest income i solves the

following equation:

$$\sum_{t \in T} \frac{CF_t}{(1 + i + r_t)^t} = 0 \tag{1}$$

where t is the annualized time difference between the loan's cash-flow date and the loan's origination date, T is the set of these time differences for all cash-flow dates, and r_t and CF_t are the cost of funds rate and loan cash-flow at time t.

We can think about the loan's net interest income as the difference between the loan's nominal interest rate and a cost of funds rate. We use the Euribor as the cost of funds rate. For loans with maturities longer than a year we complement information on Euribor with information on interest rate swaps. To compute the net interest income we use the loan's contractual terms to generate cash-flows and to determine the tenor of the cost of funds rate. Loans' contractual terms are reported by banks to the Banco de Portugal's Central Credit Register.

Instead of using the Euribor as the cost of funds rate we could have used each bank's cost of new deposits to capture the effect of bank specific financing costs on loan excess returns. In section 3.2 we report the results obtained when using this alternative measure of banks' cost of funds.

2.1.2. Fee income

We estimate a loan's fee income as a proportion of the loan's net interest income. This proportion is the ratio of total fee income to total net interest income of the bank originating the loan. It changes quarterly. Data on total net interest income and total fee income come from FINREP reports. In our sample period the average across time and banks of the ratio of total fee income to net interest income is 50.5 percent (refer to Table 1).

2.1.3. Expected loss rate

The expected loss rate is the rate that, once subtracted from the loan's net interest income and cost of funds rate, discounts to zero the sum of the loan's expected cash-flows. The loss rate is the value l that solves the following equation:

$$\sum_{t \in T} \frac{E_0 \left[CF_t \right]}{(1 + i + r_t - l)^t} = 0 \tag{2}$$

where variables t, CF_t, r_t, and i, and the set T have the same meaning as in equation (1). The expectation operator $E_0 \left[\cdot \right]$ is the expectation with respect to the loan's origination date.

We can think of the loss rate as the annualized expected loss on the loan per euro of exposure. The computation of loss rate and net interest income are similar. But to calculate the net interest income we use the contractual cash-flows, while the loss rate is computed using expected cash-flows. Expected cash-flows are equal to contractual cash-flows minus expected losses.

The expected loss in each period between consecutive cash-flow dates is the product of the loan's exposure at default, default probability, and loss given default.

The default probability between any two cash-flow dates is computed using a term structure of default probabilities from the origination to the maturity of the loan. We derive the term structure of default probabilities using estimates of a borrower's default probability and rating from Banco de Portugal's in-house credit risk assessment system, henceforth Banco de Portugal ICAS, together with the rating transition matrix in Antunes *et al.* (2016). Estimates of default probabilities available from Banco de Portugal ICAS are also based on Antunes *et al.* (2016).

We use loss given default estimates available at the Financial Stability Department of Banco de Portugal. The loss given default estimates vary by sector and firm size and are based on the regulatory loss given default reported by banks to the Banco de Portugal's Central Credit Register. They incorporate the effect of collateral and guarantees but they do so on average. They do not reflect the collateral or guarantees of a specific loan.

2.1.4. Operating costs

To estimate a loan's operating cost we combine loan and bank data. Specifically, we multiply the sum of a loan's net interest income and fees by the ratio of total operating costs to total loan income of the bank originating the loan. This ratio is computed in the quarter in which the loan is originated. Total operating costs are the sum of wages, depreciation, and general and administrative expenses. Total loan income is the sum of a bank's total fee and total net interest income. We extract these variables from banks' consolidated income statements in FINREP reports.

2.1.5. Capital costs

The capital cost of a loan is the loan's contribution to the capital of the bank multiplied by the bank's cost of equity.

Anecdotal evidence based on the CAPM puts the cost of equity of some Portuguese banks at around 8 percent, and this is the value we use. This value is consistent with the cost of equity range of 8 to 10 percent reported by European banks in the European Banking Authority Risk Assessment Questionnaire of June 2019.

The contribution of a loan to the bank's capital is the difference between (i) the loan's loss when the losses of the bank's credit portfolio equal the 99.9th percentile of the loss distribution of the same portfolio and (ii) the loan's expected losses, both terms divided by (iii) the outstanding amount of the loan. Implicitly, we are defining the bank's capital as the difference between the 99.9th percentile losses of the bank's portfolio of loans at a one-year horizon and the expected losses of the same portfolio. This definition of capital is usually referred to as economic capital. Economic capital does not correspond to the accounting equity value of the bank and it does not match the bank's regulatory capital. Nonetheless it is conceptually similar to regulatory capital and the choice of the 99.9th percentile follows from the underpinnings of Basel regulation.

To determine the contribution of a loan to the capital of the originating bank, we first compute the distribution of losses of the originator's loan portfolio. We obtain

the distribution of losses by simulating the default or non-default state of every single borrower in the originator's portfolio at a one-year horizon. We use a multi-factor model of default risk to simulate default and non-default states. The multi-factor model splits default risk into systemic and idiosyncratic risk, and allows for the existence of multiple systemic risk factors. The model captures default correlation across borrowers through their exposure to systemic risk factors, and through the correlation between those factors.[1] In each simulation trial we compute the loss associated with each loan based on whether the borrower defaulted or not. We then aggregate losses to obtain portfolio losses in a single simulation trial. We simulate many different trials to arrive at a distribution of portfolio losses. From the distribution of portfolio losses we then compute the 99.9th percentile of losses, and we identify the simulation trials associated with this level of loan losses. We then compute the mean of each loan's loss in these simulations trials and use the result to calculate the loan's contribution to the bank's capital.

In what follows we will briefly describe the portfolio and the source of the input parameters used to simulate portfolio losses. Details of the model, simulation, loss computation, and estimation of input parameters are available upon request.

Portfolio. The portfolio we use to compute the capital contribution of a specific loan is the credit portfolio of the originator in the month in which the loan is originated. The credit portfolio includes new and existing loans to households and firms, and new and existing credit securities – such as commercial paper and bonds – issued by firms. Loans and securities from borrowers deemed to be in default are excluded. We aggregate household loans into two exposures. One exposure aggregates mortgage loans and the other aggregates consumer loans. Data on household and firm loans comes from the Banco de Portugal's Central Credit Register. Data on banks' holdings of credit securities comes from Banco de Portugal's Securities Statistics Integrated System.

A few comments are in order. First, the portfolios we use to compute the capital contribution of loans are largely representative of banks' assets. Household and firm exposures represent an average of 71 percent of banks' financial assets in 2018 and 2019. The most significant assets not included in the portfolios are sovereign exposures. Depending on the bank, sovereign exposures represent anywhere between 13 percent to 38 percent of banks' financial assets. The exclusion of sovereign exposures may affect results since the capital contribution of a loan is portfolio dependent.

Second, the fact that we use the portfolio of the month of origination of the loan to compute capital over a year means that we implicitly assume no variation in the bank's portfolio of that month. That is we assume that the portfolio of the bank in a given month stays constant over the following twelve months. In practice, portfolios do vary over time and this variation can affect the actual contribution of a loan to a bank's capital. In our setting we expect that the effect of portfolio variation to be of little significance, though. In a separate analysis we observe that banks' household and corporate credit

1. Our multi-factor model is a discrete time adaptation of the copula model described in Benzschawel (2012). We use a multivariate normal copula.

portfolios vary little over any given 12-month period both in terms of exposure and credit risk profile.

Third, we aggregate household loans for convenience. Since we do not have default probability estimates for individual borrowers, and since we assume household loans have no idiosyncratic risk, it makes no difference whether we aggregate household exposures or consider them individually. For more on the assumption of no idiosyncratic risk for household loans see the paragraph on simulation.

Portfolio parameterization. To compute capital we need a default probability and correlation parameters for each counterparty in the portfolio, and a loss given default for each exposure. We need, in addition, estimates of the correlation between the factors of our multi-factor model.

We use default probability estimates from Banco de Portugal ICAS for firm counterparties in the portfolio. For the household counterparties we use default probabilities estimates available at the Financial Stability Department of Banco de Portugal.

The loss given default of each exposure is the same as the one used to compute the expected loss in section 2.1.3. It varies by firm size and sector. The loss given default of each of the two household exposures is estimated using the regulatory LGD that IRB banks report in the for their mortgage and consumer loans.

Correlation parameters include correlations between the systemic factors of our multi-factor model and the loading of each borrower on those factors. Our multi-factor model has thirteen industry factors and two household factors. We use Santos and Silva (2019) estimates of the thirteen industry factor correlations and of firm factor loadings. We estimate the correlation among the two household systemic factors and between the household factors and industry factors using a similar approach to Santos and Silva (2019). To estimate the systemic factor loadings of the household exposures we exploit time variation in the volatility of the default rates of mortgage loans and consumer loans.

Simulation. When simulating defaults we treat firms individually and simulate a default event for each firm. As mentioned earlier, for the two household aggregate exposures, we assume there is no idiosyncratic risk. This assumption implies that what we simulate is, in effect, a default rate for each of these two exposures rather than a default state. Assuming no idiosyncratic risk is the same as assuming that the household portfolio is large and loans are reasonably homogeneous. In the data, the household portfolio for any given month, bank, and loan type – mortgage loan or consumer credit – is indeed large, with the number of loans ranging between 50 000 and 800 000. Each of these portfolios is not homogeneous with respect to loan amount. The loan amount is concentrated on a small share of loans, especially in the consumer credit portfolios. The top 1 percent of loans with highest loan amount represent between 17 percent and 40 percent of total credit in the consumer credit portfolios and between 5 percent and 7 percent of total credit in the mortgage loan portfolios. The lack of homogeneity in the household portfolios may render the assumption of no idiosyncratic risk for household exposures unappealing. We carry on with this assumption, though, noting that a small share of a large number of loans is still a sufficiently large number.

	Fixed Int. Rate	Spread	Average Maturity	ICAS PD	LGD	Capital	Loan Fees	Oper. Costs
Unit	%	%	Months	%	%	%	%	%
Mean	3.3	2.3	29.6	3.3	38.1	2.7	61.3	50.6
Std. Dev.	2.9	1.2	34.7	6.3	4.2	7.3	9.2	8.5
Min	0.0	0.1	0.1	0.0	31.2	-16.9	47.9	40.1
P10	1.0	1.0	1.6	0.2	33.2	-1.2	48.6	43.5
P25	1.5	1.5	3.0	0.5	36.1	-0.5	51.0	45.0
Median	2.5	2.0	18.7	1.3	38.2	-0.2	62.7	47.4
P75	4.0	3.0	43.5	3.4	38.9	4.2	68.9	56.9
P90	6.9	4.0	78.2	8.1	45.3	9.4	72.4	59.8
Max	45.0	33.0	639.7	80.6	50.5	46.1	76.7	79.0
Obs. (#)	187195	111354	298549	298549	298549	298549	42	42

TABLE 1. Summary statistics of key variables.

Source: Banco de Portugal and authors' calculations.
Notes: This table contains exposure-weighted statistics of the following variables of interest: 'Fixed Int. Rate' is the interest rate of loans with fixed interest. 'Spread' is the spread of loans with variable interest rate. 'Average Maturity' is the average loan maturity in months. 'ICAS PD' is the default probability of the firm obtaining the loan. It is estimated according to Antunes *et al.* (2016) and available from Banco de Portugal ICAS. 'LGD' is the loss given default of the loan. 'Capital' is the loan's capital per euro of exposure. This table also has non-weighted statitics of banks' quarterly operating costs and loan fees between September 2018 and December 2019. 'Loan Fees' are banks' total fee income as a fraction of net interest income. 'Oper. Costs' are banks' operating costs as a fraction of loan income. The statistics are computed with the sample of loans used in the analysis of section 3.

