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Content

Editor's note[1]

Pedro Duarte Neves

January 2021

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1. This issue of *Banco de Portugal Economic Studies* includes four studies. The first study presents a set of useful indicators for monitoring monetary policy in the euro area. The following two studies illustrate how costs with some degree of rigidity – in fixed operating costs in the first case and financial costs in the second – may differentially affect at sectoral and corporate level the ability to react to adverse shocks. Finally, the fourth study uses a general equilibrium model to explain the behaviour of the Portuguese economy over the last 20 years.

2. The study by Iskrev, Lourenço and Soares, which opens this edition of *Banco de Portugal Economic Studies*, presents two useful indicators for monitoring monetary policy: the well-known Taylor rule and financial conditions indicators.

In 1993[2] John Taylor proposed an empirical rule with great capacity to replicate monetary policy decisions in the United States. Since then, and until recently, this rule has been used as a benchmark for monetary policy key rates, not only in the United States but also in the euro area, the United Kingdom and several other countries. The study by Iskrev, Lourenço and Soares presents a highly comprehensive review of the literature on various specifications of the Taylor rule, illustrating its behaviour in the euro area in the last 20 years. The Taylor rule has proven to be a good proxy for monetary policy key rates over the entire time period considered. However, it began to deviate when what is conventionally referred to as the 'lowest threshold for interest rates' was reached. Since then, interest rates have ceased to be the main instrument and non-standard monetary policy measures have assumed a leading role.

In the second part of the study, these authors develop a set of financial conditions indicators for the euro area and for some economies, including Portugal.[3] These

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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. See "Discretion and policy rules in practice", John Taylor (1993), *Carnegie-Rochester Conference Series on Public Policy* 39 (1993) 195-214.

3. For several years, the Banco de Portugal has been using this type of index to monitor the prevailing monetary and financial conditions. See for example "Monetary conditions index", Sónia Costa, *Economic Bulletin*, Banco de Portugal, September 2000, and "Monetary conditions index for Portugal", Paulo Soares Esteves, *Economic Bulletin*, Banco de Portugal, June 2003.

indicators use a well-established statistical methodology, based on factor and principal component analysis, to obtain a summary measure of the financial conditions. In this study, this measure is estimated on the basis of several financial series grouped into six main categories: bank credit, bond markets, stock markets, money markets, foreign exchange markets and risk and uncertainty indicators.

The authors develop three variants of financial conditions indicators for the last 15 years, which follow similar trends over the period under review. Nevertheless, some differences are identified at specific times, and thus the authors advocate using these variants as a complement. The role that these indicators can play in monitoring monetary and financial conditions in the euro area and some of its economies remains to be confirmed in the future.

3. Given its truly unique nature, the COVID-19 pandemic crisis has affected the world economy in an unparalleled way, with extremely varied and unprecedented repercussions, which have been classified differently:

- Gita Gopinath, Chief Economist of the International Monetary Fund, used the term **The Great Lockdown** to highlight the magnitude and speed of the collapse of economic activity following the adoption of containment measures at planetary level;[4]
- Joseph Stiglitz, Nobel Prize in Economics, used the expression **The Great Divide** to characterise the potential effect on increasing income inequality,[5] for going disproportionately after the poor and, in advanced economies, after those with no guaranteed access to healthcare and also those who work in sectors most affected by the pandemic and whose skills are more difficult to adjust to the new normal;
- Economists Jeremy Bulow, Carmen Reinhart, Kenneth Rogoff and Christopher Trebesh used the expression **The Debt Pandemic** to describe difficult debt management in the short term for a vast group of emerging or developing countries;[6]
- Agustín Carstens, General Manager of the BIS, preferred to refer to the historical period we are living in as **The Great Reallocation**.[7] Non-reversible changes

4. See "The Great Lockdown: Worst Economic Downturn Since the Great Depression", Gita Gopinath, *IMF Blog*, 14 April 2020.

5. See "Conquering the Great Divide", Joseph Stiglitz, *Point of View, Finance & Development*, IMF, September 2020.

6. See "The Debt Pandemic", Jeremy Bulow, Carmen Reinhart, Kenneth Rogoff, and Christoph Trebesch, *Finance & Development*, IMF, September 2020.

7. See "The Great Reallocation", Agustín Carstens, BIS, Op-ed, 12 October 2020. See also "COVID-19 is also a reallocation shock" by José Maria Barrero, Nick Bloom and Steven J. Davis, May 2020, *NBER WP 27137*, and "COVID-19, asset prices, and the Great Reallocation", Marco Pagano, Christian Wagner and Josef Zechner, 11 June 2020, VOX, CEPR Policy Portal.

in the economic environment – such as the emphasis on digital preferences, the demonstration of the possibilities of remote working, and the development of new digital production processes – will lead to an in-depth reallocation of resources, possibly unprecedented on a worldwide scale, from the sectors hardest-hit by these changes to those that will emerge stronger in the post-pandemic crisis period.

In this context, it is crucial to identify a firm's ability to adjust and ascertain whether, for example, temporary liquidity problems may or may not become solvency problems in the short term. In his speech, Agustín Carstens presents BIS estimates of a 20% rise in bankruptcies among advanced-economy firms between 2019 and 2021.

Agustín Carstens states that businesses that can succeed in this new economy need help as they undergo debt restructuring and repair their balance sheets; he also stresses that it is important to encourage and enable businesses in the most severely damaged sectors to reallocate their resources toward those sectors that are more likely to thrive in the post-pandemic economy.

4. It is precisely from this adjustment standpoint in the face of an adverse shock that the following two studies are framed. These studies present empirical evidence of the role that fixed operating costs and financial costs may play in the presence of an adverse economic shock such as that currently affecting the Portuguese economy.

There are firms in each sector of economic activity in better conditions to adapt to an economic environment that has undergone profound changes. A firm's cost structure is key for its ability to adjust. In particular, the existence of costs with some degree of rigidity – operating or financial – condition the profit margin, the investment capacity and ultimately a firm's ability to survive in an adverse situation, such as a sudden reduction in demand or an unanticipated rise in interest rates. In the presence of a shock with quite different sectoral effects – such as the current COVID-19 pandemic crisis – the flexibility to adjust cost structure is instrumental for the final impacts on the different sectors and, ultimately, on each firm.

5. The study by Félix, Moreira and Silva presents estimates for the fixed operating costs of Portuguese firms, defined as the operating costs expected next year should sales fall to zero. The authors explore heterogeneity as regards firm size and sector of activity. The higher these costs, the more difficult it is for a firm to adjust its non-financial cost structure in the face of an adverse shock.

The two main results in this study are as follows:

(a) The importance of fixed operating costs, expressed as a proportion of sales, tends to decrease with firm size, i.e. smaller-sized firms tend to have greater difficulty in adjusting their operating cost structure than larger firms;

(b) Sectors such as hotels and restaurants, health and real estate activities have higher fixed operating cost structures and, therefore, it is more difficult for them to respond to adverse economic shocks; sectors such as wholesale and retail trade and transport and storage have lighter fixed operating cost structures; finally, figures for manufacturing and construction are slightly lower than the average for the Portuguese economy.

Overall, this study makes it possible to understand the effects of a firm's operating cost structure on its ability to withstand an abrupt reduction in sales. Excessive cost rigidity will tend to be associated with cash-flow difficulties in the immediate future and possibly with subsequent risks to the firm's solvency.

6. The third study – by Augusto and Mateus – projects the debt of non-financial corporations in Portugal for 2020-22 in the central and adverse scenarios presented by the Banco de Portugal in the December issue of the *Economic Bulletin*. The study focuses on two alternative debt vulnerability indicators for firms that essentially attempt to identify situations where compliance with credit obligations is more difficult over a medium-term horizon.

Clearly, the results obtained depend on the macroeconomic projection scenario. In either case, this exercise provides important indications:

(a) The downward trend of debt vulnerability indicators, noticeable since 2012-13, was interrupted in 2020 by the effects of the COVID-19 pandemic crisis;
(b) Debt reduction associated with vulnerable firms to levels close to those observed at the end of 2019 will not tend to occur before the end of 2022;
(c) Compared to developments over the period of Portugal's Assistance Programme, the worsening of debt associated with vulnerable firms is expected to be less pronounced, reflecting the projection of a swifter recovery of economic activity than in 2011-14 and lower interest rates and debt levels of non-financial corporations in Portugal;
(d) The nature of COVID-19's economic shock has produced very different sectoral effects, especially a stronger impact on manufacturing, trade and, even more markedly, on the hotels and restaurants sectors.

7. The Dynamic Stochastic General Equilibrium Models, (commonly referred to as DSGEs) have played, for various international organisations, an important role for economic analysis and forecasting.[8] In these models, the behaviour of individual agents is based on microeconomic theory principles, in a context in which markets are in

8. For a more conceptual presentation, see for example "Challenges for Central Banks' Macro Models", Linde, Jesper, Frank Smets and Rafael Wouters, 2016, Riksbank Research Paper Series, No 147 and, for an application within a macroeconomic forecast see "How the pandemic shaped the forecast", European Commission, *European Economic Forecast*, Spring 2020.

equilibrium at any given moment, nevertheless contemplating the possibility of nominal price and wage rigidity, of pricing power and the existence of information asymmetries. Despite the explanatory richness of these models, some authors have also identified a series of limitations.[9] The Banco de Portugal has used the general equilibrium PESSOA model regularly over the last 10 years for the structural interpretation of fluctuations in the business cycle[10] and also to identify the macroeconomic determinants underlying the Bank's projections.[11]

8. The final study of this issue of *Banco de Portugal Economic Studies*, by Júlio and Maria, draws on the results of two dynamic stochastic general equilibrium models to interpret developments in the Portuguese economy in the last two decades. The models used in this study are considerably comprehensive, as they include nine types of economic agent and 24 types of shock (with six different types of origin: demand, technology, profit margins, fiscal, financial and external).

The authors present two alternative model calculations for the behaviour of households: agents with infinite lives and agents with a finite stochastic life, the latter through an overlapping generation scheme. The two models are equivalent in the remaining dimensions. Different structural models may offer different interpretations of the functioning of the economy. The main motivation of the authors is to assess if the contribution of fiscal shocks to business cycle fluctuations differs between the two models.

The authors conclude that the results obtained with these two specifications are qualitatively similar, thus producing overall identical narratives on the functioning of the Portuguese economy in the last 20 years. Both specifications have a similar interpretation of the main cyclical fluctuations in the Portuguese economy and, in particular, of the double-dip recession of the Portuguese economy in the wake of the major worldwide economy recession (the Great Recession) and the subsequent sovereign debt crisis in the euro area.

Hence, this creates the expectation that, at a time when economic activity has fully recovered from the effects of the COVID-19 pandemic crisis, the PESSOA model will be able to produce a stabilised narrative of the behaviour of the Portuguese economy in this unprecedented period.

9. See for example "Do DSGE Models Have a Future?", Olivier Blanchard, Policy Brief, Peterson Institute for International Economics, August 2016, and "Why DSGEs crash during crisis", Hendry, David F. and Grayham E. Mizon, June 2014, VOX, CEPR Policy Portal.

10. Further details can be found in "The Portuguese post-2008 period: a narrative from an estimated DSGE model", Júlio, P. and J. Maria (2017), *Working Paper No 15*, Banco de Portugal.

11. The June 2020 issue of the Economic Bulletin presents a general equilibrium view on GDP projections in the period 2020-22 (see Box 3).

Non-technical summary

January 2021

Indicators of monetary policy stance and financial conditions: an overview

Nikolay Iskrev, Rita Lourenço and Carla Soares

How can one infer whether monetary policy is stimulating or restricting the economy, that is, how can monetary policy stance be measured? Considering the stance of monetary policy to be its contribution to economic developments in order to achieve the central bank's objective, this article discusses two groups of indicators useful for understanding the stance of monetary policy.

The first set of indicators focuses on interest rate rules. These rules are based on a systematic reaction by the central bank to developments in economic activity and prices. For decades, this type of rules has been a good representation of monetary policy rates in advanced economies. However, the adoption of unconventional monetary policy and the downward trend in interest rates in recent years has limited the use of this type of simple policy rules. The downward trend in interest rates can be taken into account by calculating the hypothetical nominal interest rate that would prevail in the absence of the lower bound - the interest rate at which individuals choose to replace interest-earning assets for cash. Monitoring the evolution of the Eurosystem's balance sheet can contribute to the analysis of unconventional policy, as well as to assess the way in which monetary policy has been used to fulfill essential objectives that are not directly related to policy stance, such as ensuring the proper functioning the monetary policy transmission mechanism.

Rules-based indicators do not allow us to assess financial conditions. In addition, in the last decade, several policy measures were adopted that aimed at stabilizing financial markets. It is therefore important to monitor financial conditions as a contribution to the central bank's policy. This can be done by monitoring a vast set of information about the financial system, but also through composite indicators. To that end, several new indices of financial conditions are presented. The indices have the advantage of using a common methodology for the euro area, the four largest economies, and Portugal, and incorporate information from a broader set of variables than other indices of the same type. The indices are developed using factor analysis and aggregate information from financial series grouped into six categories: bank credit, bond markets, equity markets, money markets, foreign exchange markets, and risk and uncertainty. Three different but complementary versions of the indices are calculated, namely (i) weighting factors according to their contributions to overall volatility, and (ii) weighting factors according to their contributions to the simultaneous forecast ability of GDP growth and inflation and (iii) filtering the financial variables from macroeconomic developments and weighting factors according to their contributions to overall volatility. The overall evolution is very similar, although some differences can be found at times, as shown in Figure 1. The indices allow capturing the periods of greatest tightening in financial conditions at the time of the global financial and sovereign debt crises. The comparison between the indices also allows us to separate the influences of the macroeconomic evolution on the financial conditions, as well as to evaluate the importance of the conditions for the future evolution on the activity and inflation.

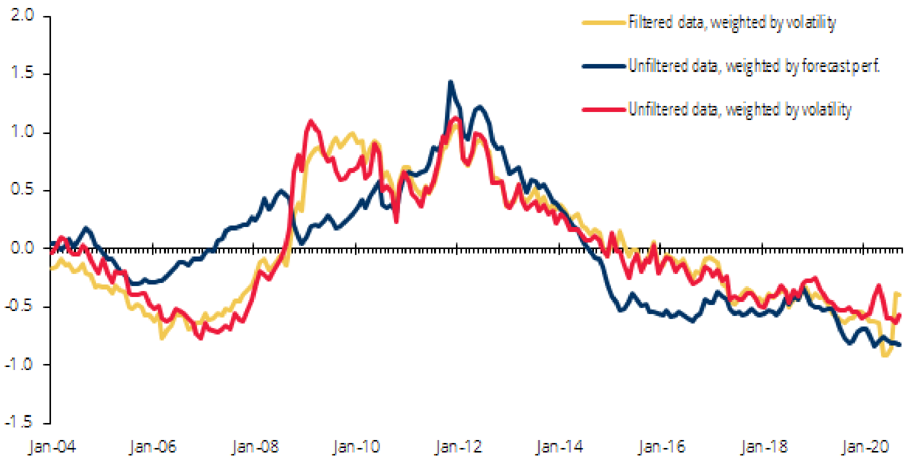

FIGURE 1: Financial conditions indices for the euro area
Last observation: September 2020.

The set of indicators presented in this study is useful for assessing monetary and financial conditions and understanding the reaction function of central banks. However, it is by no means exhaustive and the analysis is always subject to expert judgment. In addition, the Eurosystem operates in specific institutional circumstances that justify the need to have a different perspective on the monetary policy stance relative to other large central banks. In particular, fragmentation issues and impediments to the transmission of policy may not be immediately visible in the indicators discussed, but they may justify intervention by the central bank as occurred in the past.

Indicators of monetary policy stance and financial conditions: an overview

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Abstract
The article discusses different indicators that can be used by central banks, market participants, and other economic agents to evaluate the monetary policy stance at each moment in time. This discussion considers that monetary policy aims at stabilizing the economy, and the position of the underlying indicators along to the business cycle are an indication of its stance. First, we describe some simple monetary policy rules and examine how unconventional measures and the lower bound on interest rates could be taken into account in assessing monetary policy stance through balance-sheet and shadow rates approaches. Second, we discuss how financial conditions can be assessed using disaggregated data as well as composite indicators. We also develop and estimate financial conditions indices for the euro area, the four largest economies, and Portugal. Overall, the set of indicators presented in the article is helpful in both supporting the policy decision and in understanding central banks' reaction function. However, these indicators alone are not able to fully rationalize the monetary policy decisions since policy makers' interpretation and judgment play a crucial role in the decision process. (JEL: E43, E44, E52, E58)

How can one infer whether monetary policy is stimulating or constraining the economy? An important goal of monetary policy is to stabilize the economy and thus improve welfare. Behind this argument is the idea that there is a first-best that can be approximated with policy intervention. However, this first-best situation is only a theoretical construct and is not observed in reality. Moreover, central banks are usually assigned with a mandate, which can differ depending on countries and their institutional setup. One could consider a benchmark ideal state that the monetary authority aims to achieve and that would result from a neutral monetary policy. However, setting policy optimally to achieve this benchmark is not feasible for two main reasons. First, it is not possible to infer the benchmark state of the economy because it is not observable. This benchmark depends on the model interpretation of the economy and the shocks driving it which is not possible to fully understand and disentangle. Second, it is also not feasible to determine the true state of the economy in real-time and relate it to the benchmark. If those states were observable, one could

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determine the appropriate policy response, i.e., whether monetary policy should be accommodative or contractionary. Monetary policy stance can then be considered as the contribution that it gives to economic developments in order to reach the central bank objective.

The monetary policy stance is therefore hard to measure. There are many potential informative indicators, but none is sufficient on its own. These indicators can be used as part of the information set available to policy decision-makers, who also apply their own interpretation and judgment. This article discusses several indicators, that can be useful for central banks, market participants, and other agents in the economy to assess monetary policy stance at each moment in time. The objective is to show how these indicators are used by central bankers, such as in the Eurosystem, and how they should be interpreted. We will focus on the euro area, although a great part of the discussion can be easily extended to other economies. In section 1, we discuss policy rules as the more traditional way to infer stance when interest rates are the main policy instrument. We also discuss the drawbacks of the rules in a very low-interest rate environment and the extensive use of unconventional policy. Policy rules are complemented by an analysis of the financial conditions and how policy is supporting these. In practice and especially since the crises, central banks look at a broad range of information that is explored in section 2. This reflects the importance of financial intermediation in the transmission mechanism and the ability of the Eurosystem to influence it. We present new financial conditions indices for the euro area, the four largest economies, and Portugal. The article ends with some concluding remarks.

1. Assessing the monetary policy stance through policy rules

1.1. Policy rules on interest rates

Central banks in developed economies in general have a mandate for price stability and to promote real economic growth. If there were a simple way to establish the relationship between the policy instrument and the policy objectives, the central bank role would be easy to implement and be followed by participants in the economy. This is the idea behind policy rules and the reason for their popularity. In practice, it is not easy to understand such a relationship and to adequately measure the intended objectives, as will be discussed in this section.

Policy rules describe a relationship between the policy rate, the primary policy instrument, and measures of real economic activity and inflation, in line with central banks' mandates. The most common policy rule was first developed by Taylor (1993) and became quite popular for being able to closely replicate policy decisions of the US Federal Reserve. The Taylor rule foresees the policy rate i_t to be set according to

$$i_t = r^* + \pi_t + \alpha(\text{inflation gap}_t) + \beta(\text{output gap}_t) \tag{1}$$

where r^* is the equilibrium real rate, i.e., the real interest rate consistent with the economy in the long-run, π_t is the current inflation rate, the inflation gap is given by the deviation of observed inflation from the inflation target and the output gap is given by the deviation of observed output from potential output. The parameters α and β were set by Taylor (1993) equal to 0.5, but over time other values have been used in the economic literature. Such parametrization is consistent with the Taylor principle, as the total coefficient associated with inflation $(1 + \alpha)$ is greater than 1, warranting a greater response of policy to inflation deviations and avoiding persistent deviations in inflation expectations from the objective (Woodford 2001). Whenever the interest rate estimated from the policy rule is above the current policy rate, it suggests that monetary policy is too accommodative and that an increase in the rate should follow.

There have been different adjustments to this simple rule, in order to account for institutional and other differences among central banks, as well as to make the rules more robust to the complex environment in which central banks operate. For instance, the Federal Reserve uses several policy rules as a means of communicating to the public this complex decision process that is subject to uncertainty (Garciga *et al.* 2016).

In order to reflect the uncertainty that a real-time decision process is subject to, central banks usually opt for a conservative approach, which can be translated into incorporating inertia into the policy rule. The respective adjustment to the policy rule (1) consists of keeping the policy rate by a ρ share at the previous value and $1 - \rho$ adjusting at the rule. Empirical studies find an improvement in the estimates with this specification and usually find an inertia parameter at high levels, around 0.8 and 0.9 for quarterly data (Goodhart 1998; Smets and Wouters 2003; Canzoneri *et al.* 2015). The incorporation of inertia can also be rationalized in models where volatility is considered undesirable and expectations are forward-looking (Sack and Wieland 2000; Gertler *et al.* 1999).

The rule in equation (1) sets policy according to past or current values of inflation and output, which could mean that monetary policy is only reactive. However, in reality, monetary policy decisions influence future outcomes; past inflation only matters for its information power about future inflation. Thus, forward-looking policy rules may be better suited, i.e., rules where $(inflation\ gap_t)$ and $(output\ gap_t)$ in equation (1) are replaced by their future expected values $E_t(inflation\ gap_{t+i})$ and $E_t(output\ gap_{t+i})$ and where the adequate forward-looking time period *i* can be discussed depending, in particular, on the lags between policy decisions and their effects on real and nominal variables (Gertler *et al.* 1999). This seems to be the rationale behind the quantitative definition of price stability of the ECB of "inflation rates below, but close to, 2% over the medium term". The medium-term orientation relies on the evidence that policy transmission takes time thus policy decisions should be based on a forward-looking assessment and price stability should be aimed over long periods of time.[1]

The incorporation of gradualism and forward-looking nature in the policy rule implies a revision of equation (1) to the following expression, considered closer to the reaction function of the Eurosystem:

1. See https://www.ecb.europa.eu/mopo/strategy/princ/html/orientation.en.html

$$i_t = \rho i_{t-1} + (1-\rho)[r^* + \pi_t + \alpha(\pi_{t+i} - \pi^*) + \beta(y_{t+j} - y^P_{t+j})] \quad (2)$$

where i and j are the relevant forward-looking horizons for inflation and output, respectively.

The Taylor rule makes use of unobservable variables, namely the natural rate of interest and the output gap. Both variables are defined relative to the potential of the economy, a state that corresponds to a theoretical construct that would be the state of the economy where there are no nominal frictions such as rigidities in price-setting, and there are no unexpected shocks that take the economy out of this state. The output gap is of great interest for policy makers and several organizations compute estimates of it, including the Eurosystem, despite the difficulty in estimating this unobservable variable according to its model definition. An overestimation of the output gap would imply a tighter policy than desirable, as the estimated potential output would be lower than the effective potential and the economy would be interpreted as "overheating".

The natural rate of interest is usually interpreted as the real interest rate that is consistent with an economy at its potential in the absence of any frictions or transitory shocks. It is a theoretical concept of high relevance for monetary policy. Given the relationship between interest rates and inflation, if the objective of the central bank is price stability, nominal and real interest rates should move one-to-one in the long-run. Assuming that the natural rate of interest is determined solely by structural factors exogenous to monetary policy,[2] the central bank should set nominal interest rates in order to steer real rates towards the natural rate of interest. As the natural rate changes, so should the trend in the policy rate. It is widely accepted that in the last decades there has been a decreasing trend in the natural rate of interest due to factors such as demographic changes or changes in preferences for savings (Banco de Portugal 2019; Brand *et al.* 2018). Despite the common trend, estimates of the natural rate of interest vary widely. Holston *et al.* (2017) estimates, based on a semi-structural model, are one of the most widely used and are available for some of the larger developed economies, in particular for the euro area (henceforth referred to as HLW). Figure 1 shows the current estimates (2020Q1) and the real-time estimates available since 2015Q4. The difference between the two estimates reveals the difficulties posed to policy makers when making decisions: besides the uncertainty related to being an estimated variable, even if we consider the model as accurate, the real-time estimates could lead to an underestimation of the natural real rate that could go up to 1 p.p., given the absence of accurate real-time information. This difference advises in favour of a cautious approach when using this information, preferably a more qualitative input. Along these lines, one could argue that the period between 2011 and 2016 of decreasing estimates to historically low levels would have suggested monetary policy to be more accommodative, which

2. The exogeneity of monetary policy to the natural rate of interest is not entirely consensual. Juselius *et al.* (2017) argue that, besides the "usual" business cycle, there is a financial cycle, influenced by monetary policy through its impacts on asset prices. Taking this into account, it is possible to define the "finance-neutral natural rate", which is estimated above the most common estimates of the natural rate.

may have happened with some delay with policy rate cuts and the launch of several unconventional policy measures.

We can incorporate the estimates on the natural real interest rate into the policy rule. Figure 2 shows the resulting real policy rates by applying different estimates of r^* of the euro area in equation (1) and comparing with the EONIA rate in real terms.[3] Overall, the effective rate follows closely the recommended policy, especially prior to 2012, the height of the sovereign debt crisis and the period when interest rates in the euro area reached the zero level. Based on this assessment, one could argue that monetary policy was too restrictive in the period 2013-2014, while from 2017 onward it was too loose. However, for the first period, this policy assessment does not take into account the many unconventional policy measures aiming at providing accommodation that were implemented at the time. In 2020, the large negative pandemic shock led to a strong fall in the real rates implied by the Taylor rule, that reached levels around -4% and -5% in the second quarter, while policy rules remained unchanged. Therefore, given that we are close to the effective lower-bound on interest rates and policy rates are not the primary policy instrument currently, the policy advice from these rules is quite limited.

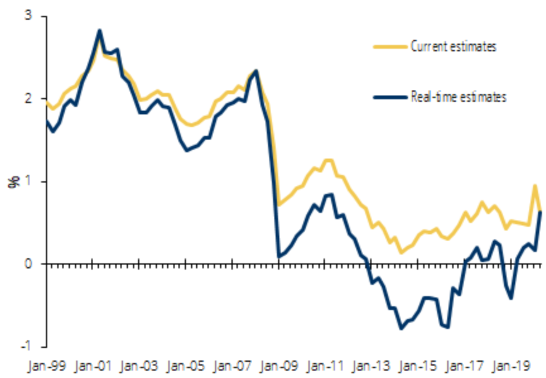

FIGURE 1: HLW estimates for the euro area natural rate of interest

Source: Federal Reserve Bank of New York

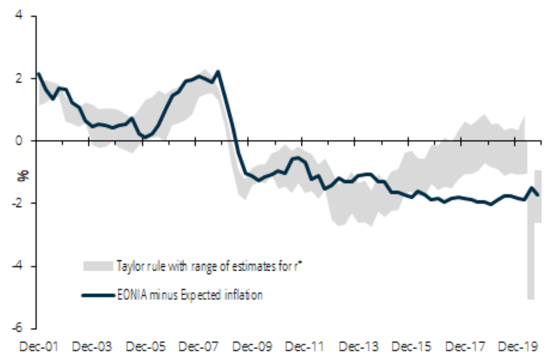

FIGURE 2: Observed short-term real rate and implied by Taylor rule for different estimates of the natural rate of interest

Note: Expected inflation is Eurosystem inflation forecast 18-months ahead; r^* based on current and real-time HLW estimates and Fiorentini *et al.* (2018); Taylor rules based on Eurosystem forecasts.