2.2. Data

In this article we use detailed loan level data from Banco de Portugal's Central Credit Register, together with data in FINREP and COREP reports, market data, and other internal databases of Banco de Portugal. The Credit Register data provides information on all lending relationships between Portuguese credit institutions and firms. From September 2018 onward there was a substantial increase in the scope and the granularity of the data: The number of variables available increased from 24 to around 180 and they are now reported at loan level rather than borrower level. Our analysis takes advantage of this increased scope and granularity. The richness of the data includes several loan specific characteristics of interest such as loan amount, performing status, origination date, maturity, amortization schedule, purpose and type of contract, interest rate, spread, type of interest rate – fixed or floating, – and the reference rate if the interest rate is floating.

Our data consists of loans to non-financial firms originated from September 2018 to December 2019 by the seven largest banks operating in Portugal. We exclude from the data loans in default. We also exclude loans with incomplete or inconsistent data except in cases in which we can fill in the missing data by making reasonable assumptions. We expect our assumptions to be of minimal consequence for the final results. The resulting sample covers approximately two thirds of the number of loans and loan amount in the data. When we split the sample by relevant loan and firm characteristics we see a seemingly high coverage. For further details refer to Table A.1 in the Appendix.

We now briefly summarize the data and data sources already mentioned in section 2.1. We extract data on Euribor rates and Euribor interest rate swaps from Refinitiv. From FINREP reports we get net interest income, fee income, and operating costs. From Banco de Portugal internal databases we obtain firm features such as size, sector of economic activity, and firm credit ratings and firm default probabilities. Firm default probabilities were obtained from Banco de Portugal in-house credit assessment system and were estimated in accordance with the methodology presented in Antunes *et al.* (2016). Data on banks' holdings of credit securities are available on Banco de Portugal's Securities Statistics Integrated System. We report summary statistics of key variables in Table 1.

3. Results

3.1. Main analyses

In what follows we present two different averages of loans' excess returns. One average measures the short-run effects and the other measures the long-run effects of newly originated loans. The first average uses the loan's amount to weight excess returns. We interpret it as the one-month annualized excess return of the portfolio of newly originated loans. The second average weights excess returns with the product of the loan's amount by the loan's average time to maturity. The loan's average time to maturity is the average of the time elapsed between origination and cash-flow dates weighted by the contractual cash-flow at each date. We interpret this second measure as the excess return of the portfolio of loans a bank will end up with if it keeps on originating loans as it did during the sample period. This measure implicitly accounts for the rolling over or replacement of short-term loans by other loans with the same maturity, excess return, and amount.

To grasp intuition on the link between the excess return of a bank's long run portfolio and the weighting of loans by amount and maturity consider the following example. Suppose a bank originates 1-month and 5-year loans with the same face value at the beginning of every month. For simplicity assume that the principal is payable at maturity. At the end of the first month of operation this bank has two loans in its portfolio, one 1-month loan that is maturing and one 5-year loan. At the end of the second month it has three loans, one 1-month loan that is maturing and two 5-year loans. Iterating this reasoning forward, at the end of the sixtieth month, this bank has one 1-month loan that is maturing, one 5-year loan that is also maturing, and fifty nine 5-year loans. From this month onward the bank's portfolio of loans is always the same. Every month it has 61 loans, 60 of those with 5-years original maturity and one with 1-month original maturity. This is the bank's long-run portfolio. The weight the 1-month and 5-year loans have on the bank's long-run portfolio is $1/61$ and $60/61$. These are the same weights as the ones we would obtain if weighting by amount and maturity the bank's new loans in any given month.

There's mixed evidence of under and overpricing. Our results show that, on the one hand, the exposure weighted average of excess returns is positive and around 11 basis points, leading to a return of 12.2 percent on new firm loans to banks' equity holders. On the

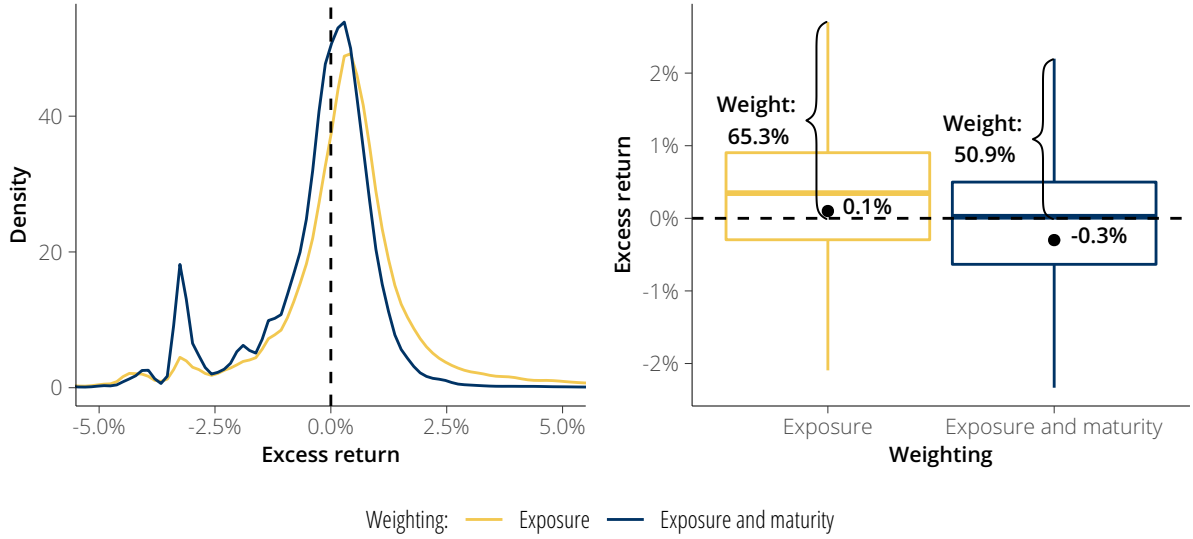

FIGURE 1: Density (left) and boxplot (right) of excess returns on loans to firms originated between September 2018 and December 2019.

Source: Banco de Portugal and authors' calculations.
Notes: The left plot has estimates of two probability density functions of excess returns, each corresponding to a different weighting of excess returns. Excess returns are either exposure-weighted or exposure and maturity weighted. Excess returns extend beyond the range shown in the x-axis and go all the way from -39 percent to 30.7 percent. The weight of the region not shown is less than 3.9 percent when excess returns are exposure weighted and less than 0.7 percent when excess returns are exposure and maturity weighted. The plot on the right has boxplots of excess returns, each corresponding to a different weighting of loans. The top, middle, and bottom line in each boxplot correspond to the 75th, 50th, and 25th quantile of distribution of excess returns. The whiskers are 1.5 times larger than the 25th-75th inter-quantile range. The circles inside each boxplot are the weighted average of excess returns. The weight of non-negative excess returns in the distribution is next to the curly brackets. The weight of the region of excess returns not shown is 13.5 percent when excess returns are exposure weighted and less than 11 percent when excess returns are exposure and maturity weighted.

other hand, the exposure and maturity weighted average of excess returns is negative and around -29 basis points, leading to a return of 2 percent on new firm loans to banks' equity holders.

It is reassuring to see in Figure 1 that most of the weight of the distribution of excess returns is on returns higher than the mean. In addition, more than 65 percent of the new loans' exposure has a positive excess return. On the flip side, around 35 percent of exposure and a little less than 50 percent of the maturity-weighted exposure have negative excess returns. Underpricing is common.

It is also reassuring to see in Figure 2 that excess returns are positive in most months of the sample period, and that excess returns are positive or only slightly negative after April 2019. These results suggest that, in the sample period, loan underpricing is the exception rather than the rule, and that loan underpricing is seemingly decreasing overtime. In contrast, if banks were to continue originating loans as they did in 2019, they would generate a return of 5.1 percent to banks' equity holders in the long-run.

Short-term loans tend to be overpriced and long-term loans tend to be underpriced. We now turn our attention to loan mispricing across borrower and loan characteristics. We start

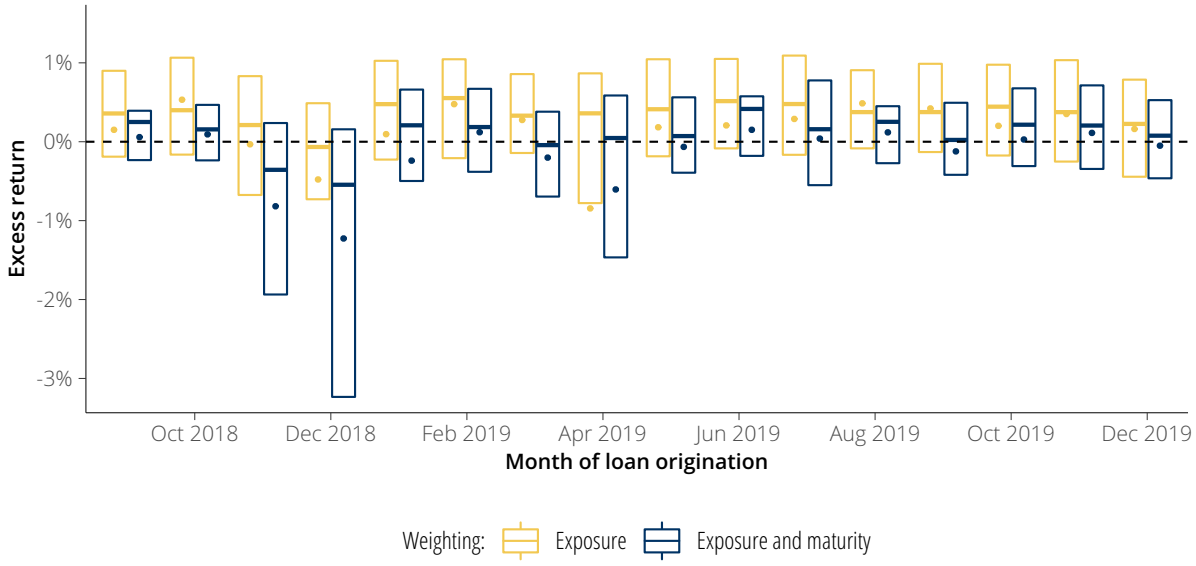

FIGURE 2: Quartiles and average excess returns on loans to firms by month of loan origination.

Source: Banco de Portugal and authors' calculations.
Notes: The plot represents quantiles and mean excess returns of loans split by month of loan origination. In each month there are two boxes, each corresponding to a different weighting of the loans. The top, middle, and bottom line in each box correspond to the 75th, 50th, and 25th quantile of distribution of excess returns. The circles inside each box are the weighted average of excess returns.

by dividing loans into maturity buckets and computing the exposure-weighted average of loans' excess returns for each maturity bucket. Figure 3 shows that loans with a maturity longer than a year are underpriced, while loans with shorter maturities are overpriced.

The effect of this result on loans' excess returns and on the return to banks' equity holders at different horizons can be seen in Figure 4. Average excess returns on new loans are positive for horizons shorter than six months and negative otherwise. If banks keep on originating loans as they did during the sample period, equity holders are expecting to earn average capital returns higher than 8 percent on new loans only at short horizons. At horizons longer than three-months the capital return falls below 8 percent. For example, at the six-months, one-year, and two-years horizon equity holders expect to earn a return of 6.4, 5.1, and 4.3 percent on new loans.

Equity holders' returns are consistently higher when we focus our attention on loans originated in 2019. Still, they fall short of the 8 percent mark at horizons equal to or longer than one year. If banks keep on originating loans as they did in 2019, then at the six-months, one-year, and two-years horizon, equity holders should expect to earn a return of 8.8, 7.5, and 6.7 percent.

These results suggest that the interest rates on firm loans are sufficient to compensate banks' equity holders in the short-run, but not in the long-run even after accounting for the roll-over of short-term loans. If interest rates of new long-term loans do not increase going forward, firm loan portfolios are unlikely to adequately compensate banks' equity holders.