In order to overcome the difficulty in using unobservable variables in the policy rule, Orphanides (2003) suggested using instead a rule based on the changes in the policy rate instead of the level of the rate itself. The first-differences rule is thus set as

$$\Delta i = 0.5(inflation\ gap) + 0.5(\Delta output\ - \Delta potential\ output) \tag{3}$$

where the parameters of the rule are the same as in Taylor (1993). Orphanides and Wieland (2013) show that this rule is able to characterize quite well the ECB's policy

3. EONIA is the benchmark overnight unsecured interest rate for the euro area and is seen as the implicit operational target of monetary policy.

without the need of an estimate of the natural rate of interest and of the output gap in real-time, which is especially useful in times of uncertainty and a wide dispersion of forecasts, more common in crisis periods. Hartmann and Smets (2018) perform a further exercise confirming the robustness of this rule by using ECB/Eurosystem forecasts, showing that the estimated coefficients are not significantly different from 0.5. Nonetheless, they find that the performance of the rule weakens as the euro area approached the zero-lower bound. This can be either due to a too benign interpretation of the sovereign debt crisis that left the policy too restrictive or to the non-incorporation of the unconventional policy measures taken at the time.

Figure 3 shows a range of prescriptions for the policy rate in the euro area were the ECB to follow an estimated Orphanides rule up to 2012Q2 and extrapolated afterward.[4] For such estimates, we use several possible combinations of forecasters, namely ECB/Eurosystem, European Commission, IMF, SPF, Consensus Economics and The Economist, and several possible combinations of forecast horizons, taking into account the information available ahead of each Governing Council meeting. Similarly to Hartmann and Smets (2018), we confirm the relatively tight interval of our estimates. As seen before, in the period 2013-2015, the rule suggested a looser policy stance. However, this recommendation is not able to account for the policy easing from the unconventional measures.

With the Global Financial Crisis (GFC), concerns about financial stability and the interactions with nominal stability have regained interest. There are studies showing that a central bank can be more effective in responding to financial shocks if it incorporates financial variables in its reaction function, even without an explicit mandate for financial stability (Gilchrist and Zakrajsek 2012; Verona *et al.* 2017; Juselius *et al.* 2017). In practice, interpreting the conclusions from such rules can be quite complex, as the conflict between two objectives with solely one instrument may easily arise. The ECB includes in its strategy a cross-check with monetary analysis, which means that such information is taken into account ahead of policy decisions, without the need to be explicitly incorporated in the policy reaction function (Smets *et al.* 2011).

1.2. Limitations of interest rate rules and alternatives

Policy rules focus on the policy rate as the only policy instrument, meaning that they are not able to fully capture the unconventional policy measures implemented during the last decade. Unconventional measures include negative rates and forward guidance, which can be captured in some way by policy rules given the impact in market rates, and measures that work through the expansion of the central bank balance sheet, in particular lending operations and asset purchase programs. In the euro area, such measures were used in a first phase with the aim of curbing financial markets stress and ensuring policy transmission, and in a second phase at providing monetary

4. As mentioned before, reaching the zero-lower bound on interest rates and the implementation of unconventional policy measures alters the relationship between inflation and output and the implied policy rate.

accommodation simultaneously with the reduction of fragmentation in the euro area that was impairing the transmission mechanism within the monetary union.[5]

The evolution of the central bank balance sheet over time, in particular the items related to monetary policy implementation, is useful to assess the policy stance. In the case of the Eurosystem, the relevant items on the asset side are the ones relative to lending operations and to monetary policy portfolios (Figure 4). These can still be disaggregated according to the operation. For lending operations, currently, it is useful to monitor the TLTRO (Targeted Longer-Term Refinancing Operations), refinancing operations for maturities up to four years with attractive conditions to banks in order to ease private sector credit conditions and stimulate bank lending to the real economy. In June 2020, the allotted amount in these operations reached a new maximum, due to the high demand for liquidity amid the pandemic crisis and the extremely favourable lending conditions. The outright portfolio for monetary policy purposes is also divided according to the different programs, namely the ones currently active in purchases: the APP (Asset Purchase Programme), set in 2014 and encompassing different subprograms according to the assets purchased (public sector bonds, corporate bonds, covered bonds, and asset-backed securities), and the PEPP (Pandemic Emergency Purchase Programme), both aiming at supporting financial market functioning and the adequate functioning of the transmission mechanism, with the final objective of price stability. Purchases under these programmes following the Governing Council response to the large negative shock induced by the covid pandemic have also induced a historic balance sheet expansion, contributing to the necessary monetary accommodation, besides providing a backstop that contributed to ensuring the monetary transmission in the monetary union.

The large expansion in the liquidity provision has, as a counterpart on the liability side of the central bank balance sheet, an expansion of the excess reserves (in the strict sense and including those at the deposit facility) (Figure 4). The way this excess liquidity is distributed across the euro area is a way to measure the fragmentation. A well-functioning interbank market would redistribute this liquidity evenly, as banks face a cost on holding it with the central bank.[6] As we can observe from Figure 5, the distribution of liquidity is quite asymmetric and persistent, where more vulnerable economies and more hardly hit by the sovereign debt crisis have a lower share of excess liquidity relative to the size of the banking sector. This suggests that risks of excessive fragmentation in the euro area persist and should continue to be monitored, especially following the large pandemic shock that may have different implications for these more vulnerable countries. Risks of fragmentation can be considered as an additional task of monetary policy exclusive to the euro area, but are not possible to measure in the same way as the policy stance. Without a common monetary area where policy

5. See, for instance, Hartmann and Smets (2018) or Banco de Portugal (2015) for further details on the measures taken.

6. From October 2019 onwards, the ECB implemented an exemption scheme on excess reserves with the objective of reducing the potential negative impact of a prolonged negative interest rate policy on banks and consequently on the transmission of monetary policy.

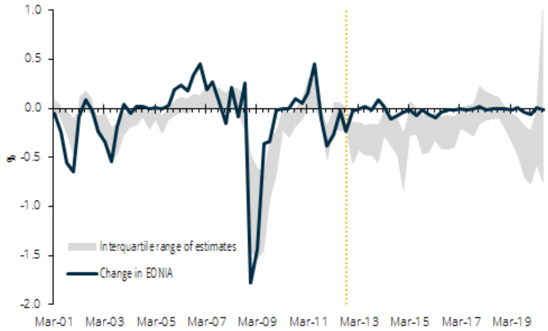

FIGURE 3: Orphanides rule prescription for the euro area

Interquartile range of estimates based on all possible combinations of forecasts on inflation an output from Eurosystem, European Commission, IMF, SPF, Consensus Economics and The Economist and using European Commission potential output or SPF long-run GDP growth. We selected only regressions that yielded positive estimates for inflation and output parameters and implied inflation target between 0% and 3%. Estimation uses data up to 2012Q2, marked by the vertical line.

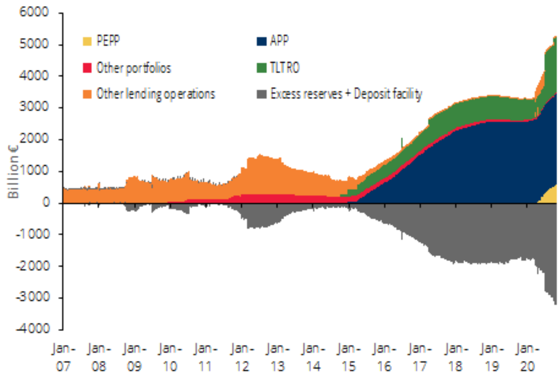

FIGURE 4: Eurosystem balance sheet items related to monetary policy

Source: Refinitiv

is transmitted uniformly, indicators of stance are not very informative of the actual conditions. Therefore, the ECB needs to monitor also the transmission mechanism across the euro area with different indicators and intervene whenever necessary in order to guarantee a uniform stance through the entire area.

In the last decade, most advanced economies central banks reached the zero lower-bound on interest rates, or even crossed it, as the ECB, raising the question about the exact effective lower bound. 'Shadow rates' are a way to use the short-term interest rate as the primary indicator of monetary policy stance, overcoming the lower bound constraint. They can be interpreted as the hypothetical nominal interest rate that would prevail in the absence of the lower bound that leads individuals to replace holdings of interest-bearing assets with cash. There are several possible methodologies to estimate shadow rates. However, results differ substantially across methodologies, which weakens their usefulness for policy purposes. Figure 6 shows the output for the euro area of two commonly used methodologies, namely those of Krippner (2013) and Wu and Xia (2017). Both estimates are based on term structure models where the lower bound is imposed through a non-linearity that could be equivalent to a call option on bonds. Given the consecutive cuts in the deposit facility rate in negative territory, estimates include the possibility of a time-varying effective lower bound.[7] The estimated rates fall below zero in 2012, when the ECB policy rate reached the zero-level, and stay at negative levels since then, suggesting that the information available about the state of the economy implies a worse outlook than the one implied by the nominal effective

7. Differences in the estimates can be due to both the methodologies and the data used (Wu and Xia (2017) uses the AAA-government bond yield curve while Krippner (2013) uses the OIS yield curve).

short-term interest rate. Again, unconventional measures are expected to have been filling this gap.

More broadly, and in practice, central banks look at an array of indicators to assess the monetary policy stance and do not focus specifically on policy rules. This is the subject of the next section.

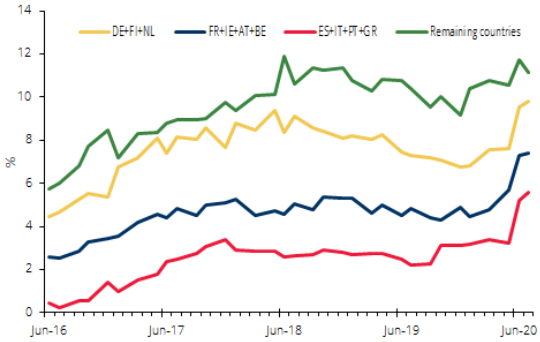

FIGURE 5: Excess reserves and deposit facility over total MFI assets

Source: ECB and author calculations

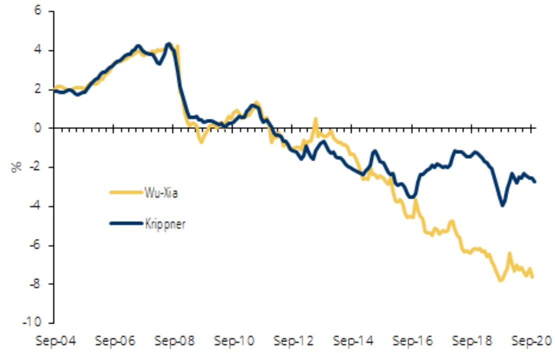

FIGURE 6: Shadow rate estimates for the euro area

Source: Refinitiv and LJKmfa

2. Financial conditions

Financial conditions are a relevant factor to understand the state of the economy, the spillovers of financial shocks to the real economy, and the transmission of monetary policy. For instance, tighter financial conditions per se, without any changes in the non-financial part of the economy, may call for policy makers to loosen policy. In reality, interactions in the economy are complex, and there are financial and nominal stability objectives that may not be compatible and may not imply a unique policy response. Consider for instance the case of an asset price boom following a productivity shock without risks to price stability. In this case, there is no reason for monetary policy to react as financial conditions may have eased significantly.

There are several channels of the transmission mechanism of monetary policy that work through the financial system (see, for instance, Boivin *et al.* 2010). Firstly, a change in interest rates changes consumers' incentives to save, and firms' investment decisions. Asset prices respond to changes in interest rates, and responses may differ depending on other factors, such as the degree of risk aversion. If we consider market imperfections, such as information asymmetries as in Bernanke and Gertler (1995), credit markets can amplify the effects of economic shocks. The idea is that an increase in interest rates increases the external finance premium of firms by reducing firms' net worth and by constraining credit supply. During the past decade, increased frictions in financial markets have generated financial stress and contributed to a significant impairment of financial conditions. Central banks expanded their sets of unconventional measures, both aiming at containing financial tensions and improving economic activity, and promoting price stability. Unconventional policy effects rely on the assumption of market frictions such as investors preferred habitats (Vayanos and Vila 2009). Assets are not perfect substitutes, thus the effect on prices of the purchases by central banks is not proportional across different types of assets. The pandemic crisis of 2020 has raised new challenges to policy makers and has, thus far, shown that a quick and determined policy response can contain financial market stress that can have real consequences.

In order to understand these relationships at each moment in time, central banks monitor financial conditions through several indicators. In what follows, we discuss in more detail why monitoring financial markets is relevant, and what type of information they reveal for policy assessment. The information set is quite extensive, so we present it in buckets that we will use later to compute a composite financial conditions indicator for the euro area, the four largest economies, and Portugal.

2.1. A selection of financial markets indicators

2.1.1. Money market

Traditionally, monetary policy is implemented in a way to steer short-term interest rates. The money market comprises transactions with maturities up to 1 year. This includes borrowing of liquidity between banks and other financial institutions, either secured (against collateral) or unsecured, but also includes derivatives transactions such as interest rate swaps or forward agreements. Arbitrage between the different instruments should ensure interest rates for the same maturity would be close, except for premia covering risk or liquidity. Very short-term unsecured transactions are those more similar to primary liquidity, so we would expect its rates to follow the policy rate closely. In the euro area, the benchmark rate usually monitored for this purpose was the EONIA (Euro Overnight Index Average), which is currently in the process of being discontinued and to be replaced by the €STR (euro short-term rate) by 2022. Unsecured interest rates for maturities of 3- or 6-month are also followed in order to assess the steering ability of policy and financing conditions to the economy, as these are usually benchmark rates to other financial instruments and to loans to households and non-financial corporations (Figure 7).

2.1.2. Bond market

Besides short maturities, longer maturities interest rates are also relevant to assess financial conditions in the economy. The yield curve, i.e., the relationship between the yields of a given debt security for different maturities, is a very relevant piece of information in this regard. Both the level and the slope of the yield curve provide information on financial conditions. The level at shorter maturities is usually given by money market rates like the ones discussed above. The slope is usually positive, reflecting the fact that investors seek higher yields for longer-term investments. When the spread between long and short-term interest rates narrows, this flattening of the yield curve typically indicates that investors expect economic weakness as it may signal that inflation and interest rates are expected to stay low for a long time.

Monetary policy aims firstly at influencing the risk-free yield curve, i.e., does not aim at influencing directly the credit risk component of bond yields, which reflects fundamentals that should be borne by investors and not be distorted by policy. In the euro area, the reference risk-free rates are given by the Overnight Index Swap (OIS), an agreement to exchange cash-flows against a predetermined benchmark overnight rate at the maturity of the contract. In OIS there is no exchange of the principal amount, which minimizes risk implied in the instrument. According to the expectations hypothesis, longer-term risk-free yields include two components: expectations component, and a term premium. The expectations component represents the average expectation of short-term interest rates over the maturity of the yield. The term premium represents compensation for investors for the risk of unexpected future changes in the short term yield. There are many different approaches used to separate the two components, and, unfortunately, they usually lead to different results. One popular approach is to estimate an affine term structure model imposing no-arbitrage conditions. A particular implementation, the results of which are shown in Figure 8, builds on the work of Joslin *et al.* (2011). Figure 8 shows the risk free yield curve for the euro on two recent dates, 18 March 2020, the announcement day of the Pandemic Emergency Purchase Programme (PEPP), and 5 June 2020, the day after the Governing Council where further measures were decided in response to the pandemic crisis. The yield curve shows a decrease in the slope, due to the decrease in the term premium component. This movement was a consequence of the PEPP announcement and implementation, which acts mostly by extracting duration risk with flexibility across jurisdictions. In shorter maturities, there was an increase in yields as a consequence of an increase in expectations. This was also in line with anecdotal evidence at the time when market participants began to anticipate in the early phase of the pandemic a cut in policy rates, which was reverted afterward following ECB officials' statements.

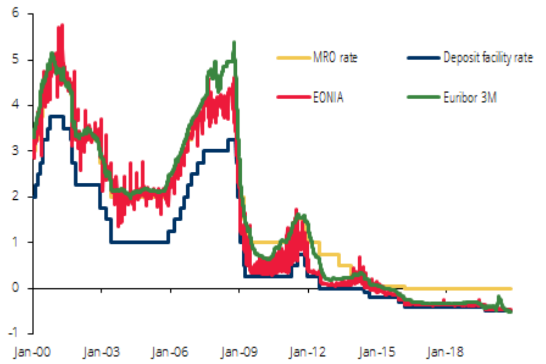

FIGURE 7: Policy and money market rates for the euro area

Sources: ECB and Refinitiv

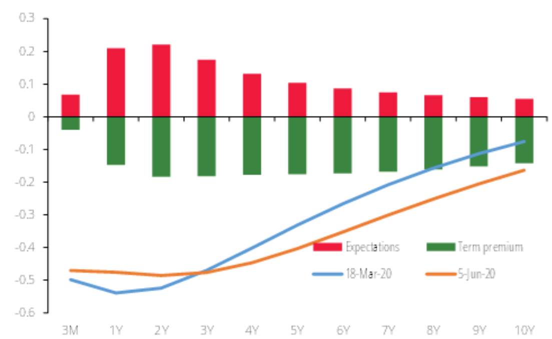

FIGURE 8: Risk-free yield curve for the euro area (OIS rates) and decomposition of changes between the dates

Source: Refinitiv and authors' calculations

The euro area has the particularity that the risk-free yield curve does not coincide with the sovereign debt yield curve, as in other major economies. Sovereign yields are relevant as indicators of financial conditions for the sovereign and benchmarks for the financial conditions of private agents. In the euro area, there is one yield curve for each government and the curves may differ substantially over time reflecting factors such as credit risk or 'flight-for-safety' movements. The relevance of monitoring these different market segments became clear during the sovereign debt crisis (Figure 9). The Governing Council of the ECB intervened in order to ensure policy transmission and the unity of the monetary union. Sovereign spreads in the euro area declined effectively following the President of the ECB, Mario Draghi's "whatever it takes" speech on the preservation of the euro in June 2012 and the launch of the Outright Monetary Transactions (OMT) programme. Thus, intra-area yield spreads are also relevant indicators of fragmentation and impairments in the transmission mechanism of monetary policy.

So far we have been discussing nominal rates but what is relevant for firms and households decisions is the real cost of funding, i.e. the nominal cost adjusted for inflation. In order to infer correctly the incentives for saving and investment, we need to either look at prices set in real terms or, as is more common, nominal prices deflated by the relevant deflator. In the euro area, there are inflation-indexed bonds that allow measuring the real interest rate as priced in the secondary markets. Alternatively, we may want to deflate nominal bonds by market expectations of inflation over the relevant term. Both are shown in Figure 10, where it is possible to observe a decreasing trend in these rates at least over the last decade.

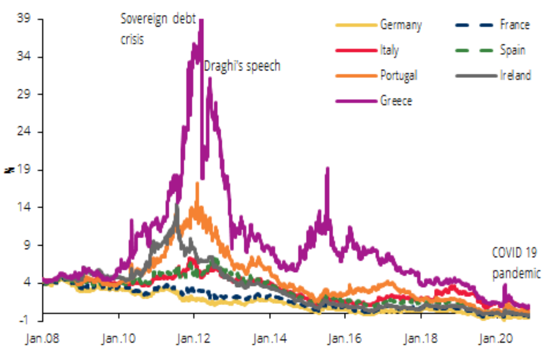

FIGURE 9: 10-year government bond yield rates in selected euro area countries

Source: Refinitiv

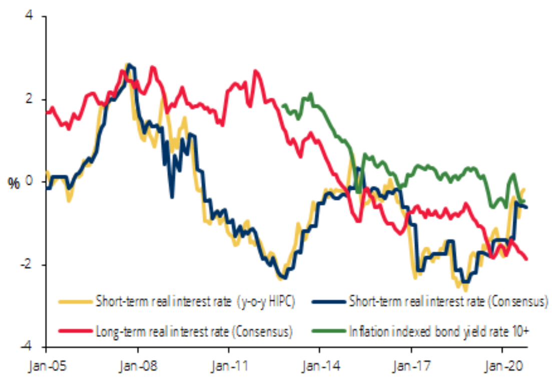

FIGURE 10: Real interest rates for the euro area

Sources: Bloomberg, Consensus Economics, Eurostat, Refinitiv and authors calculations
Note: Short-term deflated by the HICP y-o-y quarterly forecast or by the Consensus quarterly expectations; Long-term deflated by the average of Consensus inflation expectations over 10 years; IBOXX euro-inflation linked yield over 10 years.

Central bank rates and sovereign yields can be considered as benchmarks for the pricing of private sector assets. Corporations can finance themselves in bond markets and the costs at which they do so are an indication of the financial conditions they face. A type of indicator of this information is corporate bond spreads, i.e., the spread between the corporate bond yields and a benchmark or risk-free yield, usually government bonds. Given the importance of bank funding in the euro area and that these are the first link in the monetary policy transmission mechanism, it is particularly important to monitor banks' funding conditions through debt markets. The financial crisis of 2008 and the current pandemic crisis showed an immediate spike on corporate spreads, signaling tighter borrowing constraints, particularly for firms with a low rating (Figure 11).

2.1.3. *Equity market*

Firms can finance themselves via debt securities as mentioned above or via capital as equity issuance in public markets. Thus, information on equity markets is relevant to assess firms' financial conditions. Moreover, equity prices reflect also the expected value of the firm, so there is a relationship between the economic outlook and firms' net worth as given by their equity. This is the reason behind the fall in stock markets immediately after crises, in particular the recent pandemic crisis (Figure 12). But it should also be stressed that the prompt and effective reactions from monetary authorities by boosting liquidity contributed to stabilizing financial markets quite rapidly.

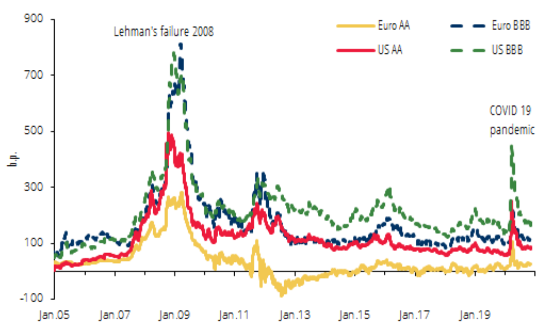

FIGURE 11: Corporate bond spreads in the US and euro area

Sources: Bloomberg - Merrill Lynch. 7-10 year corporates and government bond yields

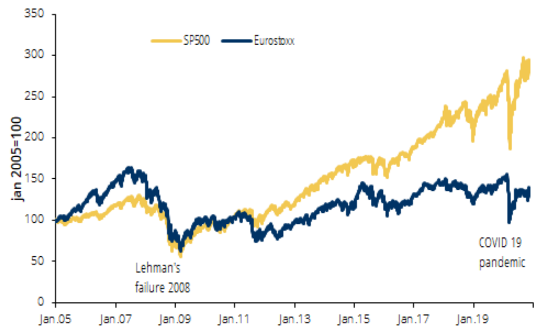

FIGURE 12: Equity indices in the US and euro area

Sources: Refinitiv

2.1.4. *Foreign exchange market*

Exchange rates influence financial conditions by affecting net exports and capital flows between countries. In the euro area, it is relevant to follow both the main currency pairs, as well as the effective exchange rates that aggregate bilateral exchange rates according to each currency's relevance for international trade. A euro appreciation against the US dollar, which is the currency denomination for oil prices, will turn oil cheaper, which can have a large and immediate impact on inflation. A euro appreciation against a basket of currencies turns euro area exports more expensive and imports cheaper.

2.1.5. *Risk and uncertainty*

Financial conditions can also be driven by risk considerations. For example, if the probability of default increases broadly following a negative shock, it is likely that this increase should be reflected in the cost of borrowing. There are some financial instruments that allow observing directly a market price for risk. Corporate Default Swaps (CDS) are one such instrument and represent a type of insurance against several default events by firms or sovereign entities. The CDS spread, i.e., the premium paid over the capital "insured" gives thus an indication of the level of credit risk of the entity.

Sometimes, it may happen that there is no change in the risk, i.e., the average probability of default in the future is the same, but there may be changes in the distribution of such events and investors may want to insure against a wider distribution. When uncertainty is higher, the number of possible states in the future is higher. In a world where we could cover all possible states by financial instruments, this would imply a larger number of transactions. This could be visible in the increased dispersion of prices of the financial assets, which by itself is costly. Uncertainty about the future thus normally contributes to the worsening of current conditions. The pricing model of options on financial instruments, such as equity or interest rate options, allows us to infer measures of future uncertainty, namely the implied volatility of the underlying asset. The VIX and VSTOXX are such measures of implied volatility for the S&P500 and the Eurostoxx50 equity indices, respectively, and are widely used as measures of expected market volatility in the near future.

2.1.6. Bank credit developments

Bank funding is of greater importance than market funding for euro area firms, especially SMEs. By focusing only on capital and bond markets, one would be ignoring this source of funding, that may counteract what happens in these markets, given that many firms and households have limited access to arbitrage in between financial and banking systems. An increase in the cost of borrowing through banks for firms and households could imply greater difficulties in funding their projects. The observed prices could reflect different compositions of credit portfolios, for instance, a greater demand for credit for riskier projects, but could also reflect changes in credit supply. The first factor (demand related) would reflect the usual credit business without the need for changes in pricing, while the second factor (supply related) may reflect changes in banks' preferences that may be needed to be taken into account by policy makers, as they could imply an unwanted tightening of credit standards. For example, in the current pandemic crisis banks reported in the Bank Lending Survey (BLS) broadly unchanged credit supply conditions to firms, thanks in large part to fiscal and monetary policy measures (ECB 2020). Thus, in the absence of such measures we we would have likely experienced an unwanted tightening in financial conditions through bank loan supply.

2.2. Financial conditions indices for the euro area, the four major euro area economies and Portugal

We develop financial conditions indices for the euro area as a whole, the four largest economies (Germany, France, Italy, and Spain) and Portugal. The indices aggregate information from 48 monthly financial series that are grouped into six categories: bank credit, bonds, equities, money markets, foreign exchange, and risk and uncertainty.

The selection of the variables and categories reflects the discussion in the previous subsection. The full list of variables is shown in Table A.1 of the appendix.[8] The country-specific indices are obtained similarly with some minor differences due to data availability. The FCIs can be seen primarily as a summary indicator for financial conditions, that can be used to describe the common developments among a wide set of financial market developments in a concise manner. As such, the FCIs are useful regardless of how much they tell us about other developments in the real economy or inflation or other objective variable.