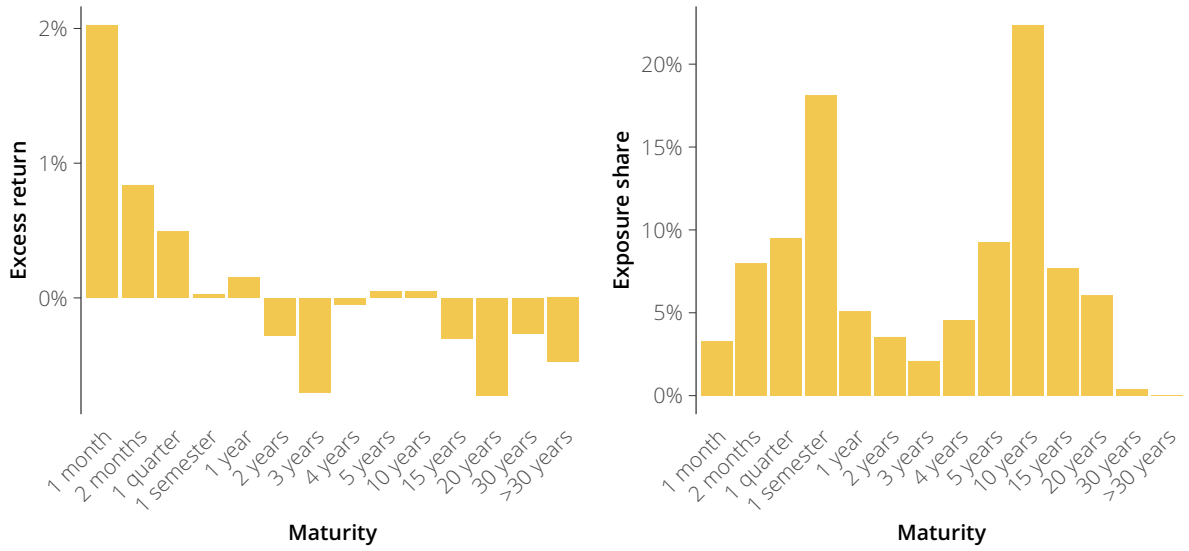

FIGURE 3: Loan excess returns (left) and loan exposure (right) by loan maturity.

Source: Banco de Portugal and authors' calculations.
Notes: The plot on the left shows the exposure-weighted average of excess returns by maturity bucket of loans to firms originated between September 2018 and December 2019. Each maturity bucket contains loans with a maturity at origination shorter than the maturity of the bucket and longer than the maturity of the preceding bucket. For example, bucket "2 months" has all loans with maturity shorter than two months and longer than one month. There are more than 1000 observations in each bucket except in buckets '30 years' and '> 30 years', which have 159 and 5 observations. The plot on the right has the share of total exposure of loans in each bucket.

Low credit quality loans have negative excess returns. A casual observation of the Portuguese credit market may lead to the conjecture that intense bank competition for high credit quality borrowers is driving the spreads on these borrowers' loans below the level commensurate with an adequate compensation for risk. Our evidence does not support this conjecture. Figure 5 shows that average excess returns are positive for loans to borrowers with credit rating CR1&2, i.e., borrowers with highest credit quality. In fact, excess returns are negative only for loans to borrowers with the lowest credit quality. These borrowers have higher default probabilities than other borrowers and their loans contribute to capital more than other loans. But they are charged a spread only moderately higher than what is charged to other borrowers. A similar result was also observed in the euro area significant institutions over the same period of our analyis as reported in European Central Bank (2020).

It is worth highlighting that loans to low credit quality borrowers represent a substantial part of banks' new credit to firms and banks stand to make losses on them. In our sample loans to borrowers with credit rating CR8 represent more than 17 percent of new credit, and their expected return to banks' equity holders is either -18.2 percent or -3.2 percent depending on whether they are exposure or exposure and maturity weighted.

The fact that low credit quality borrowers receive loans with negative excess returns on loans suggests some of these borrowers are unlikely to survive without bank support.

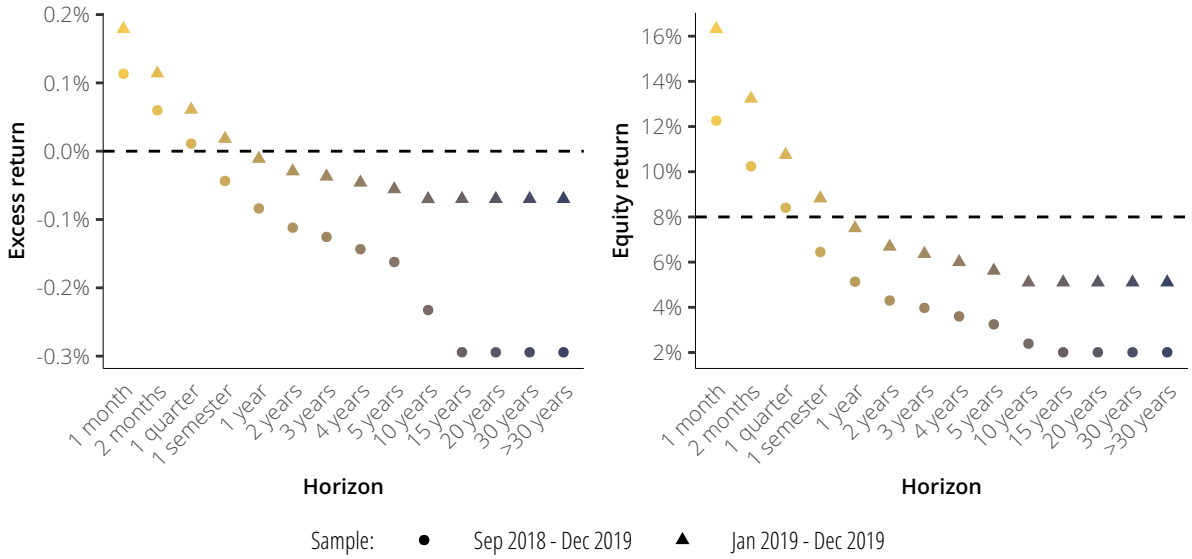

FIGURE 4: Average excess returns (left) and average equity holders' return (right) on new loans at different horizons.

Source: Banco de Portugal and authors' calculations.
Notes: This figure depicts average excess and equity holders' returns at different horizons. The average equity return is the ratio of average excess returns to average capital contributions. These averages are computed assuming that until the end of the horizon under consideration, banks originate loans as they did during the sample period. To this end, excess returns and capital contributions are weighted by the product of the loan's amount with the minimum between the horizon and the loan's average maturity. The interpretation of this weighting is similar to the interpretation of the wheighting by loan amount and maturity. Each plot has two series, one which uses all available data and another that focus on loans originated between January 2019 and December 2019.

They may be receiving loans at rates lower than what would be commensurate to risk because that is all they can afford. When faced with a negative shock these borrowers may not be able to afford the underpriced spreads they are being charged and banks may experience substantial losses as a result.

Construction, real estate, and transportation and storage sectors have the worst excess returns. Looking now at loans' excess returns by sector in Figure 6 it is not surprising to see that loans to the construction, real estate, and transportation and storage sectors have significantly negative excess returns. These were the sectors most affected by the financial and sovereign debt crises of 2008-2012. Some borrowers in these sectors were left with a large debt and are likely facing a protracted recovery. On this topic see, for example, Azevedo *et al.* (2018).

Compared to other sectors, the low excess returns in the construction, real estate, and transportation and storage sectors are explained by the higher default probabilities of their borrowers. The low excess returns in the construction and real estate sectors are also explained by the high exposure of banks to these sectors which, combined with high default probabilities, leads to high loan capital contributions.

Note the significant discrepancy between the exposure-weighted and the exposure-and-maturity-weighted average excess returns for the construction sector. It is suggestive that short-term loans have lower excess returns than long-term loans in this

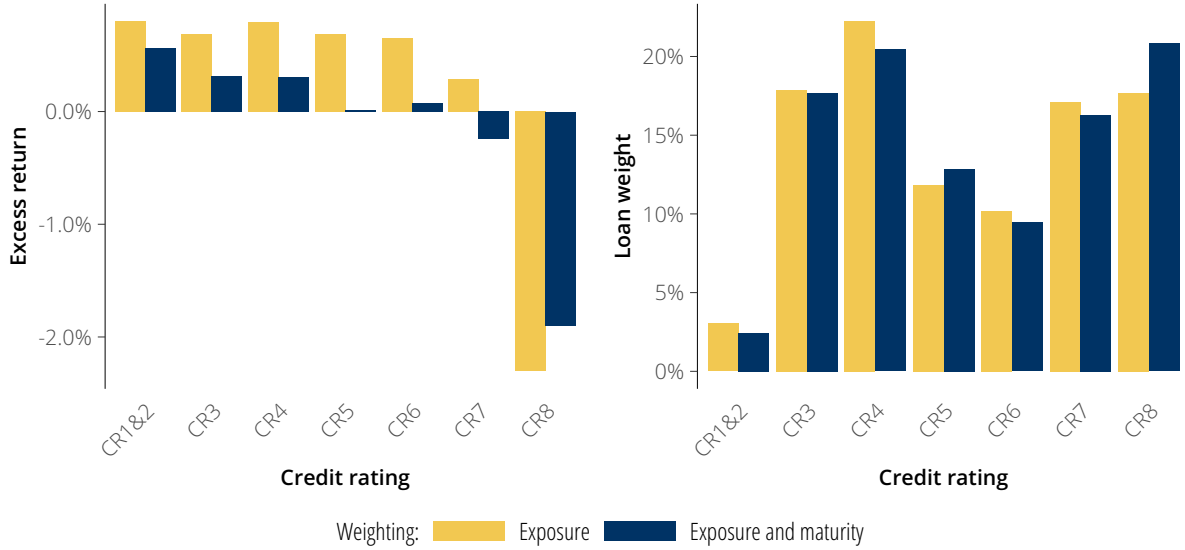

FIGURE 5: Loan excess returns (left) and loan weight (right) by borrower credit rating.

Source: Banco de Portugal, ECB, and authors' calculations.
Notes: The plot on the left shows the average of loans' excess returns by borrower credit rating. The average is both exposure-weighted and exposure and maturity-weighted. The sample comprises loans to firms originated between September 2018 and December 2019. Borrower credit ratings are obtained through the Eurosystem mapping between default probabilities and credit quality steps, using probability of default estimates from Banco de Portugal ICAS. The Eurosystem credit quality steps mapping has eight credit ratings numbered from 1 to 8 to which we attach the prefix 'CR'. Lower numbers mean higher rating. Few firms are classified in credit rating 1 and so we pool them with firms rated in 2. For further details on the credit quality steps please refer to Antunes *et al.* (2016). The plot on right has the weight in the full sample of loans in each credit rating.

sector. In contrast, in all other sectors, short-term loans command a higher excess return than long-term loans.

New loans to large firms are typically underpriced. The observation that stands out from Figure 7 is that loans to large firms are typically underpriced. Otherwise, there is no clear pattern in the relation between excess returns and firm size. When we weight loans by exposure, excess returns are positive for all other firm size categories. But once we weight excess returns by maturity and exposure, excess returns are positive only for small firms and holdings.

Long-term loans, loans to low credit quality firms, loans to large borrowers, and loans to firms operating in the construction sector have negative excess returns. Results thus far are based on a univariate analysis of the relation between excess returns and loan and borrower characteristics. A point of concern is whether these relations are independent or driven by a common factor. Are the negative excess returns we observe in the construction sector driven by borrowers in this sector having low credit quality?