The FCIs are constructed using principal component analysis, which is a standard method for constructing uncorrelated factors that represent common variations in multivariate data. Prior to estimation of the factors, most of the variables we use are transformed in some way, in order to make them more stable over time and improve the interpretability of the estimated factors. For instance, most of the interest rates we consider are expressed as spreads vis-a-vis the relevant benchmark rate (for example, the 10-year OIS in the case of long-term yields), while monetary and credit variables are expressed in terms of growth rates. Furthermore, all variables are normalized to have mean zero and standard deviation of one. The transformed variables are then used to extract a number of common factors that explain around 80% of the variability of the full data set. In the case of the euro area, the number of factors needed is 5, while for the individual countries we need 7 common factors.[9]

In addition to the aforementioned standard transformations of the data, we also consider a version of our data set where financial variables are orthogonalized with respect to measures of economic activity. This is achieved by regressing each financial variable on the current and lagged rates of inflation and industrial production growth and using the residuals in the construction of common factors. This step was pioneered by Hatzius *et al.* (2010) (see also Moccero *et al.* 2014) and is an attempt to remove the effect of the economic cycle on financial variables. In particular, it results in a measure of financial conditions that is relative to the typical economic conditions at the given stage of the business cycle.

Each FCI represents a weighted average of the extracted factors. We consider two weighting schemes that have been proposed in the literature: first, weighting the individual factors with the fraction of total variance explained by each one of them, and second, using the relative importance of each factor in jointly forecasting a-quarter-ahead GDP and inflation, following a Taylor rule-type of argument. As a result, we obtain three versions of FCI: two indices with financial variables unfiltered for macroeconomic developments and with different weights meaning the indices can be read as a summary of financial developments or by its potential impact on the

8. In addition to monthly series, our data set includes daily and quarterly series. We use monthly averages for the former and linearly interpolate the latter.

9. Factor loadings are rotated so that the correlation of each variable with one factor is maximized.

economic situation and one index with financial variables filtered by macroeconomic developments and aggregated according to factors' contribution to overall volatility.[10]

Figure 13 shows the three FCIs for the euro area, where an increase in the index corresponds to a tightening in financial conditions. The zero-level can be interpreted as the average financial conditions over the estimation period, i.e. since 2004. All indices capture major movements in the perceived financial conditions during the last 16 years, in particular, the GFC and the sovereign debt crisis. Nonetheless, some differences are worth highlighting. Indices weighted by the factors' contribution to overall volatility have a greater contribution from credit variables. Thus, the evolution of both indices is quite similar and captures both the GFC and the sovereign debt crisis in a similar way. On the other hand, when using unfiltered data with weights based on the forecasting performance, the sovereign debt crisis is interpreted as a period with greater tightening in financial conditions, due mainly to the evolution of bond markets, while the tightening during the GFC was mainly due to money market developments. This suggests a strong interaction between bond markets and macroeconomic conditions, where it may be difficult to disentangle the direction of influence between bond markets and macroeconomic conditions.

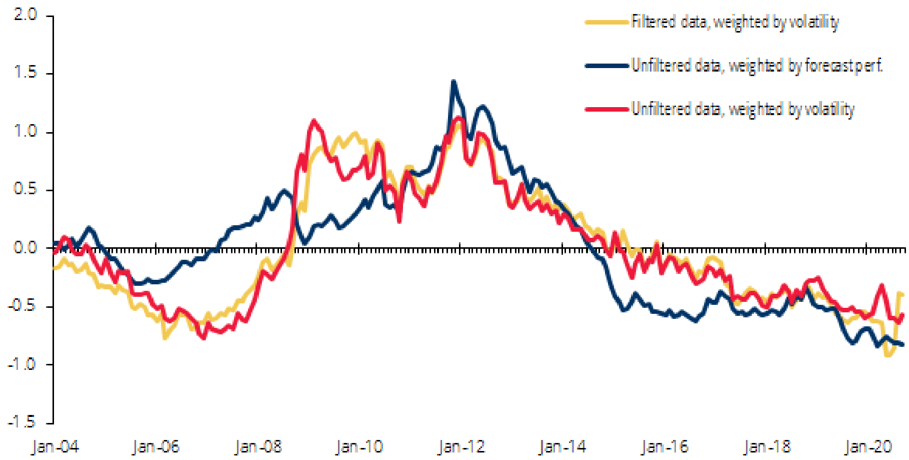

FIGURE 13: Financial conditions indices for the euro area
Last observation: September 2020.

The evolution of the indices in 2020 and the effect of the pandemic crisis is also different. Figure 14 shows the decomposition between categories of the changes in the FCIs between January and September 2020. The filtered FCI, better suited to measure "pure" financial conditions relative to the state of the economy, points to a tightening in conditions, coming mainly from bond market variables. Given the large negative shock to economic activity following the pandemics, past regularities would have suggested a stronger fall in yields in this market. The low interest rate environment close to the

10. There would be a fourth possible index with filtered values and factors weights based on forecasting performance. However, we find that the factors with filtered data contain very little information about future macroeconomic developments and we disregard this hypothesis.

effective lower bound is likely limiting the extent of the changes in these variables. The tightening coming from bond markets does not show up in the unfiltered FCIs. Comparing to the beginning of the year, the unfiltered weighted by volatility FCI, better suited to captures the agnostic summary of financial conditions, points to unchanged financial conditions. This reflects opposite evolution of different variables: risk and uncertainty measures point to a tightening in financial conditions, while the significant expansion of bank credit counterweighted such impact. When taking into account the different impact that the financial variables are likely to have on prices and real activity, captured by the third FCI shown in the figure, it seems that financial conditions were easier in September, relatively to January. This easing was mainly due to the low bond yields and spreads, especially in comparison to the historical average, while the easing contribution from bank credit is more muted then the other two indices.

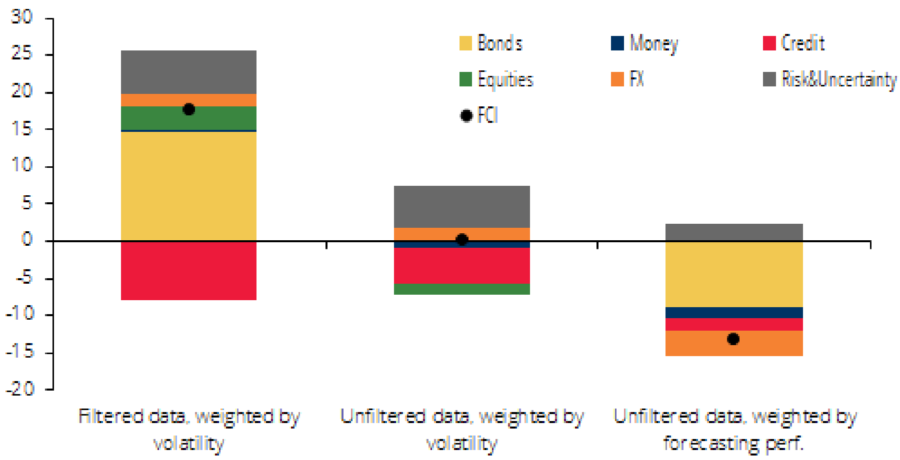

FIGURE 14: Decomposition of the changes in the financial conditions between January and September 2020

The country-specific indices are computed individually, meaning that levels are not comparable across countries, since the variables are normalized over the estimation period for each country. Figure 15 shows the computed FCI based on filtered data and using weights based on factors' contribution to overall volatility. The three indices share similarities with the euro area indices, so for exposition purposes we show here only one of the indices. The complementary of the analysis between the three indices also applies to the countries. The overall trend of the FCI is similar across countries, capturing the tighter period of the GFC and the sovereign debt crisis and the easing period that began with the launch of the ECB's Outright Monetary Transactions (OMT) in the second half of 2012. In all countries, credit conditions are very relevant as a driver for the financial conditions, but there are some differences in some periods. For instance, indicators of risk and uncertainty and bond markets were quite relevant for Spain and Italy between 2008 and 2012, reflecting the fact that these countries were more adversely hit by the sovereign debt crisis. Recently, since the beginning of the pandemic crisis, financial conditions, after taking into account macroeconomic developments have tightened in all countries. As mentioned before, this reflects the relatively muted evolution especially in bond markets and risk measures relative to the large economic shock to real activity and when compared with past regularities. On the other hand, credit conditions were particularly relevant for an easing contribution, reflecting the huge credit expansion that occurred since March, in large part thanks to government and monetary policy measures such as loan guarantees and the easing in TLTRO-III conditions.

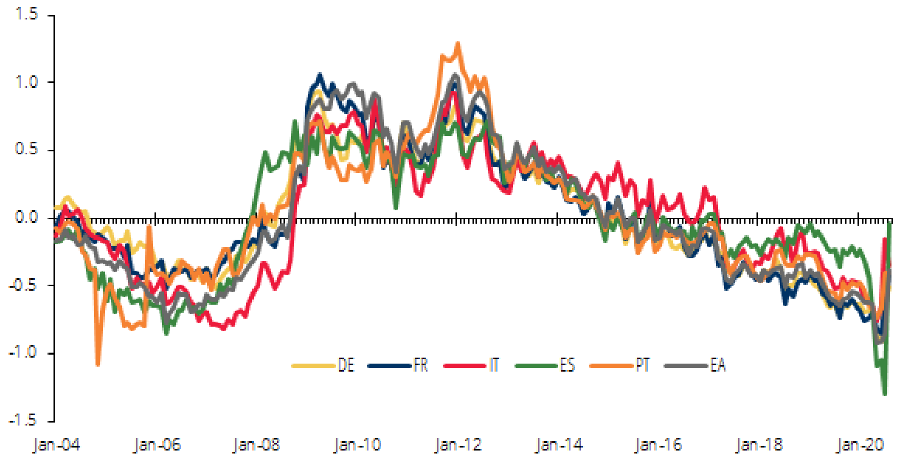

FIGURE 15: Financial conditions indices for selected countries of the euro area, based on filtered data and volatility weights

Note: The levels are not comparable between countries. Last observation: August 2020.

A comparison with our FCIs with other widely used FCI, such as the FCI by Bloomberg and Goldman Sachs, shows that all indices follow broadly a similar trend, with the exception of the pandemic period (Figure 16). The Bloomberg FCI is a simple average of variables on euro area money, bond, and equity markets to help assess the availability and cost of credit. The index is normalized relative to its pre-crisis levels, such that a negative (positive) level is interpreted as tighter (easier) conditions relative to the period before the crisis. The index computed by Goldman Sachs follows another common methodology of weighting variables according to their impact or their predictive power on a target variable, for instance, real GDP growth or inflation (Stehn *et al.* 2019).[11] Differences in the evolution between our FCIs and these indices reflect not only the wider set of variables that we include but also the methods applied in the computation, namely the procedure to take into account the feedback effect from macroeconomic conditions on financial variables and the weighting schemes.

There are several other FCI for the euro area, differing in the variables considered, the methodology used, and the frequency, for which some examples are mentioned next. Petronevich and Sahuc (2019) uses time-varying component weights, thus a change in the index can be due to either changes in the factors or to changes in their relative importance. Angelopoulou *et al.* (2014) construct an FCI for the euro area covering wide set of measures, going from prices to volumes, risk premia, and volatility and

11. The euro area Goldman Sachs index is a weighted average of nine countries FCIs, all constructed with the same methodology. Each country index is the weighted average of short and long-term rates, sovereign and corporate bond spreads, equity prices, and the euro exchange rate. The weights capture the effects of the variables on real GDP growth over a one-year horizon from a VAR model.

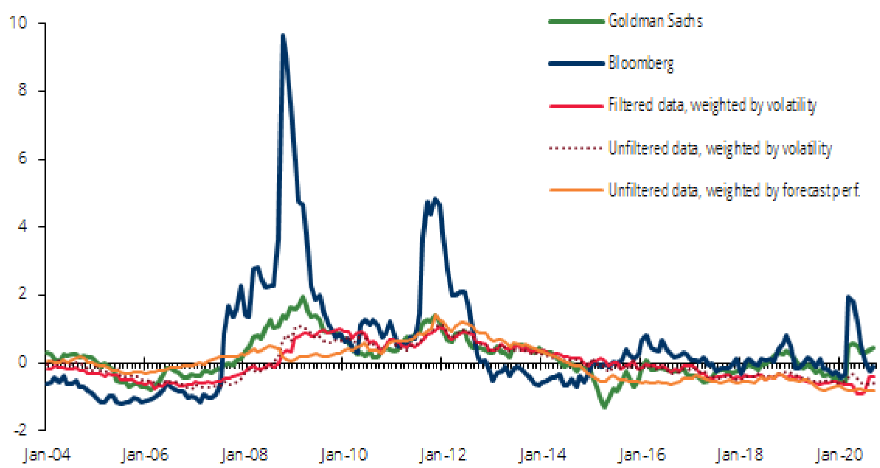

FIGURE 16: Comparison with Bloomberg and Goldman Sachs FCI for the euro area
Last observation: September 2020.

as well as qualitatively data from surveys, and monetary policy data. In this case, the interpretation of the FCI must take into account monetary policy itself, and it is not able to extract purely financial shocks. Moccero *et al.* (2014) try to overcome the latter issue by following Hatzius *et al.* (2010) methodology in computing a FCI for the euro area isolated from the impact of non-financial factors and based on the main sources of firms' external finance, i.e. the banking sector, the fixed income market, and equity markets. Kapetanios *et al.* (2018) go further ahead in the incorporation of macroeconomic factors by considering a large set of such variables, which they find to improve forecasts of real GDP.