To address this concern we complement the univariate analysis with a multivariate regression of excess returns on the same loan and borrower characteristics used in the univariate analysis. The results reported in Table 2 largely confirm the outcome of the univariate analysis: Loans with longer maturities, loans offered to large firms,

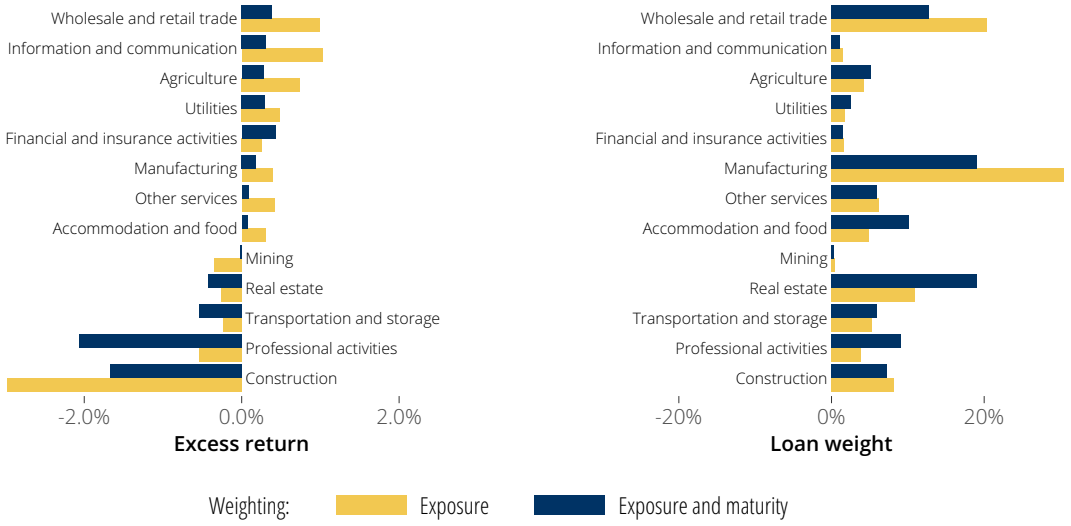

FIGURE 6: Loan excess returns (left) and loan weight (right) by borrower sector.

Source: Banco de Portugal and authors' calculations.
Notes: The plot on the left shows the average of loans' excess returns by borrower sector. The average is both exposure-weighted and exposure and maturity-weighted. The sample comprises loans to firms originated between September 2018 and December 2019. Each borrower's sector is determined according to NACE Rev.2 sector classification. Sectors are aggregated at section level. Sector 'Utilities' comprises borrowers classified in sections 'D - Electricity, gas, steam and air conditioning supply' and 'E - Water supply; sewage; waste management and remediation services'. Sector 'Professional activities' corresponds to section 'M - Professional, scientific and technical activities'. The plot on right has the weight in the full sample of loans in each sector.

loans to low credit quality firms, and loans to borrowers operating in the construction sector tend to have low excess returns in comparison with other loans. Sector-by-sector and bank-by-bank regressions similar to the ones in Table 2 and regressions with alternative specifications of the relation between excess returns and loan and borrower characteristics yield the same qualitative results.[2]

3.2. Additional analyses

We now assess whether results are driven only by highly indebted firms facing a protracted recovery from the financial and sovereign debt crises. We do this assessment by analyzing excess returns in two subsamples of interest. The first subsample comprises loans to firms created after 2013. The second subsample contains only loans to firms that before receiving the loan had no relation with the bank that originates it. In either of these two subsamples, the key results from the baseline analysis remain unchanged. However, there's evidence supporting the possibility that our baseline sample includes firms that are financially unsound and bank-dependent. The underpricing associated with the construction sector and with high credit risk firms is lower in the subsamples than in the full sample.

2. Details on our robustness analysis are available upon request.

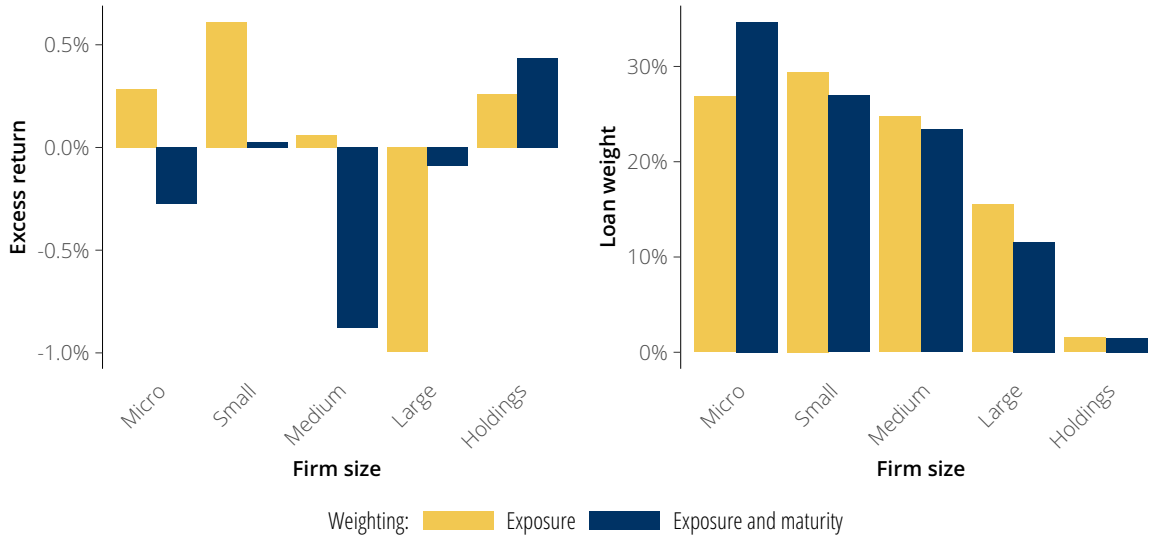

FIGURE 7: Loan excess returns (left) and loan weight (right) by borrower size.

Source: Banco de Portugal and authors' calculations.
Notes: The plot on the left shows the average of loans' excess returns by borrower size. The average is both exposure-weighted and exposure and maturity-weighted. The sample comprises loans to firms originated between September 2018 and December 2019. Borrower size is defined in 2003/361/EC: Commission Recommendation of 6 May 2003. The plot on right has the full sample weight of loans in each size bucket. Exposure and exposure and maturity weights do not sum up to 100 percent since no size is available for some firms. Firms without information on size amount to less than 2 percent of total exposure and of total exposure and maturity.

We also assess whether the previous section results are driven only by loans to group-affiliated firms. Our concern is that the default probabilities we use may not represent a comprehensive risk-assessment for group-affiliated firms.[3] We replicate the previous section analysis on the subsample of loans to firms that are not group-affiliated. We find that excess returns are on average higher, especially when weighting loans by exposure. Underpricig is mitigated in loans to firms in the construction sector and to high credit risk firms and aggravated in loans to firms in the real estate and transportation and storage sectors. We conclude that a more comprehensive assessment of the default risk of group affiliated firms is unlikely to change our key results, but it might mitigate some of the underpricing we identify in the previous section.

In our last analysis, we assess the impact of computing loan excess returns with another measure of banks' funding costs. In our baseline analysis, excess returns don't account for the heterogeneity of banks' funding costs or for the possibility that these costs are higher than Euribor rates. To assess the impact of this limitation, we repeat our analysis using banks' interest rates on new deposits as a measure of banks' cost of funding. Compared to the baseline analysis, excess returns are lower by 10 basis points

3. Banco de Portugal ICAS measures firms' default risk both as stand alone entities and as group-affiliated entities. We use the former measure because it is available for a larger set of firms.

Characteristic	Regressor	**Excess return** (%, Exposure weighted)	**Excess return** (%, Exposure and maturity weighted)
Sector	Agriculture	2.09^{***}	1.73^{***}
		(0.43)	(0.16)
	Mining and quarrying	1.64^{***}	1.33^{***}
		(0.33)	(0.17)
	Manufacturing	1.85^{***}	1.50^{***}
		(0.41)	(0.16)
	Utilities	2.37^{***}	1.84^{***}
		(0.48)	(0.18)
	Construction	Base category	Base category
		$(-)$	$(-)$
	Wholesale and retail trade	2.01^{***}	1.55^{***}
		(0.47)	(0.17)
	Transportation and storage	2.62^{***}	1.78^{***}
		(0.64)	(0.23)
	Accommodation and food	2.08^{***}	1.51^{***}
		(0.34)	(0.15)
	Information and communication	2.32^{***}	1.54^{***}
		(0.47)	(0.23)
	Real estate activities	1.94^{***}	1.24^{***}
		(0.32)	(0.15)
	Financial and insurance activities	2.37^{***}	2.01^{***}
		(0.49)	(0.22)
	Professional activities	1.29^{***}	-0.19
		(0.39)	(0.41)
	Other services	1.75^{***}	1.28^{***}
		(0.42)	(0.16)
Firm Size	Log of assets (in €)	-0.23^{***}	-0.12^{***}
		(0.03)	(0.02)
Credit Risk	Probability of default (in %)	-0.23^{***}	-0.10^{***}
		(0.06)	(0.03)
Maturity	Log of average maturity (in months)	-0.27^{***}	-0.16^{***}
		(0.05)	(0.04)
	Constant	3.49^{***}	1.34^{***}
		(0.54)	(0.33)
Bank	Bank fixed effects	Yes	Yes
N		297430	297430
R^2		0.57	0.55
adj. R^2		0.57	0.55
BIC		1141694	852499

TABLE 2. Regression of excess returns on loan and borrower characteristics.

Source: Banco de Portugal and authors' calculations.

Notes: The sample comprises loans to non-financial firms originated between September 2018 and December 2019. Construction is the base category for sector, thus the coefficients of the other sectors represent the discrete change from the construction sector. Since the discrete change is always positive, ceteris paribus, being in other sector is associated with a larger excess return. Sector 'Utilities' comprises borrowers classified in sections 'D - Electricity, gas, steam and air conditioning supply' and 'E - Water supply; sewage; waste management and remediation services'. Sector 'Professional activities' corresponds to section 'M - Professional, scientific and technical activities'. Results are robust to substituting the continuous variables 'log of assets', 'probability of default', and 'log of average maturity' by the discrete counterparts used in the previous analysis. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

on average for the whole sample and across loan maturities, borrowers' sectors, ratings, and firm sizes.

3.3. Limitations

The limitations of our analysis are mostly due to coarse and incomplete data.

First, due to incomplete data our results are based on a subsample of all the loans originated during the sample period. While the subsample is representative of the full sample, we cannot exclude the possibility that our conclusions may change if we have complete data on all the loans originated during the sample period.

Second, our data on fee income and operating costs is not granular. We use balance sheet data together with loan level data on net interest income to allocate fees and operating costs to loans. This allocation crucially depends on the relation between certain balance sheet variables also holding at the loan individual level. There is no guarantee that this relation actually holds, and our results are sensitive to it. If, for example, fee income is systematically higher in loans with low net interest income and vice-versa, we may end up observing little or no underpricing.

Third, banks may expect operating costs to decrease going forward and we do not account for such decrease. Back of the envelope calculations suggest that long-run average excess returns – those weighted by exposure and maturity – become positive if banks' operating costs fall by 15 percent or more.

Fourth, the default probability estimates we use have no qualitative overlays to account for soft information such as management quality or group structure. A more comprehensive credit risk assessment may change the default probability estimates and, as a result, some of our conclusions about loan underpricing.

4. Conclusion

We assess the pricing of firm loans originated by banks operating in Portugal between September 2018 and December 2019.

Results about the average pricing of loans suggest that banks' equity holders are being adequately compensated for bearing risk in the short-run. In the medium to long-run, however, banks' equity holders stand to make less than an 8 percent return, especially if banks keep on originating loans as in the sample period. This result is mitigated when we focus on the subsample of loans originated in 2019. Results also show underpricing in loans with maturities longer than a year, in loans to the construction, real estate, and transportation and storage sectors, and in loans to high credit risk borrowers.

Our analysis points to a couple of vulnerabilities in the Portuguese banking system with respect to corporate loans' pricing. First, banks' profitability and their ability to generate internal capital may decrease in the medium to long-run on account of loans with maturity longer than a year being underpriced. Second, the underpricing of loans to firms with high credit risk and to firms in the construction, real estate, and transportation and storage sectors, suggests these firms are not performing as strongly

as other firms and may thus be more sensitive to the business cycle. In a recession, they may be a source of loan losses for banks.