3. Concluding remarks

Central banks take decisions on monetary policy based on their assessment of the policy stance at each moment in time. In this context, monetary policy stance can be considered as the contribution that monetary policy gives to economic developments in order to reach the central bank objective. Such contribution is also based on the several channels of the monetary policy transmission, i.e. the ways that monetary policy passes its impulses to the rest of the economy, whose interpretation can be based on a set of economic models. The real-world economy is far more complex than stylized economic models, and a great deal of uncertainty exists about the shocks hitting the economy, and how to measure them properly. Thus, a more conservative approach, making use of a wide set of information, is advisable. In this way, central banks make use of several indicators when assessing the policy stance, instead of relying on one simple rule. A rule-based approach has large benefits and can be complemented with the combination of different indicators that provide additional information. This has been especially useful in the last decade, as the GFC and the sovereign debt crisis have pushed policy rates to the effective lower-bound and monetary policy instruments have expanded greatly beyond interest rates, encompassing different types of unconventional measures.

We discussed policy rate rules and how different specifications may be useful to describe monetary policy decisions of central banks. A major shortcoming of such rules is the difficulty to account for the lower-bound of interest rates and unconventional monetary policy. This type of policy can be taken into account through balance-sheet and shadow rates approaches. Another lesson from the last decade was the importance of financial markets for policy transmission, reinforcing the need to follow and monitor financial conditions. We discussed how this can be done through both directly observed data and composite indicators. We have also presented new financial conditions indices that have the advantage of using a common methodology for the euro area, its four largest economies, and Portugal, and incorporating information from a wider set of variables than other indices.

Overall, the set of policy stance indicators discussed in this article is helpful in both supporting the policy decision and in understanding central banks' reaction function, but it is by no means exhaustive and the analysis is always subject to expert judgment. Moreover, the Eurosystem works under specific institutional circumstances that justify the need to have a different perspective on monetary policy stance relative to other major central banks. The different member states can be affected differently from economic shocks, in particular related to non-fundamental factors, that can lead to fragmentation within the euro area and impair the transmission mechanism. In order to ensure that monetary policy adequately transmits through the entire euro area, the Eurosystem has taken unprecedented decisions to respond to these challenges, which should also be taken into account when analysing the euro area monetary policy stance.

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Appendix

A.1. Variables used in the FCI

Variable	Geo	Source	Category	EA	DE	FR	IT	ES	PT
10Y yield Gov bond AAA	EA	SDW	Bonds	X					
10Y yield Gov	DE	Refinitiv	Bonds		X				
	FR	Refinitiv	Bonds			X			
	IT	Refinitiv	Bonds				X		
	ES	Refinitiv	Bonds					X	
	PT	Refinitiv	Bonds						X
10Y Gov spread to OIS	DE	Derived from Refinitiv	Bonds	X	X				
	FR	Derived from Refinitiv	Bonds	X		X			
	IT	Derived from Refinitiv	Bonds	X			X		
	ES	Derived from Refinitiv	Bonds	X				X	
	PT	Derived from Refinitiv	Bonds	X					X
Gov spread AAA 10Y 3M	EA	SDW	Bonds	X					
Gov spread 10Y 3M	DE	Derived from Refinitiv	Bonds		X				
	FR	Derived from Refinitiv	Bonds			X			
	IT	Derived from Refinitiv	Bonds				X		
	ES	Derived from Refinitiv	Bonds					X	
	PT	Derived from Refinitiv	Bonds						X
Corp AAA bond spread Gov	EA	Refinitiv	Bonds	X	X	X			
Corp BBB bond spread Gov	EA	Refinitiv	Bonds	X			X	X	X
Corp fin bond spread Gov	EA	Refinitiv	Bonds	X	X	X	X	X	X
Corp NFC bond spread Gov	EA	Refinitiv	Bonds	X	X	X	X	X	X
ILS 1Y	EA	Refinitiv	Bonds	X	X	X	X	X	X
ILS 5Y	EA	Refinitiv	Bonds	X	X	X	X	X	X
MFI debt sec growth	EA	SDW	Bonds	X					
	DE	SDW	Bonds		X				
	FR	SDW	Bonds			X			
	IT	SDW	Bonds				X		
	ES	SDW	Bonds					X	
	PT	SDW	Bonds						X
NFC debt sec growth	EA	SDW	Bonds	X					
	DE	SDW	Bonds		X				
	FR	SDW	Bonds			X			
	IT	SDW	Bonds				X		
	ES	SDW	Bonds					X	
	PT	SDW	Bonds						X
M1	EA	SDW	Credit	X	X	X	X	X	X
M2	EA	SDW	Credit	X	X	X	X	X	X
M3	EA	SDW	Credit	X	X	X	X	X	X
NFC loans growth	EA	SDW	Credit	X					
	DE	SDW	Credit		X				
	FR	SDW	Credit			X			
	IT	SDW	Credit				X		
	ES	SDW	Credit					X	
	PT	SDW	Credit						X
Housing loans growth	EA	SDW	Credit	X					
	DE	SDW	Credit		X				
	FR	SDW	Credit			X			
	IT	SDW	Credit				X		
	ES	SDW	Credit					X	
	PT	SDW	Credit						X
Consumption loans growth	EA	SDW	Credit	X					
	DE	SDW	Credit		X				
	FR	SDW	Credit			X			
	IT	SDW	Credit				X		
	ES	SDW	Credit					X	
	PT	SDW	Credit						X
NFC (CoB) credit spread	EA	Derived from Refinitiv and SDW	Credit	X					
	DE	Derived from Refinitiv and SDW	Credit		X				
	FR	Derived from Refinitiv and SDW	Credit			X			
	IT	Derived from Refinitiv and SDW	Credit				X		
	ES	Derived from Refinitiv and SDW	Credit					X	
	PT	Derived from Refinitiv and SDW	Credit						X
NFC (up to 0.25ml) credit spread	EA	Derived from Refinitiv and SDW	Credit	X					
	DE	Derived from Refinitiv and SDW	Credit		X				
	FR	Derived from Refinitiv and SDW	Credit			X			
	IT	Derived from Refinitiv and SDW	Credit				X		
	ES	Derived from Refinitiv and SDW	Credit					X	
	PT	Derived from Refinitiv and SDW	Credit						X
Housing (CoB) credit spread	EA	Derived from Refinitiv and SDW	Credit	X					
	DE	Derived from Refinitiv and SDW	Credit		X				
	FR	Derived from Refinitiv and SDW	Credit			X			
	IT	Derived from Refinitiv and SDW	Credit				X		
	ES	Derived from Refinitiv and SDW	Credit					X	
	PT	Derived from Refinitiv and SDW	Credit						X
Consumption credit spread	EA	Derived from Refinitiv and SDW	Credit	X					
	DE	Derived from Refinitiv and SDW	Credit		X				
	FR	Derived from Refinitiv and SDW	Credit			X			
	IT	Derived from Refinitiv and SDW	Credit				X		

Variable	Geo	Source	Category	EA	DE	FR	IT	ES	PT
	ES	Derived from Refinitiv and SDW	Credit					X	
	PT	Derived from Refinitiv and SDW	Credit						X
Credit standards to NFC	EA	SDW	Credit	X					
	DE	SDW	Credit		X				
	FR	SDW	Credit			X			
	IT	SDW	Credit				X		
	ES	SDW	Credit					X	
	PT	SDW	Credit						X
Credit standards for house	EA	SDW	Credit	X					
	DE	SDW	Credit		X				
	FR	SDW	Credit			X			
	IT	SDW	Credit				X		
	ES	SDW	Credit					X	
	PT	SDW	Credit						X
Credit standards for consumption	EA	SDW	Credit	X					
	DE	SDW	Credit		X				
	FR	SDW	Credit			X			
	IT	SDW	Credit				X		
	ES	SDW	Credit					X	
	PT	SDW	Credit						X
Eurostoxx to GDP	EA	Derived from Refinitiv and SDW	Equities	X					
Eurostoxx Consumer services ratio	EA	Derived from Refinitiv	Equities	X					
Eurostoxx Financials ratio	EA	Derived from Refinitiv	Equities	X					
Eurostoxx Technology ratio	EA	Derived from Refinitiv	Equities	X					
Eurostoxx Telecom ratio	EA	Derived from Refinitiv	Equities	X					
Eurostoxx Utilities ratio	EA	Derived from Refinitiv	Equities	X					
DAX to GDP	DE	Derived from Refinitiv and SDW	Equities		X				
DAX AUTOMOBILE ratio	DE	Derived from Refinitiv	Equities		X				
DAX CONSTRUCTION ratio	DE	Derived from Refinitiv	Equities		X				
DAX FINANCIAL SERVICES ratio	DE	Derived from Refinitiv	Equities		X				
DAX INDUSTRIAL ratio	DE	Derived from Refinitiv	Equities		X				
DAX TECHNOLOGY ratio	DE	Derived from Refinitiv	Equities		X				
CAC to GDP	FR	Derived from Refinitiv and SDW	Equities			X			
EURONEXT CAC CONSUMER SVS ratio	FR	Derived from Refinitiv	Equities			X			
EURONEXT CAC FINANCIALS ratio	FR	Derived from Refinitiv	Equities			X			
EURONEXT CAC TELECOM ratio	FR	Derived from Refinitiv	Equities			X			
EURONEXT CAC UTILITIES ratio	FR	Derived from Refinitiv	Equities			X			
MIB to GDP	IT	Derived from Refinitiv and SDW	Equities				X		
FTSE ITALY CONSUMER SVS ratio	IT	Derived from Refinitiv	Equities				X		
FTSE ITALY FINANCIALS ratio	IT	Derived from Refinitiv	Equities				X		
FTSE ITALY INDUSTRIALS ratio	IT	Derived from Refinitiv	Equities				X		
FTSE ITALY TELECOM ratio	IT	Derived from Refinitiv	Equities				X		
IBEX to GDP	ES	Derived from Refinitiv and SDW	Equities					X	
SPAIN-DS Consumer Staples ratio	ES	Refinitiv	Equities					X	
SPAIN-DS Financials ratio	ES	Refinitiv	Equities					X	
SPAIN-DS Industrials ratio	ES	Refinitiv	Equities					X	
SPAIN-DS Technology ratio	ES	Refinitiv	Equities					X	
PSI to GDP	PT	Derived from Refinitiv and SDW	Equities						X
EURONEXT PSI CONSUMER SVS ratio	PT	Derived from Refinitiv and SDW	Equities						X
EURONEXT PSI FINANCIALS ratio	PT	Derived from Refinitiv and SDW	Equities						X
EURONEXT PSI INDUSTRIALS ratio	PT	Derived from Refinitiv and SDW	Equities						X
EURONEXT PSI UTILITIES ratio	PT	Derived from Refinitiv and SDW	Equities						X
NFC shares growth	EA	SDW	Equities	X					
	DE	SDW	Equities		X				
	FR	SDW	Equities			X			
	IT	SDW	Equities				X		
	ES	SDW	Equities					X	
	PT	SDW	Equities						X
EER-19	EA	SDW	FX	X	X	X	X	X	X
USD/EUR	EA	SDW	FX	X	X	X	X	X	X
GBP/EUR	EA	SDW	FX	X	X	X	X	X	X
CHF/EUR	EA	SDW	FX	X	X	X	X	X	X
JPY/EUR	EA	SDW	FX	X	X	X	X	X	X
USD volatility 3M	EA	Refinitiv	FX	X	X	X	X	X	X
GBP volatility 3M	EA	Refinitiv	FX	X	X	X	X	X	X
EONIA	EA	Refinitiv	Money	X	X	X	X	X	X
3M Euribor	EA	Refinitiv	Money	X	X	X	X	X	X
3M Euribor-OIS spread	EA	Derived from Refinitiv	Money	X	X	X	X	X	X
CDS Europe	EA	Refinitiv	Risk & Uncertainty	X	X	X	X	X	X
CDS senior financial	EA	Refinitiv	Risk & Uncertainty	X	X	X	X	X	X
Sov CDS	DE	Refinitiv	Risk & Uncertainty		X				
	FR	Refinitiv	Risk & Uncertainty			X			
	IT	Refinitiv	Risk & Uncertainty				X		
	ES	Refinitiv	Risk & Uncertainty					X	
	PT	Refinitiv	Risk & Uncertainty						X
EUR volatility	EA	Refinitiv	Risk & Uncertainty	X	X	X	X	X	X
Vstoxx	EA	Refinitiv	Risk & Uncertainty	X			X	X	X
VDAX	DE	Refinitiv	Risk & Uncertainty		X				
CAC40 VOLATILITY INDEX	FR	Refinitiv	Risk & Uncertainty			X			

Note: Country columns marked mean that the variable is used for the country FCI.

Non-technical summary

January 2021

On the measurement of Portuguese firms' fixed operating costs

Sónia Félix, Pedro Moreira and Nuno Silva

The current Covid-19 pandemic outbreak has emphasized the relevance of firms' fixed operating costs in their capacity to weather an abrupt decline in sales. A firm's fixed operating cost is usually defined as a cost that does not change with its sales. These costs affect the firms' capacity to weather adverse shocks. However, a firm may have substantial fixed costs and still have the flexibility to reduce them at a low cost and in a relatively short time period. This flexiblity depends, *inter alia*, on how extensively the firm uses fixed-term or permanent contracts, outsourcing or leasing contracts. In this article we take these dimensions of flexibility into account and estimate fixed operating costs as the expected operating costs next year if sales were zero. We estimate fixed operating costs at the firm level for the period between 2006 and 2018, exploring the heterogeneity by firm size and sector of economic activity. The estimates show that on average fixed operating costs of Portuguese firms account for approximately 15% of their sales. Figure 1 shows that the firms' fixed operating costs are substantially heterogeneous, reflecting the differences on the production technology of each sector and firm idiosyncratic characteristics.