While results on loan underpricing point to vulnerabilities in the Portuguese banking system it is important to keep them in perspective. The sample we analyze represents a small fraction of bank's stock of credit to firms – less than 16 percent – and of bank's total assets – less than 5 percent. Thus, the overall effect on bank profitability of the loan underpricing that we document is likely limited. It is also worthwhile emphasizing that the low equity returns on new firm loans that Portuguese banks are expected to earn in the medium to long-run is in line with the low profitability that euro area banks are experiencing since the financial crisis. Between 2008 and 2019, the yearly equity returns of euro area banks was never higher than 6 percent.

Appendix

	Number of loans	Exposure
Total	**65%**	**67%**
Firm size - subtotal	**67%**	**71%**
Micro firms	63%	74%
Small firms	75%	76%
Medium-sized firms	69%	70%
Large firms	50%	61%
Rating class - subtotal	**73%**	**80%**
CR1&2	79%	73%
CR3	75%	79%
CR4	75%	81%
CR5	76%	85%
CR6	73%	79%
CR7	72%	78%
CR8	68%	78%
Sector - subtotal	**67%**	**71%**
Agriculture	74%	78%
Mining and quarrying	73%	66%
Manufacturing	73%	72%
Utilities	73%	69%
Construction	55%	70%
Wholesale and retail trade	71%	66%
Transportation and storage	61%	77%
Accommodation and food	48%	74%
Information and communication	57%	71%
Real estate activities	59%	77%
Financial and insurance ativities activities	34%	76%
Professional activities	59%	66%
Other services	52%	57%

TABLE A.1. Sample representativeness by loan and firm characteristics.

Source: Banco de Portugal and authors' calculations.
Notes: The table shows the share of new loans originated between September 2018 and December 2019 and the corresponding share of exposure that we end up using in our analysis. The total share of loans and exposure associated with each loan or firm characteristic is systematically higher than the total share of loans and exposure of the sample. This result is due to missing values in the data. We exclude loans with missing values in the data when we compute the share of loans and exposure for each loan and firm characteristic.

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Non-technical summary

April 2021

Curb your enthusiasm: the aggregate short-run effects of a borrower-based measure

Daniel Abreu and Joana Passinhas

The macroprudential measure implemented by Banco de Portugal in July 2018 aimed at taking pre-emptive action in relation to the emergence of signs of relaxation in credit standards in household lending. In order to do so, the measure recommends the implementation of prudent standards on the borrower's creditworthiness assessment which limit the granting of credit to borrowers with higher risk profile. The measure covers both loans for consumption and house purchase and introduces limits to the LTV (loan-to-value) and DSTI (debt service-to-income) ratios, to the maturity and a requirement of regular payments of interest and principal. By defining prudent standards on the borrower's creditworthiness assessment, the measure aims at enhancing the resilience of the financial sector to adverse shocks and at promoting sustainable financing by households. Even though it does not target the overall lending activity to households, the measure might contribute to curb credit growth. Additionally, it can eventually impact house prices, as a decrease in new loans for house purchase might contribute to reduce the demand for residential real estate, and also economic activity.

Therefore, an important question when implementing this type of measures concerns its short-run effects on the credit market. To assess these potential short-run effects, this article constructs a counterfactual scenario – a representation of what could have happened if the measure had not been introduced. The comparison between the counterfactual scenario and the observed data provides us information on the likely impact of the measure.

The counterfactual scenario is constructed by estimating a model that considers two sets of variables: (i) a set of endogenous variables, for which we estimate the counterfactual scenario, that comprises new loans for house purchase and consumption, real house prices and economic activity; and (ii) a set of control variables that account for the developments in the broader economy and factors that might influence credit and housing markets – such as residential investment or reference interest rates.

Using this model and data prior to the adoption of the measure, we obtain forecasts of the endogenous variables for the first 6 months following the implementation of the macroprudential measure. These forecasts mimic the dynamics of the variables in a situation in which the measure had not been introduced.

The results suggest that the macroprudential measure curbed the volume of new loans granted to households, both for house purchase and consumption, after 4 months since the introduction of the measure (Figure 1). In fact, the counterfactual scenario suggests that new loans granted to households would continue to grow in the absence of the measure, whereas the observed data shows that new loans decelerated after its introduction. The difference between the counterfactual and the observed data increases over time, becoming statistically significant after 4 months, as new loans fall below the lower bound of the forecast. In contrast, we do not find supportive evidence of an effect of the measure on real house prices and economic activity.

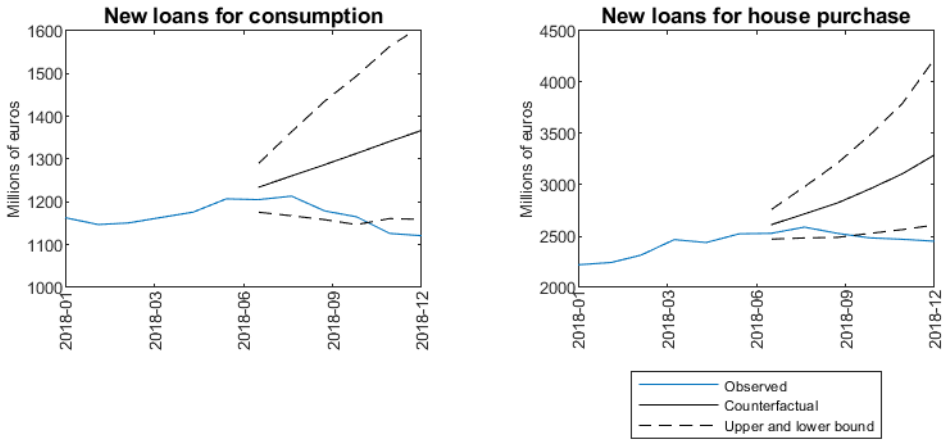

FIGURE 1: Counterfactual for new loans

Sources: Banco de Portugal.
Notes: Counterfactual corresponds to the median of the predicted posterior distribution given by a BVAR(5). Upper and lower bound are the 97.5th and 2.5th percentiles, respectively, of the same distribution.

Curb your enthusiasm: the aggregate short-run effects of a borrower-based measure

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April 2021

Abstract
We estimate the ex-post short-run (6 months) impact of the Portuguese macroprudential borrower-based measure on new loans for house purchase and consumption, on house prices and on the economic activity. The macroprudential measure introduced a set of recommendations on the criteria used by banks in borrowers' creditworthiness assessment: i) limits to LTV and DSTI ratios and to maturity and ii) the requirement of regular payments of interest and principal. In an ideal scenario, the impact of this set of restrictions would be measured by comparing the path of the variables after the introduction of the measure to their path in a no-policy change scenario, usually called the counterfactual. However, the no-policy change scenario is not observable and, therefore, needs to be estimated under some assumptions. We use a Bayesian VAR model to estimate the counterfactual of the variables of interest in the 6 months after the introduction of the policy. Our analysis suggests that the measure contributed to curb the growth of new loans granted to households, both for house purchase and consumption, 4 months after its implementation. We do not find evidence that the macroprudential measure had a significant impact on house prices or on economic activity, in the 6 months following its introduction. (JEL: C54, E44, E47, E58)

1. Introduction

In February 2018, the Banco de Portugal announced the implementation of a borrower-based macroprudential measure, which entered into force in July 2018 as a recommendation (hereinafter referred to as Recommendation or policy) under a regime of comply or explain. The Recommendation applies to new loans granted to households for house purchase and consumption and introduces a set of limits to i) loan-to-value (LTV) ratio, ii) debt-service-to-income (DSTI) ratio and iii) maturity and the requirement of regular payment of interests and principal. The limit imposed to the DSTI ratio is applicable to a ratio that comprises both interest rate and income shocks and considers the overall amount of payments associated with household debt (including loans for house purchase and consumption). The simultaneous introduction of limits to the LTV ratio, to the DSTI ratio and to the maturity overcomes the shortcomings

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associated to the implementation of each individual instrument per se and reinforces the effectiveness of the Recommendation as discussed in Leal and Lima (2018).

The objective of the Recommendation is twofold: i) enhance financial sector resilience against adverse shocks by preventing excessive risk taking when granting credit; and ii) minimize the default risk of households by promoting access to sustainable financing. Overall, it is designed to prevent the build-up of systemic risk and was calibrated to have an impact on lending to borrowers with a high risk profile (high LTV and/or high DSTI ratios), i.e. borrowers that in a downturn are more likely to default and/or if in default will imply a higher loss for the bank, thus putting pressure on banks profitability. The Recommendation does not aim to affect the general lending activity to households or the dynamics of house prices, although it may have a mitigating effect on the feedback loop between both variables. Some flexibility was considered in the design of the Recommendation also to prevent a disrupting impact on credit activity. In particular, part of new credit agreements, such as credit cards, were excluded from its scope of application.[1]

The timing of the introduction of the Recommendation reflected the emergence of signs of some relaxation in credit standards by banks in Portugal. Moreover, the steady increase of new lending to households in a context of low interest rates and a recovering economic environment was creating incentives for higher competition among banks and a further relaxation of credit standards. This context, in tandem with the high level of household indebtedness and low savings rate, could pose a threat to future financial stability, notably in the case of an increase of interest rates or a deterioration of economic conditions.

This analysis aims at assessing the impact of the Recommendation just described in the 6 months following its implementation on a set of financial and macroeconomic variables. In particular, we are especially interested in the impact of the Recommendation on the level of new loans for house purchase and for consumption. Additionally, we examine its potential impact on the dynamics of house prices and economic activity.

To disentangle the effects of the Recommendation we conduct a counterfactual analysis, i.e. a characterization of the evolution of new loans granted to households, both for consumption and house purchase purposes, house prices and economic activity in a no-policy change scenario, and compare it with the observed post-Recommendation data.

The specification of a counterfactual scenario to study the policy impact on aggregate variables is a common approach in the literature. This framework has been used to assess the impact of measures from different policy areas and hence, can also be applied to assess the impact of macroprudential measures. Both Bloor and McDonald (2013) and Cussen *et al.* (2015) use a Bayesian Vector Autoregression (BVAR) model to provide an ex-ante estimate of the impact of introducing a LTV ratio limit in New Zealand and

1. For detailed information on the limits set by the Recommendation upon its announcement that remained applicable during the period considered in this article see `https://www.bportugal.pt/sites/default/files/macroprudential_measure_background_doc.pdf`.

in Ireland, respectively. Their approach is to impose a shock to the BVAR model that mimics the introduction of the measure in order to compute the counterfactual scenario. Bloor and McDonald (2013) specify this shock as a reduction of house sales or as an increase in mortgage interest rates. In contrast, Cussen *et al.* (2015) define the shock as a reduction in new loans for house purchase, which is estimated by simulating the impact of the introduction of the policy measure using loan-level data.

Both ex-ante studies estimate a negative impact of the LTV ratio restriction on housing credit growth and on house prices. In particular, Cussen *et al.* (2015) find that the effect on house prices is reduced in the initial months and peaks in the third year after the policy measure's introduction.

Price (2014) evaluates the ex-post impact of the introduction of a LTV ratio in New Zealand by estimating a counterfactual using forecasts for the relevant variables based on a BVAR model. Results suggest that the LTV ratio restriction reduced the number of house transactions and mortgages approvals in the first 6 months of implementation, while it had no statistically significant effect on credit growth nor on house prices.[2]

Following Price (2014), we specify a BVAR model which accounts for the historical relationships between new loans for house purchase, new loans for consumption, house prices and economic activity before the introduction of the Recommendation. The model is estimated using information prior to the policy implementation and the counterfactual values for the variables of interest correspond to the forecasts of the model in the 6 months following the policy intervention. The difference between the observed values of the variables of interest and their counterfactual values reflects the potential impact of the macroprudential policy measure.

The results suggests that the Recommendation contributed to curb the volume of new loans granted to households, both for house purchase and consumption, 4 months after the introduction of the policy. Under our estimated counterfactual, house prices would continue to grow at a similar rate as before the implementation of the Recommendation. However, observed house prices are higher than the counterfactual and this difference is statistically significant after 4 months. It is nevertheless unlikely that this difference is caused by the Recommendation as tighter credit standards are expected to either have no effect or a negative impact on house prices (Ahuja and Nabar 2011; Igan and Kang 2011). The difference between the observed house prices and the estimated counterfactual values might be explained by the historically unprecedented buoyancy in the Portuguese housing market since 2017. House prices have shown signs of overvaluation since the beginning of 2018 (Banco de Portugal 2019b). The recent increase of residential investment by non-residents, that do not borrow from the domestic credit market and, therefore, are not affected by the Recommendation, was an important factor that contributed to the buoyancy of the Portuguese housing market. In fact, as documented in Banco de Portugal (2019b), residential investment by non-residents during 2018 increased in relation to investment

2. An alternative approach considered in the literature on the impact of macroprudential policy is to estimate a counterfactual scenario using DSGE models. For a broad overview of both theoretical and empirical contributions to the literature on macroprudential policy see Galati and Moessner (2018).

by residents, while the percentage of transactions financed with domestic bank credit remained constant. Finally, we do not find evidence of a statistically significant effect of the Recommendation on economic activity in the 6 months following its introduction.

2. Methodology, variables and data used

2.1. Methodology

In order to develop a counterfactual scenario, we specify a VAR model, and estimate it using Bayesian techniques. Let $y_t = (y_{1t}, y_{2t}, ..., y_{nt})'$ be a $(n \times 1)$ vector of endogenous variables to be forecasted and $x_t = (x_{1t}, x_{2t}, ..., x_{mt})'$ a $(m \times 1)$ vector of control variables. Under a VAR(p) model, each one of the time series to be forecasted is assumed to be a linear function of their past values, of the past values of the remaining variables included in y_t up to p lags and of the control variables such that

$$y_t = A_1 y_{t-1} + ... + A_p y_{t-p} + C x_t + E_t \ , \tag{1}$$

where $t = 1, ..., T$, A_j, $j = 1, ..., p$, are $(n \times n)$ matrices of autoregressive coefficients, C is an $(n \times m)$ matrix of coefficients associated with the set of control variables and E_t=$(E_{1t}, E_{2t}, ..., E_{nt})'$ is an $(n \times 1)$ vector of innovations that follow a multivariate normal distribution $E \sim N(0, \Sigma)$. The estimation of the model considers data on a monthly frequency and the sample runs from 2003M3 to 2018M6. The BIC criteria is used to select the lag order of the BVAR model.

The endogenous variables (variables of interest) considered are (i) new loans granted to households for consumption (ii) new loans granted to households for house purchase, (iii) the real house prices index, to account for interdependences with credit dynamics, and (iv) a proxy for the economic activity. A rise in house prices can reinforce credit growth as the value of the property, which is usually pledged as collateral, increases. At the same time, credit growth can contribute to a further increase in house prices. Therefore, there is a feedback loop effect between the two variables that must be taken into account, fitting in with the VAR framework.

Because both credit and housing markets are influenced by external factors, we let the forecasts be influenced by the observed path of a set of control variables. Considering that the control variables are included in the model contemporaneously, we use their realized values when computing the forecasts. In order to properly estimate the counterfactual, this set of controls only includes variables that are not supposed to be affected (at least in the short-run) by the Recommendation. The selection of the control variables was based on the results of studies that delve into the main determinants of credit granted to households in Portugal, such as Castro and Santos (2010), and of housing market developments such as Lourenço and Rodrigues (2017). The variables selected as controls are i) residential investment by residents (gross fixed capital formation), ii) residential investment by non-residents (foreign direct investment in housing which includes house purchases by non-residents), iii) the 12-month Euribor

rate, to account for bank funding costs, and iv) the year-on-year rate of change of the euro area GDP to account for external economic environment.

The estimation of VAR models using Bayesian techniques has become an increasingly popular approach in forecasting settings. VAR models typically include a large number of parameters, thus raising the risk of overfitting the data and, consequently, of undermining the forecasting accuracy of the model. This risk increases when the model is estimated with relatively short times series. BVAR models, in turn, rely on the ability of Bayesian techniques to shrink the estimates towards a predefined set of prior beliefs about the distribution of the parameters, which ultimately leads to a reduction in the variance of the parameter estimates and to an improvement in forecast performance; see Karlsson (2013).

To specify the prior distribution of the VAR(p) parameters we adopt the Minnesota (or Litterman) prior (Doan *et al.* 1984). The main idea behind this prior is to shrink the slope estimates towards a multivariate random walk model. In addition to its simplicity, this approach has been found useful to predict economic time series.[3]

After estimating the model, the counterfactual for each variable of interest is obtained as the median of the posterior predictive distribution of the endogenous variable, that is, the distribution of future realizations of the endogenous variable over the h horizon, conditional on the information set, using the algorithm proposed by Karlsson (2013). The calculations were made in MATLAB employing the Bayesian Estimation, Analysis and Regression (BEAR) Toolbox; see Dieppe *et al.* (2016) for details.

2.2. Data

2.2.1. Endogenous variables

Credit variables are compiled by Banco de Portugal. We use new loans, instead of stocks, as this variable is expected to react quicker to the implementation of the Recommendation. We have also disaggregated new loans for house purchase from new loans for consumption as the policy measure encompasses both types of loans and may have a differentiated effect on each of them. To reduce the noise in the monthly flows of new lending time series, which could blur the results, we considered the quarterly flows of new loans.

The real house price index, deflated using HICP, was obtained from the OECD database on house prices (original source INE). This index is published on a quarterly frequency, and we have used linear interpolation to obtain a monthly index.

The proxy for developments in economic activity is the coincident indicator published by Banco de Portugal. This indicator, described in Rua (2004), summarizes the information of a set of indicators that are useful to monitor the evolution of economic activity and closely tracks the rate of change of gross domestic product (GDP). The main

3. In appendix A, we detail the specification and estimation of the BVAR, as well as the approach for the calibration of the hyperparameters governing the prior distribution.

advantage of using this synthetic indicator instead of the rate of change of GDP is that it is available at a monthly frequency, thus avoiding the need for interpolation.

2.2.2. Control variables

Residential investment by residents is published by OECD (original source INE) and residential investment by non-residents is published by Banco de Portugal. As these variables are both published on quarterly basis, we interpolate them using a linear rule as we did for house prices.

The 12-month Euribor rate is published by the ECB. We use the monthly time series, which is computed as the average of observations through the period. This variable aims to control for bank funding costs as it is the most common reference interest rate applied to new loans for house purchase in 2017 and 2018 in Portugal[4], which, in turn, accounts for the larger share of loans granted to households.

The year-on-year rate of change of the euro area GDP, used to control for the international macroeconomic environment given that Portugal is a small open economy, is published by the ECB. A linear interpolation is applied to obtain the series in monthly frequency.

Variables enter the model in log levels if not expressed as a rate or index. Table 1 summarizes the transformations applied to the variables, the type of variables and the data sources.

Variable	Transformations	Type	Source
New loans for consumption	s.a., quarterly flows, log	Endogenous	Banco de Portugal
New loans for house purchase	s.a., quarterly flows, log	Endogenous	Banco de Portugal
Real house price index	s.a., interpolation	Endogenous	INE, OECD
Coincident indicator	-	Endogenous	Banco de Portugal
Residential Investment by residents	s.a., interpolation, log	Control	INE, OECD
12-month Euribor	-	Control	ECB
Residential investment by non-residents	interpolation, log	Control	Banco de Portugal
Euro area GDP	s.a., interpolation, yoy rate of change	Control	Banco de Portugal

TABLE 1. Variables and transformations

Notes: Interpolation from quarterly to monthly frequency is achieved using a linear rule. S.a. stands for seasonal adjusted. Seasonal adjustment of new loans for consumption and house purchase is performed using the automatic procedures of X-13ARIMA-SEATS, the remaining variables are published with the seasonal adjustment.

4. According to Banco de Portugal (2018) the percentage of new loans for house purchase indexed to the 12-month Euribor was 94.4% in 2018 and 92.8% in 2017. The variable interest rate regime is the most predominant in new loans for house purchase in Portugal, accounting for 87.8% and 83.2% of the total amount granted in 2018 and 2017, respectively.

2.3. *Data analysis*

We begin by examining the evolution of the endogenous variables[5] (Figure 1), before and after the policy implementation. In the period leading to 2008, new loans to households were at historical highs. House transactions were mainly funded through new loans for house purchase and residential investment was largely made by residents. The global financial crisis then triggered a severe contraction of the global economy, which was then reinforced during the euro area sovereign debt crisis, having a significant negative impact on the Portuguese economic activity. This led to a decrease in disposable income and, consequently, to a decrease in consumption and residential investment. Additionally, and as a consequence of a tightening of credit standards, new lending to households, during this latter period, recorded a major contraction, more pronounced for new loans for house purchase that remained on very low levels until 2014. During this period, house prices also recorded a significant reduction, although not as severe as in other euro area countries where, in contrast to Portugal, there was evidence of house price overvaluation leading up to the crisis.

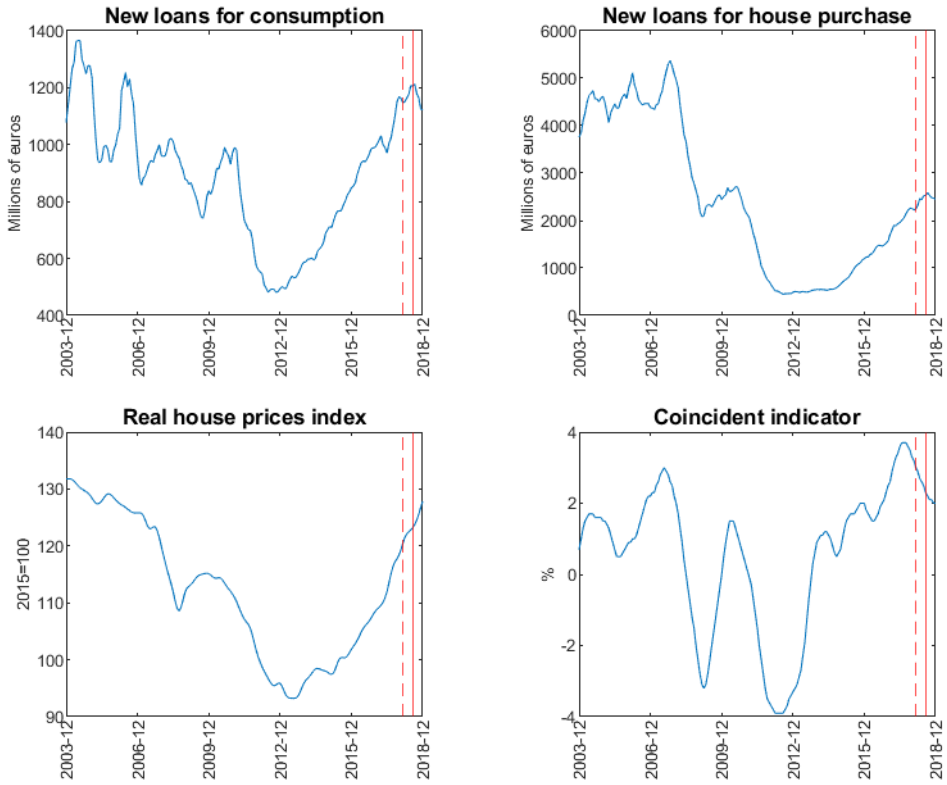

FIGURE 1: Endogenous variables

Sources: Banco de Portugal, INE and OECD. Note: Dashed line stands for the announcement date of the Recommendation and the solid line stands for the implementation date of the Recommendation.