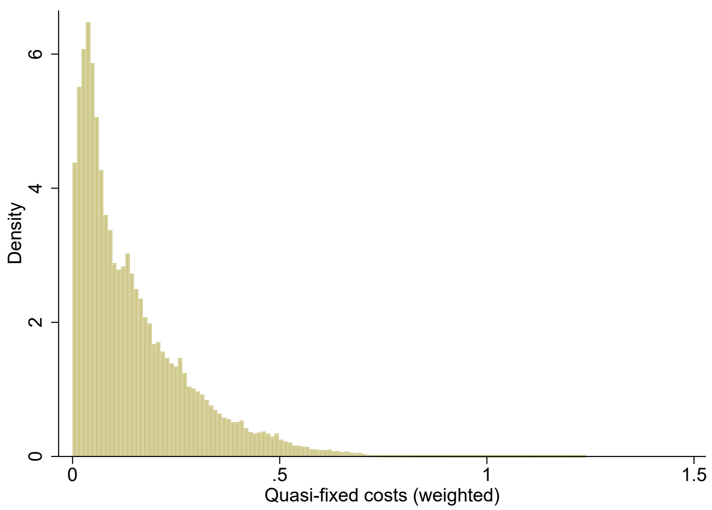

FIGURE 1: Distribution of firm estimated fixed operating costs scaled by one-year lagged sales (weighted by the firm's gross profit).

We explore the distribution of the estimated fixed operating costs by firm size and sector of economic activity. We find that, on average, fixed operating costs of very small firms account for roughly 18% of their sales while for larger firms they account for 13% of their sales. Fixed operating costs vary substantially across sectors (see Table 1). This heterogeneity reflects the asymmetry in the firm's management flexibility, which is highly dependent on the production scheme of the firms in each sector. According to the estimates, the sectors with higher fixed operating costs are mostly related with services, namely accommodation and food services (31%), human health (28%), and other services (23%). In turn, the sectors with lower ratios are the wholesale and retail trade (9%) and transportation and storage (10%). Recent evidence shows that the pandemic has severely affected the firms in the accommodation and food services sector, which is one of the sectors with highest fixed operating costs over sales ratio.

Sector of economic activity	**N**	**Mean**	**St. dev.**	**Q1**	**Q2**	**Q3**
Accommodation and food services	141,566	0.31	0.16	0.20	0.29	0.42
Human health	74,629	0.28	0.13	0.18	0.27	0.37
Real estate	24,773	0.26	0.20	0.12	0.22	0.35
Electricity and gas	240	0.25	0.15	0.13	0.22	0.38
Other services	39,188	0.23	0.15	0.12	0.20	0.30
Water supply	2,172	0.21	0.18	0.06	0.13	0.34
Education	13,654	0.20	0.10	0.13	0.19	0.26
Mining and quarrying	3,672	0.18	0.12	0.09	0.16	0.22
Agriculture	38,237	0.17	0.14	0.05	0.14	0.24
Professional, scientific and technical	117,816	0.17	0.16	0.04	0.13	0.27
Construction	89,199	0.13	0.14	0.03	0.06	0.21
Manufacturing	171,127	0.13	0.11	0.05	0.11	0.17
Information and communication	17,652	0.13	0.11	0.05	0.10	0.19
Transportation and storage	55,825	0.10	0.12	0.03	0.05	0.13
Wholesale and retail trade	335,850	0.09	0.08	0.03	0.07	0.14
Total	1,125,600	0.15	0.14	0.04	0.10	0.21

TABLE 1. Main summary statistics by sector of economic activity: fixed operating costs to sales ratio

Notes: Estimated fixed operating costs scaled by one-period lagged sales, weighted by the firm's gross profit. The sampling period goes from 2006 to 2018. N denotes the number of observations, Q1 and Q3 correspond to the first and third quartiles, respectively, and Q2 corresponds to the median.

Finally, we show a positive correlation between our estimates of the fixed operating costs to sales ratio and the share of employee expenses on total operating costs (0.17). In contrast, we find a negative correlation between the fixed operating costs to sales ratio and the share of costs of goods sold and material consumed (-0.23). These results are reassuring in the sense that the cost of goods sold are more related to the production scheme of each firm and sector while employee expenses are more sticky.

On the measurement of Portuguese firms' fixed operating costs

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Abstract
A firm's fixed operating cost is usually defined as a cost that does not change with its sales. These costs affect the firms' capacity to weather adverse shocks. However, a firm may have substantial fixed costs and still have the flexibility to reduce them at a low cost and in a relatively short time period. In this article we take the firms' flexibility into account and estimate fixed operating costs as the expected operating costs next year if sales were zero. We estimate fixed operating costs at the firm level for the period between 2006 and 2018, exploring the heterogeneity by firm size and sector of economic activity. The estimates show that on average fixed operating costs of Portuguese firms account for approximately 15% of their sales. We document two main findings. First, the fixed operating costs to sales ratio of smaller firms is higher than that of larger firms. Second, this ratio is higher in sectors of economic activity related to services. These results are linked to the operating costs structure of firms, namely the share of employee expenses, costs of goods sold, and supplies and external services on total operating costs. (JEL: D22, D25, G32)

1. Introduction

From a theoretical perspective, the notion of a firm's fixed cost is apparently straightforward. At a first glance, a fixed cost is a cost that does not change with the amount of goods or services produced or sold by the firm. Intuitively, it corresponds to the intercept of the firm's cost function. The examples of fixed costs in textbooks typically include salaries, insurance contracts, property taxes, rents, and interest payments. The first four examples are usually referred to as fixed operating costs, while the latter is a financial fixed cost. Implicit in this definition of a fixed cost is the idea that firms are not able to adjust their output capacity to respond to adverse shocks. However, a firm may have substantial fixed costs and still have the flexibility to reduce them at a low cost and in a relatively short time period. This dimension of

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flexibility implies that from a risk management perspective, a cost is only fixed if it is too costly to avoid it (see, for example, Gu *et al.* 2018; Reinartz and Schmid 2016). Throughout the analysis in this article we take the risk management perspective of a fixed cost.

Fixed costs play a crucial role in corporate risk management. Similarly to households, who know that their fixed monthly expenditures reduce their capacity to adjust to adverse shocks (for example, unemployment), corporate managers know that fixed costs, either operating or financial, reduce their capacity to weather negative economic shocks. This likely hampers the firm's investment decisions, market share and funding costs, precluding the firm from making profit maximizing choices (see, for example, Mauer and Triantis 1994). Ultimately, very high fixed costs may reduce the firm's chances of survival. Indeed, it is widely documented in the asset pricing literature that fixed costs amplify the effect of output shocks on profitability, a mechanism that is termed leverage in the literature (see, for example, Lev 1974; Mandelker and Rhee 1984). In this framework, financial and fixed operating costs are associated with financial and operating leverage, respectively. All else equal, the higher the operating or financial leverage of a firm, the higher the risk premium.

The importance of financial fixed costs to firms' performance is well established in the literature. A large class of corporate finance and credit risk theoretical models builds on the firm's fixed interest expenses to determine its default boundary, which is the level of assets or earnings below which the firm closes (Leland 1994; Goldstein *et al.* 2001). Empirical models of firm's default prediction usually include interest coverage or a similar variable as a determinant. Given the macroeconomic importance of firms' financial leverage, corporate fixed interest expenditures are permanently monitored by international institutions, namely by the International Monetary Fund (IMF).

Conversely, despite the importance of fixed operating costs for corporate risk management, they have received relatively little attention in the theoretical and empirical credit risk literature. This may be due both to conceptual and measurement challenges. In contrast to interest expenses, that are clearly stated in the firm's income statement and not flexible by definition, fixed operating costs are not grouped into a specific account and are rarely provided in the firm's financial reports.[1] A common popular way to proxy for fixed operating costs is to use the accounting item termed selling, general, and administrative costs (SG&A), which include those costs that are not directly related with the production/service process.[2] This choice is based on empirical studies that show that SG&A are relatively sticky (i.e. they increase more with the

1. Note that in the case of a firm's interest expenses, the firm does not have the capacity to unilaterally reduce its fixed financial costs, unless it reduces its external debt. However, reducing debt can only be achieved by selling assets, which is often associated with fire sale losses, or by raising external capital.

2. The balance-sheet dataset we use in this article does not allow us to calculate the SG&A for Portuguese firms. This is mainly because, in contrast to the U.S. GAAP, labor costs incurred in the production of goods are not part of the cost of goods sold in the Portuguese accounting system.

firm's expansions than they decrease with the firm's contractions).[3] Be that as it may, it is not unequivocal that SG&A fully capture the firm's flexibility in cost adjustment, most probably leading to an overestimation of the fixed operating costs. For example, SG&A do not differentiate firms that use more extensively permanent or fixed-term contracts, which is an important determinant of corporate flexibility (Donangelo *et al.* 2019). This emphasizes the importance of the firm's flexibility in determining whether fixed operating costs are associated with additional risk (Gu *et al.* 2018).

The current Covid-19 pandemic outbreak has severely affected firms across the globe. Kozeniauskas *et al.* (2020) document that the shocks to sales and employment of Portuguese firms were large on average, but heterogeneous across firms. Bartik *et al.* (2020) study the impact of the pandemic on small businesses and show that many small U.S. businesses were deeply affected by the current crisis. Their studies emphasize the financial fragility of many businesses, which will have to substantially reduce expenses, take on additional debt, and raise shareholders' capital to weather the economic disruptions caused by this unprecedented crisis. Ultimately, firms may have to declare bankruptcy due to the cash flow gap caused by the substantial decline in sales and the difficulty in adjusting their cost structure abruptly. The longer the pandemic will last, the more difficult will be for firms to weather the shock without major changes in their cost structure. In this context, the measurement of fixed operating costs has gained particular relevance. The fixed operating costs of firms affect their capacity to respond to the crisis and the willingness of their shareholders to provide financial assistance in case of distress, ultimately affecting corporate solvency.

In this article, we capitalize on a rich dataset that includes balance sheet and income statement information for virtually all Portuguese firms to estimate fixed operating costs at the firm level. We also explore the heterogeneity of these estimates by firm's size and sector of economic activity. Importantly, we take the risk management view of a fixed cost and consider that a cost is only fixed if the firm is not able to avoid it or reduce it in a relatively short time span and at a reasonable cost. In this sense, we closely follow Gu *et al.* (2018) and estimate the firm's fixed operating costs as those costs that do not scale with the contemporaneous sales. Therefore, we depart from the traditional definition of a fixed cost to take the firm's management options into account.

2. A brief literature review

Fixed operating costs amplify the effect of output shocks on firms' profitability, a mechanism that is termed *operating leverage* in the literature. We summarize the literature on fixed operating costs and operating leverage along three lines of research. The first strand of literature studies the links between operating leverage and the equity risk premium and finds that operating leverage is positively associated with systematic risk

3. Anderson *et al.* (2003) find that SG&A increase on average 0.55% per 1% increase in sales but decrease only 0.35% per 1% decrease in sales. In a similar vein, Chen *et al.* (2019) find that, on average, firms adjust their costs of goods sold (COGS) by 0.86% and their SG&A by 0.41% in response to a 1% decrease in sales revenue.

and equity returns (Lev 1974; Mandelker and Rhee 1984; García-Feijóo and Jorgensen 2010). Another strand of the literature documents a trade-off between operating and financial leverage (Kahl *et al.* 2019; Chen *et al.* 2019). Chen *et al.* (2019) consider that a firm's operating leverage is largely exogenous as it is determined by the production technology in its industry. A firm's financial leverage is then endogeneously set, such that a certain overall leverage level is attained. Finally, a third strand of literature studies the relationship between labor market frictions and the firms' degree of operating leverage. The work by Chen *et al.* (2011) shows that unionization is negatively related to operating flexibility in both labor and nonlabor production inputs, and that labor unions increase firms' costs of equity by decreasing firms' operating flexibility. Acabbi *et al.* (2019) document how the responsivess of firms to credit shocks is determined by their ability to adjust their labor costs. This labor (in)flexibility can amplify the effect of credit shocks and expose the firm to a higher liquidity risk, namely due to the presence of hiring, search, and firing costs and compensation rigidities. Finally, Donangelo *et al.* (2019) show that high labor share (*labor leverage*) firms have operating profits that are more sensitive to economic shocks and have higher expected returns.

Surprisingly, the literature on the impact of the firm's operating leverage on credit risk and the pricing of credit-related instruments is more scarce. A notable exception is the work of Favilukis *et al.* (2020) that builds on the idea that when wages are rigid, a negative economic shock leads to a rise in labor-induced operating leverage, as wages adjust too slowly and the labor share rises. This labor leverage effect increases firms' credit risk because precommitted wage payments make interest payments riskier. Two other exceptions include the studies of Chou *et al.* (2019) and Ayres and Blank (2017). Chou *et al.* (2019) posit that credit spreads are positively correlated with operating leverage only when fixed costs related to non-cash items, such as depreciations, are excluded. Ayres and Blank (2017) document that firms with higher operating leverage have significantly lower credit ratings. However, despite the importance of the firm's operating leverage for risk management, to the best of our knowledge, it is not commonly explicitly accounted for in default prediction models. An important result highlighted by Chen *et al.* (2019) is that both the probability of default from the Merton's model and the Ohlson's O-score are significantly positively correlated with operating leverage.