5. Figure B.1 in appendix B presents the evolution of the control variables over our sample.

The period following the global financial crisis and the sovereign debt crisis was characterized by a gradual recovery of economic activity and of labour market conditions, reflected in a decreasing unemployment rate and increasing wage growth, which allowed for a recovery of disposable income of households. The recovery of the Portuguese economy was accompanied by a rebound of new loans to households, which have steadily increased since 2014 until the second half of 2018. However, the volume of new loans for house purchase by then was still far from the level observed before the global financial crisis. The recovery of new loans took place in a context of accommodative monetary conditions and increasing competition in the banking sector, which contributed to a narrowing of interest rates spreads on new loans granted to households and a relative easing of credit standards. Coincidently, after a period of gradual decline towards a historical low in 2013, the house price index rapidly increased towards pre-crisis levels. The upward momentum in house prices has accelerated since 2016 reaching double digit year-on-year rates of change.

In the first half of 2018, and even after the announcement of the Recommendation in February 2018, the volume of new loans granted to households continued its upward trajectory. New loans for consumption reached, in 2018M6, a year-on-year rate of change of 24.4%, a figure above the 90th percentile (22.4%) of the distribution of the rate of change, while the growth of new loans for house purchase stood at a year-on-year rate of change of 29.0%, which is above its historical median (9.5%) but far from the historical 90th percentile (55.2%). Following the implementation of the Recommendation the year-on-year rate of change of new loans for house purchase decreased, in a similar fashion as in the case of new loans for consumption, although in a less drastic way, remaining close to its median value (9.5% in 2018M12), whereas new loans for consumption reached negative values (-4.1% in 2018M12).

In 2018, house prices continued to grow at a rapid pace and, despite the slight deceleration observed between March and September, the year-on-year rate of change in house prices returned to an upward trajectory in October. Important drivers of these dynamics in house prices have been the improvement in household's income, the low interest rate environment and the easing on credit standards on new loans for housing (Banco de Portugal 2018). In particular, the persistent low interest rate environment increased the appeal of real estate investment in relation to the investment in alternative financial instruments. Additionally, in the beginning of 2018, signs of price overvaluation have emerged in the Portuguese housing market. These developments reflected an increasing importance of investment by non-residents, which increased significantly after 2014, and the demand of real estate by investors associated with tourism, especially for local accommodation.

3. Counterfactual exercise

The counterfactual scenario is constructed for the 6 months after the introduction of the Recommendation, that is, for the 2018M7 – 2018M12 period. In our view this evaluation period strikes a reasonable balance: if it was shorter we might have insufficient data

to clearly identify the policy impact; if it was longer the methodology would likely produce less reliable results given that the difficulty in forecasting increases with the forecast horizon and that the probability of the variables of interest being affected by other shocks after the implementation of the Recommendation also increases over time.

The use of historical relationships to construct the counterfactual relies on the assumption that the Recommendation was the only relevant shock that affected the credit and housing markets, since its implementation. If other relevant shocks occurred, the difference between the counterfactual and the observed data would also reflect the presence of these additional shocks. In January of 2018, the Banco de Portugal issued a Notice introducing minimum requirements for assessing the creditworthiness of consumers. Both the Notice and the Recommendation have the common objective of promoting the access to sustainable financing by consumers. Nevertheless, and in contrast with the Recommendation, this Notice did not define concrete limits to specific credit standards. Therefore, it seems reasonable to assume that the Recommendation is more likely to have an effect on the volume of new loans granted to households than the Notice. To the best of our knowledge, there were no other pieces of regulation introduced in Portugal during the second half of 2018 that could affect, in a significant way, the credit and housing markets and thus contributing to the potential differences between the counterfactual and the observed data.

Figure 2 plots the counterfactual and the observed path of each endogenous variable. The BIC criteria suggests that 5 lags are appropriate, therefore the counterfactual values correspond to the median of the posterior predictive distribution of the estimated BVAR(5) model. The lower and upper bounds correspond to the 2.5th and 97.5th percentiles, respectively, of the posterior predictive distribution. If the observed values lie within the two percentiles, the difference between the observed values and their counterfactuals, which reflects the potential impact of the macroprudential policy measure, is negligible and comparable to common model forecast uncertainty. In other words, the difference is not statistically significant meaning that there is no evidence of an impact stemming from the policy introduction.

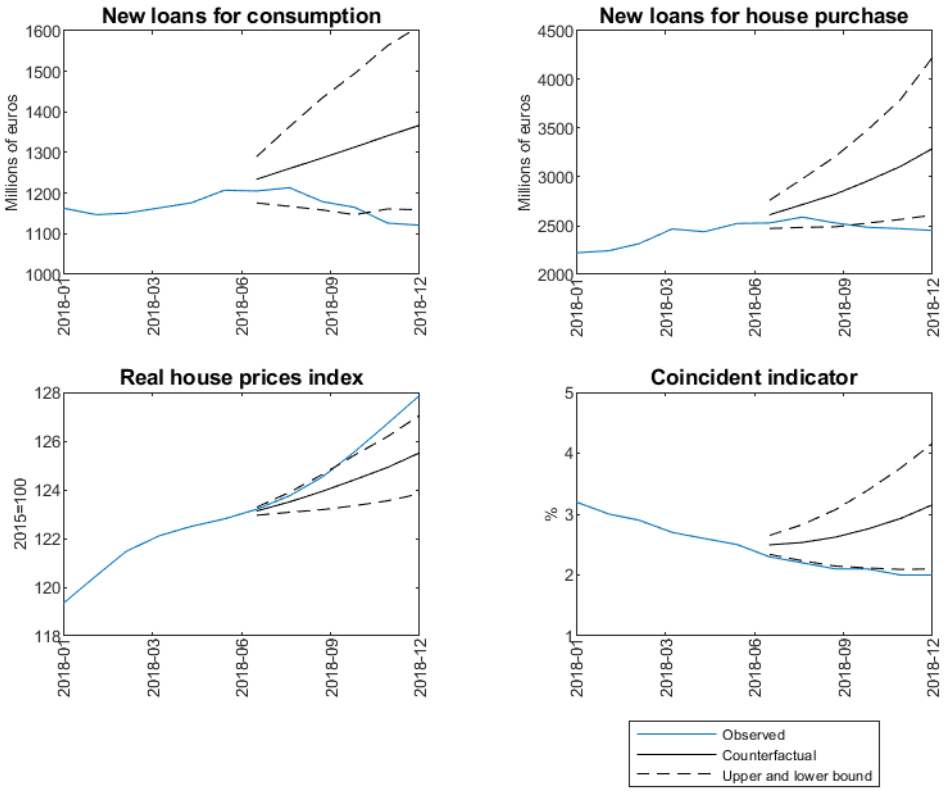

FIGURE 2: Counterfactual variables

Sources: Banco de Portugal, INE and OECD. Notes: Counterfactual corresponds to the median of the predicted posterior distribution given by a BVAR(5). Upper and lower bound are the 97.5th and 2.5th percentiles, respectively, of the same distribution.

The counterfactual suggests that, in a no-policy change scenario, new loans for consumption and for house purchase would have continued to increase. In contrast, the observed data shows that new loans lost steam in the second half of 2018, particularly in the case of new loans for consumption that even recorded negative year-on-year rates of change after October 2018. In the 3 months after the introduction of the policy measure, i.e., between July and end-September of 2018, the figures for new loans lie within the upper and lower bounds. In the following months until December 2018, both new loans for consumption and for house purchase lie outside the lower bound for the counterfactual, suggesting that the policy introduction curbed the growth of new loans in this period. Against this background, we may conclude that the Recommendation did not cause an immediate response of new loans. In fact, the evidence suggests that the adjustment in the dynamics of new lending only took place 4 months after the policy introduction. The delayed response of new loans may reflect initial operational adjustments that banks had to make to implement the limits imposed by the Recommendation. Additionally, according to Banco de Portugal (2019a, 2020) the evolution of new loans for house purchase in the first months after the introduction

of the Recommendation reflected, in part, lending decisions for which borrowers' creditworthiness assessment was carried out several months before its entry into force.[6]

As for house prices, the counterfactual suggests that in a no-policy change scenario the upward momentum observed in the first half of 2018 would continue through the second half of the year, although at a slower pace. However, observed house prices are higher than in the counterfactual and the difference between the two time series increases over time. In fact, in the first months after the introduction of the Recommendation the house prices index lies within the 2.5th and 97.5th percentiles of the posterior predictive distribution and so the difference between the observed values and the counterfactual values is comparable to usual forecast uncertainty. After October 2018, the observed values lie outside the upper bound, which could suggest a positive and statistically significant impact of the policy introduction. However, stricter credit limits are expected to have a negative effect on the growth of house prices, even if this effect might only be clear in the long-run, as house prices tend to adjust slowly. In fact, several studies find that house prices tend to slow-down several months after the introduction of borrower-based measures (e.g. Ahuja and Nabar 2011 and Igan and Kang 2011). This leads us to infer that the positive statistically significant effect on house prices after October 2018 might reflect that the counterfactual is being affected by short-term factors that influence the housing market other than the introduction of the Recommendation. In fact, the Portuguese housing market has been particularly buoyant since the second half of 2017, reflecting not only the low interest rate and high liquidity environment but also the high dynamism of tourism and demand by non-residents. This recent increase of residential investment by non-residents, that do not borrow from the domestic credit market and, therefore, are not affected by the Recommendation, is documented in Banco de Portugal (2019b), where it is shown that residential investment by non-residents increased during 2018, in relation to investment by residents, while the percentage of transactions financed with domestic bank credit remained constant. Although we condition the counterfactual on the observed values of a set of control variables, including investment by non-residents, the model might not be able to account for the historically unprecedented buoyancy in the housing market in 2018, thus leading to an underestimation of the true counterfactual of house prices. The counterfactual reflects the expected trajectory of house prices based on the historical relations between the variables in the model. Thus, although the model is not specifically designed to evaluate the deviations of house prices from its fundamentals, we consider the results to be consistent with evidence of overvaluation of house prices in Portugal during 2018 as documented in Banco de Portugal (2019b), which seems to be particularly strong in the last quarter of that year. In particular, Banco de Portugal (2019b) present the results obtained from quantile regressions which suggest that real house prices grew above the estimated 90th percentile of the respective distribution

6. This could suggest using a date beyond July 2018 as the starting point for the impact assessment of the Recommendation. However, if the estimation sample included information from months in which the Recommendation was already implemented, the estimated counterfactual would not truly reflect a no-policy change scenario, raising identification issues.

during 2018. This evidence is comparable, to a certain extent, to the result obtained from our counterfactual analysis, as house prices are above the upper bound of the forecast which corresponds to the 97.5th percentile of the predictive distribution. Additionally, the short sample employed in the estimation of the model may also explain, at least in part, this result. In fact, the recovery observed since 2013 is the only period in the sample in which a sustained upward trend in house prices is observed. This may also contribute to an underestimation of the counterfactual for house prices.

The counterfactual for the coincident indicator suggests an acceleration of economic activity during the second half of 2018. In comparison, the "observed" coincident indicator has decreased over the same period. The difference between the counterfactual and the coincident indicator increases over time, suggesting that the introduction of the Recommendation might have implied lower economic activity. By introducing stricter criteria for borrowers' creditworthiness assessment, the Recommendation might have curbed the growth of new loans, which could have had a negative effect on household expenditure and, therefore, on economic activity. The upward trajectory of the counterfactual for the coincident indicator reflects, in part, the growth in new loans in the estimated no-policy scenario (in contrast to the observed values), which is amplified by the autoregressive component of the model. However, the counterfactual for the coincident indicator is very close to the lower bound, meaning that the difference between the coincident indicator and the counterfactual is comparable to the common forecast error of the model.

Therefore, we do not find strong evidence that the introduction of the Recommendation had a significant impact on economic activity in the 6 months following its introduction. It is worth noting that although BVAR models tend to have good forecast performance over short forecast horizons as a result of their flexibility and simple (linear) structure, our model is not tailored to forecast the evolution of economic activity. This implies that accumulation of forecast errors, that occur when forecasting h periods ahead in an autoregressive framework, is especially relevant for this variable since there is a larger uncertainty in comparison to the other endogenous variables.

A number of robustness checks were conducted. In particular it was examined if the results are influenced by potential structural breaks in the data. In order to address this issue, we estimated the model with first differenced data which robustifies, to a certain extent, against structural breaks. The results based on the resulting counterfactuals were qualitatively similar to the ones obtained in the main exercise (see Figure C.1 in the appendix C).

4. Conclusions

We estimate the ex-post and short-term impact of the introduction of a borrower-based measure in Portugal on new loans granted to households, house prices and economic activity. For this purpose, we estimate a counterfactual scenario for the 6 months following the policy measure introduction, using a BVAR(5) model. The counterfactual

provides a description of the evolution of the variables of interest in a scenario that tries to mimic the absence of the policy change.

The data suggest that new loans granted to households, both for house purchase and consumption, slowed down after the introduction of the Recommendation. The counterfactual suggests that the Recommendation contributed to this slowdown of new loans granted to households, although this impact is only statistically significant 4 months after its introduction.

As for the short-term impact of the Recommendation on house prices, the results are less clear as the observed values are above the estimated counterfactual and the upper bound for the forecast values. The difference between the observed house prices and the estimated counterfactual are unlikely to reflect the introduction of the Recommendation as, according to the existing literature, tighter credit standards are expected to slow down house prices growth. Intrinsic short-term housing market shocks and the historically unprecedented buoyancy in the Portuguese housing market, mainly fuelled by investment by non-residents, might be affecting these results.

Finally, we do not find evidence that economic activity was influenced by the Recommendation in the 6 months following its implementation.

Appendix A: BVAR model estimation and specification

The set of prior beliefs associated to the model parameters (θ) are explicitly defined in the form of a prior distribution for the model parameters, $g(\theta)$. In the standard VAR(p) setting, the parameters are usually grouped in two blocks, one regarding the slope coefficients β, and another associated with the covariance matrix Σ, so that $\theta = (\beta, \Sigma)$. The information contained in the observed sample is summarized in the data likelihood function $f(y|\theta)$. Then, the posterior distribution of the model parameters, denoted by $g(\theta|y)$, can be obtained by combining the prior beliefs with the information contained in the sample via the Bayes theorem, which states the joint density as

$$f(\theta, y) = g(\theta|y)f(y) \tag{A.1}$$

hence

$$g(\theta|y) = \frac{f(y|\theta)g(\theta)}{f(y)} \Longrightarrow g(\theta|y) \propto f(y|\theta)g(\theta) \tag{A.2}$$

When setting the prior beliefs one usually specifies the prior distribution of each block of parameters, $g(\beta)$ and $g(\Sigma)$, instead of the respective joint distribution $g(\theta)$. In order to simplify the definition of $g(\theta)$, the model parameters are assumed to be independent so that

$$g(\theta) = g(\beta, \Sigma) = g(\beta) \times g(\Sigma) \tag{A.3}$$

Similarly, we are interested in evaluating the posterior distribution of each block of parameters.

One of the simplest methods to specify the prior distribution of the VAR(p) parameters is the Minnesota (or Litterman) prior (Doan *et al.* 1984). The main idea behind this strategy is to shrink the slope estimates towards a multivariate random walk model. In this setting the covariance matrix Σ is assumed to be known. A convenient way to define Σ is to simply use the OLS covariance matrix estimate from the VAR(p) model. Therefore, in order to obtain the posterior distribution of the parameters $g(\theta|y)$ we only need the following elements: the data likelihood function $f(y|\beta, \sigma)$ and the prior distribution $g(\beta)$ for β.

The data likelihood function $f(y|\beta, \sigma)$ has a Gaussian form, as the error term is assumed to follow a multivariate normal distribution $E \sim N(0, \Sigma)$. The slope parameters are assumed to follow a multivariate random walk model so that the prior distribution for β can be expressed as $\beta \sim N(\beta_0, \Omega_0)$. The prior distribution of β is governed by the so-called hyperparameters β_0 and Ω_0, which are specified as follows:

- β_0 is oriented by the prior belief that each endogenous variable can be characterized by a random walk. Thus, the first autoregressive coefficients of the endogenous variables should be set to one and coefficients of further autoregressive lags, cross-variable lags and control variables should be set to zero. Following this strategy, β_0 will simply translate into a vector of ones and zeros.
- to identify Ω_0 we use the following principles:

- the covariance between the elements in vector β is zero so that Ω_0 is a diagonal matrix;
- coefficients associated to the most distance lags are assumed to be close to zero and we express this prior belief by assigning a smaller variance to coefficients associated with further lags;
- The prior belief that the coefficient is close to zero should be stronger for the coefficients associated with cross-variable lags;
- No prior information is available for the control variables (control variables) and, therefore, we set the variance associated with these coefficients to infinity.

Therefore, using this information, the elements of Ω_0 can be summarized as follows:

$$\sigma^2_{a_{ij}} = \begin{cases} \left(\frac{\lambda_1}{l^{\lambda_3}}\right)^2 & if \quad i = j \\ \left(\frac{\sigma_i^2}{\sigma_j^2}\right)\left(\frac{\lambda_1\lambda_2}{l^{\lambda_3}}\right)^2 & if \quad i \neq j \end{cases}$$

where λ_1 and λ_2 are parameter that control the overall tightness of the autoregressive and cross-variables coefficients, respectively. λ_3 controls the speed at which the coefficients of further lags converge to zero, and l is the number of the lag. Finally, σ_i^2 is the i^{th} diagonal element of the VAR(p) covariance matrix, which can be replaced by the respective OLS estimate. In practice, hyperparameters are selected through a grid-search procedure to find the values that minimize a measure of fit of the model to the data.

Appendix B: Control variables

Figure B.1 plots the control variables over the period considered in the sample. Residential investment has been increasing since 2012, both from residents and non-residents. In 2018, residential investment continued to increase having accelerated in 2018m12 relatively to 2018M6. This happened in a context of historically low interest rates, largely influenced by monetary policy, as reflected by the 12-month Euribor graph, and a deceleration of the Euro area gross domestic product, after the recovery experienced after the global financial crisis and the sovereign debt crisis in some European countries.

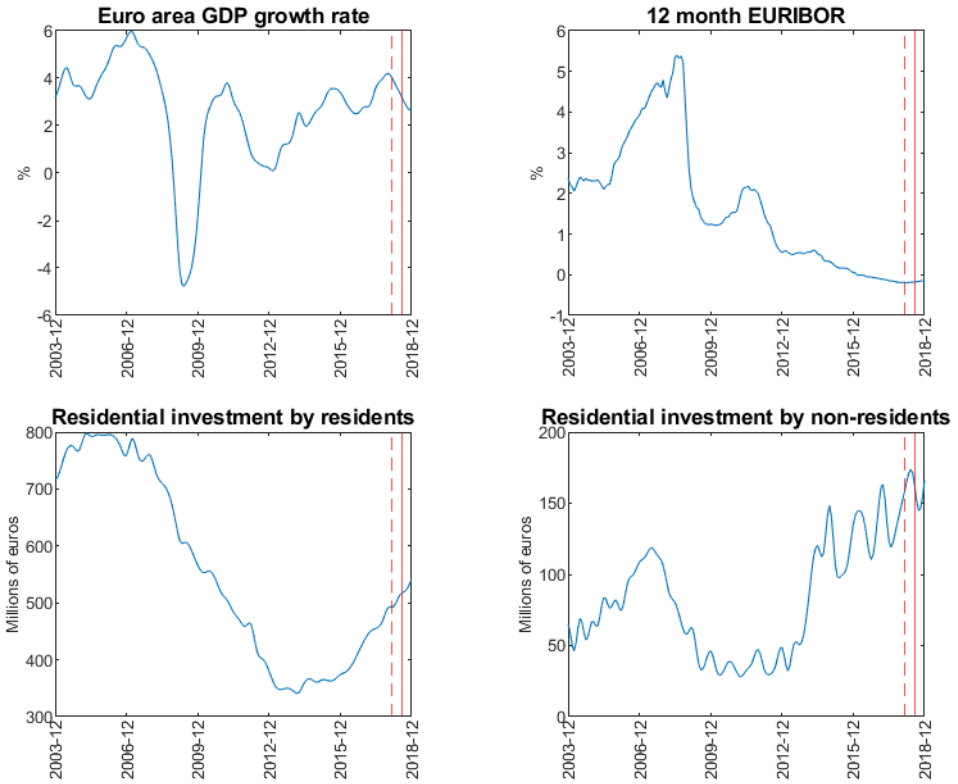

FIGURE B.1: Control variables

Sources: Banco de Portugal, INE, OECD and ECB. Note: Dashed line stands for the announcement date of the Recommendation and the solid line stands for the implementation date of the Recommendation.

Appendix C: Counterfactual estimated with first differenced data

In order to account for possible structural breaks in the data, we estimated the BVAR model on first differenced data and computed the counterfactual from this estimated model. Differentiation robustifies the analysis against structural breaks and can improve the forecast ability of the model. It can be seen from Figure C.1 that the counterfactual estimated with the data in levels ("Counterfactual - levels") and from the model estimated with first differenced data ("Counterfactual – 1st differences) are very similar. In particular, the sign of the estimated effect of the introduction of the macroprudential measure appears to be robust when estimating the model in first differences. Regarding the results on new loans for consumption and house purchase, the distance between the counterfactual (both with levels and differenced data) to the observed series increases in the months at the end of the forecasting period. Therefore, we consider that this exercise supports the conclusion of a more pronounced reduction of the volume of new loans 4 months after the policy implementation.

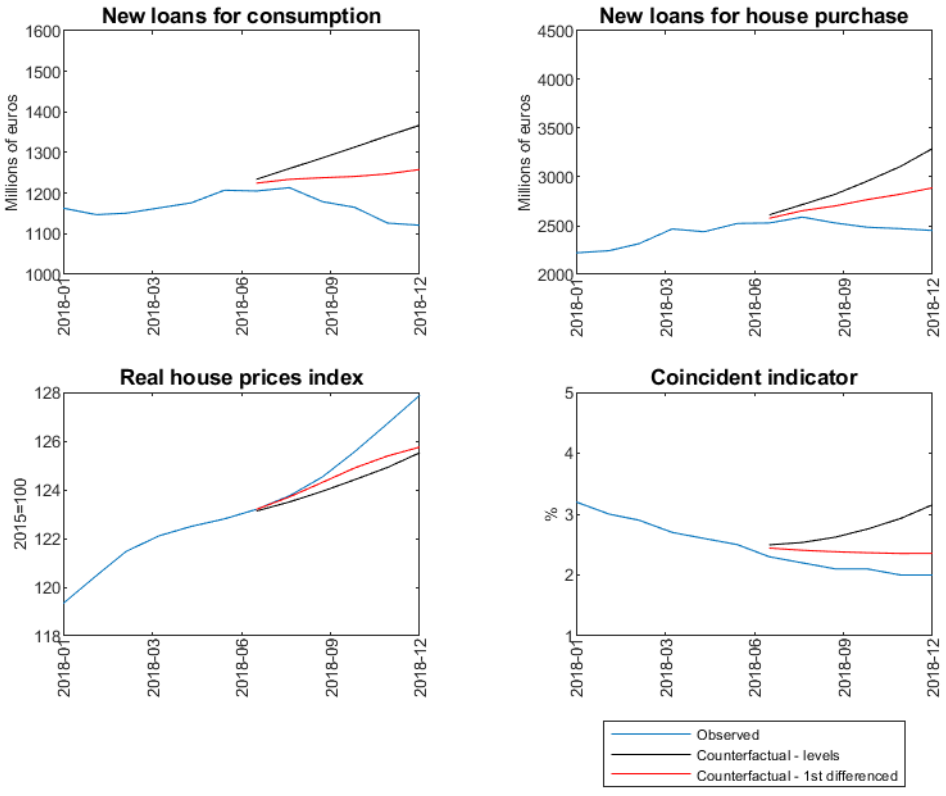

FIGURE C.1: Counterfactual estimated with the data in levels and first differences

Sources: Banco de Portugal, INE and OECD. Notes: Counterfactual corresponds to the median of the predicted posterior distribution given by a BVAR(5).

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