Embedded in this literature is the question of how to measure firms' operating leverage and the firms' amount of fixed operating costs. Four approaches take front stage to measure operating leverage. First, a prominent measure in the literature is the degree of operating leverage (DOL), which can be estimated in different ways. The most well-known method was suggested by Mandelker and Rhee (1984) and consists of a regression of the logarithm of the firm's earnings before interest and taxes (EBIT) on the logarithm of the firm's sales.[4] Second, an alternative point-in-time measure of operating leverage is the ratio of fixed assets to total assets (Ferri and Jones 1979). Third, more

4. This method was subsequently extended by O'Brien and Vanderheiden (1987) to account for the growth of the firm's EBIT to sales ratio and by García-Feijóo and Jorgensen (2010) to address the possibility of negative earnings.

recently, Kahl *et al.* (2019) propose computing the sensitivity of innovations in the growth rate of the firm's operating costs to innovations in the growth rate of the firm's sales. Finally, an alternative approach is to measure a firm's inflexibility as the historical range (maximum minus minimum) of its operating costs to sales ratio, scaled by the volatility of the firm's sales growth. Therefore, a smaller range suggests that the firm can adjust more easily its operating costs structure in response to changes in its profitability (Gu *et al.* 2018).

In what concerns the measurement of the amount of firms' fixed operating costs, setting these equal to SG&A is the most popular method because it is simple, transparent, and provides point-in-time estimates. However, as explained above, SG&A may not fully take into account the firm's management flexibility to respond to adverse shocks. Lev (1974) suggests that one way to take this flexibility into account is to estimate a regression of the firm's operating costs on sales. The estimated regression intercept would then be interpreted as the firm's fixed operating cost. More recently, Gu *et al.* (2018) estimate fixed costs as the next period's expected costs if sales were zero. In this article, we closely follow Gu *et al.* (2018) to estimate the fixed operating costs of Portuguese firms.

3. The structure of operating costs of Portuguese firms

We use the Central Balance Sheet (CBS) Database, which is a comprehensive dataset that covers the population of virtually all Portuguese nonfinancial corporations.[5] Firms report detailed balance-sheet and income statement information as well as information on several important variables. CBS data are available from 2006 to 2018.

In this section, we analyze the structure of firms' operating costs without distinguishing variable from fixed operating costs. From an accounting perspective, the firm's operating costs are mainly comprised of material consumed and costs of goods sold (COGS), supplies and external services, employee expenses and expenses of depreciations and amortizations. These accounting items are very different in terms of management flexibility. For example, while COGS tend to vary with output, employee expenses tend to be very costly to change in the short term. Supplies and external services is a very broad category that includes both rigid (for example, rents and long-term IT contracts) and flexible items (for example, energy and publicity). Depreciations and amortizations is a non-cashflow item that measures the cost of the deterioration of capital investment.

Figure 1 shows the importance of the four aforementioned operating cost categories in total operating costs by sector of economic activity. According to this decomposition, the cost structure of firms across sectors of economic activity is very heterogeneous. In general, the most important accounting items are either COGS or supplies and external

5. This database covers mandatory financial statements reported under the fulfillment of the Simplified Corporate Information - IES (Informação Empresarial Simplificada) - that consists of a system to collect firm non-consolidated mandatory annual economic, financial, and accounting information for a single moment and a single entity.

services, even though the relative importance of these items differs considerably across sectors of economic activity. On average, these items represent 34% and 37% of total operating costs, respectively. Employee expenses account for approximately 20% of total operating costs. Finally, even though depreciations represent only a small share of operating costs in most sectors, they represent a very important share of total costs of high capital-intensive firms.

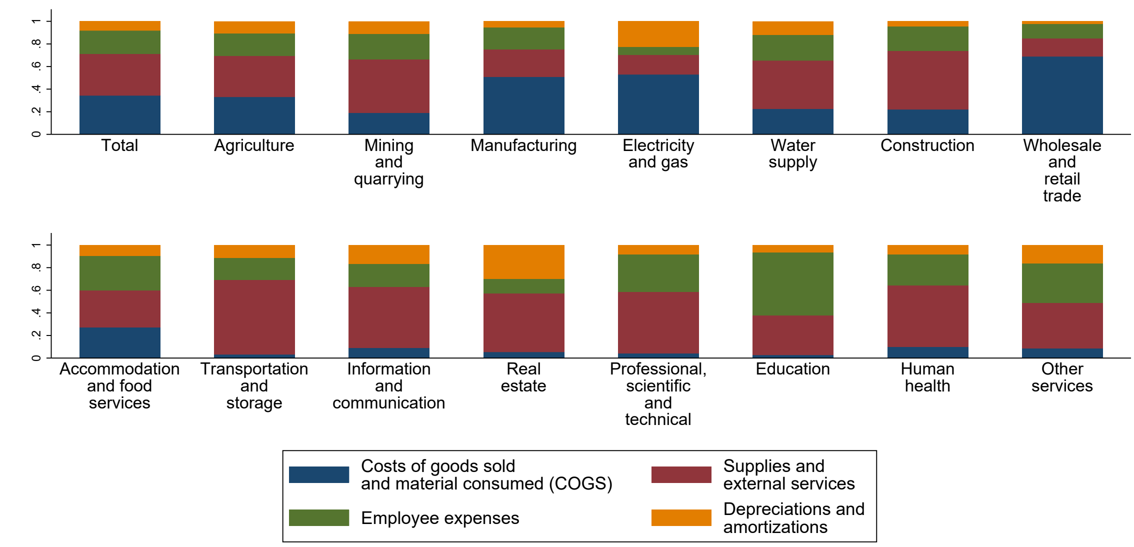

FIGURE 1: Operating costs decomposition.

Notes: The shares of each type of cost are computed at the firm level and then agregated at the sector level using the gross profit as weights.

A more thorough analysis of Figure 1 shows that COGS tend to represent a substantially higher share of operating costs in the case of wholesale and retail trade (69%) and manufacturing (51%). Interestingly, COGS are also very relevant in the case of the electricity and gas sector (53%). This result is mostly explained by the high weight in total operating costs of firms operating in the energy/gas trading and distribution businesses. Conversely, in the case of education and transportation and storage, COGS represent a very small share of total operating expenses (3%).

The supplies and external services item is the most important expense in the case of transportation and storage (66%), human health (55%), information and communication (54%), professional, scientific and technical activities (54%), construction (52%), and real estate (52%). In the case of transportation and storage, this may be partly related to fuel costs. In the five other sectors, a natural guess is that firms operating in these sectors rely more heavily on outsourcing.

Employee expenses represent an important share of total operating costs in the case of education (56%), other services (35%), professional, scientific and technical activities (33%), accommodation and food services (30%), and human health (27%). Furthermore, employee expenses represent only 19% of total operating expenses in the manufacturing sector, being less relevant than supplies and external services. Electricity and gas and wholesale and retail trade are the sectors in which employee expenses have less importance in terms of total operating costs.

Finally, the depreciations share on total operating costs varies from about 2% in the case of the wholesale and retail trade to approximately 30% in the case of real estate. The weight of depreciations in total operating costs in the electricity and gas is 23% and in the information and communication, and other services is approximately 16%. Interestingly, depreciations are more relevant in the professional, scientific and technical activities, and accommodation and food services sectors than in the manufacturing sector.

4. Firms' fixed operating costs: an econometric approach

In this article, we aim at measuring the fixed operating costs at the firm level. We take the risk management view of a fixed cost and consider that a cost is only fixed if the firm is not able to avoid it or reduce it in a relatively short time span and at a reasonable cost.

We measure fixed operating costs using the regression-based methodology proposed by Gu *et al.* (2018). Intuitively, in their framework, fixed operating costs are those costs that do not scale with the firm's contemporaneous sales. In contrast to using accounting items to proxy for fixed operating costs, this methodology takes firms' flexibility into account. This dimension of flexibility of a fixed cost has led the authors to use the terminology quasi-fixed costs (QFC). In what follows next, the expressions fixed operating costs and quasi-fixed operating costs are used interchangeably.

The baseline empirical specification to be estimated can be written as:

$$OpCost_{i,t} = a_i + b_j OpCost_{i,t-1} + c_j Sales_{i,t} + d_j Sales_{i,t-1} + \varepsilon_{i,t} \tag{1}$$

where the dependent variable $OpCost_{i,t}$ is the operating cost of firm i in year t. The independent variables are the one-period lagged firm's operating cost, the firm's contemporaneous and one-period lagged sales. The term a_i is a firm fixed effect and $\varepsilon_{i,t}$ is a disturbance term. The intercept is estimated at the firm level and the slope coefficients b_j, c_j, and d_j are estimated at the sector level j using a linear regression model with one-interacted high dimensional fixed effect (Guimarães and Portugal 2010). The high dimensional fixed effect considered to estimate the slope coefficients is the 5-digit classification of economic activities (*j*) for identification purposes. This empirical specification separates the impact of contemporaneous and one-year lagged sales on operating costs. Therefore, it allows us to estimate the impact of shocks in sales on firms' operating costs.[6]

6. We restrict the sample to firms with at least 5 years of observations and require that the absolute value of yearly growth rates of firm's operating costs, sales, and assets are no more than 75%. We also restrict the sample to 5-digit sectors of economic activity with at least 50 observations. We trim at the first and 99 percentiles the estimated 5-digit sector specific slopes and QFC to sales ratio in order to avoid too much sampling error. We end up with a sample comprised of about 620 different 5-digit sectors.

Specifically, the predicted fixed costs next period is the regression intercept plus the contribution of the lagged variables. Then, the predicted quasi-fixed costs in year t can be computed through the following expression:

$$QFC_{i,t} = a_i + b_j OpCost_{i,t-1} + d_j Sales_{i,t-1} \tag{2}$$

According to equation (2), QFC are the expected operating costs next period in case contemporaneous sales were zero. The distribution of the firm's QFC scaled by (one-period lagged) sales is depicted in Figure 2.[7] The main summary statistics are reported in Table 1. Figure 2 shows that the QFC of firms are substantially heterogeneous. The distribution is skewed to the right, with mean values roughly 5 percentage points above the median values.

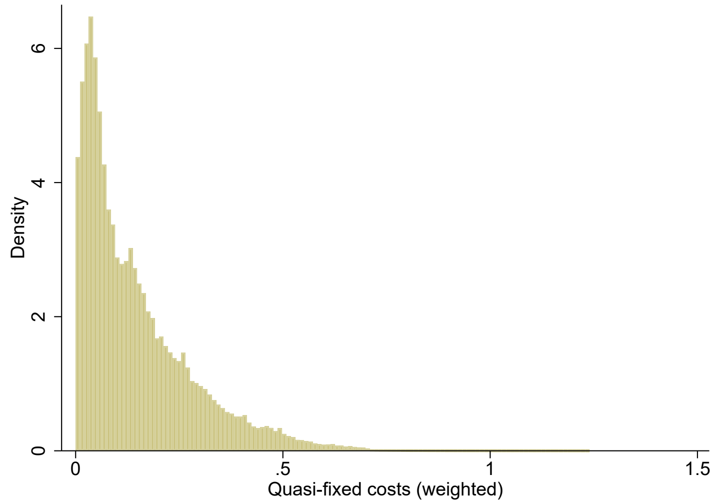

FIGURE 2: Distribution of firm estimated QFC scaled by one-year lagged sales (weighted by the firm's gross profit).

Notes: We restrict the sample to observations with non-negative estimated QFC to sales ratio.

The results reported in Table 1 show that, on average, fixed operating costs are approximately 15% of the firm's sales. This estimate is virtually the same if we instead scale the QFC by the firm's total operating costs. Using the same econometric approach, Gu *et al.* (2018) rely on Compustat data, which is mostly comprised of large firms, and estimate that fixed operating costs account for 17% of sales of U.S. firms.

Next, we explore the distribution of the estimated firm quasi-fixed costs by firm size and sector of economic activity. These results are shown in Tables 2 and 3, respectively. We show that on average smaller firms have a higher QFC to sales ratio. In particular, on average, the fixed operating costs of very small firms account for 18% of their sales while fixed operating costs of larger firms account for 13% of their sales. This finding may be

7. The histograms of the estimates $\widehat{a}_i, \widehat{b}_j, \widehat{c}_j$, and $\widehat{d}_j$ are available upon request. We restrict the histogram to non-negative estimates of the QFC to sales ratio. The negative estimates account for roughly 10% of the observations and may be due to measurement error.

	Count	Mean	St. dev.	Q1	Q2	Q3
$QFC_t/Sales_{t-1}$	1,125,600	0.15	0.14	0.04	0.10	0.21

TABLE 1. Main summary statistics: QFC to sales ratio

Notes: Estimated QFC scaled by one-period lagged sales, weighted by the firm's gross profit. The sampling period goes from 2006 to 2018. We restrict the sample to observations with non-negative estimated QFC to sales ratio. N denotes the number of observations, Q1 and Q3 correspond to the first and third quartiles, respectively, and Q2 corresponds to the median.

partly explained by economies of scale (i.e. an increase in the production scale leads to a reduction in the average cost per unit), which occur due to the dilution of fixed costs. Therefore, smaller firms may have a higher fixed operating costs to sales ratio because they benefit less from economies of scale. This result is in line with the predictions of Glover *et al.* (2011)'s model, in which a decrease in the optimal firm size leads to higher operating leverage due to the presence of fixed costs. A concurrent reason may be that larger firms outsource a larger part of their costs, which gives them more flexibility to adjust. Moon and Phillips (2020) analyse a database of purchase contracts in the U.S. and find that larger firms tend to resort more to outsourcing than smaller firms.

Firm's size	**N**	**Mean**	**St. dev.**	**Q1**	**Q2**	**Q3**
Very small firms	892,911	0.18	0.15	0.07	0.14	0.26
Small firms	197,977	0.14	0.13	0.05	0.11	0.21
Medium firms	31,178	0.14	0.13	0.04	0.10	0.20
Large firms	3,534	0.13	0.13	0.03	0.08	0.18
Total	1,125,600	0.15	0.14	0.04	0.10	0.21

TABLE 2. Main summary statistics by firm size: QFC to sales ratio

Notes: Estimated QFC scaled by one-period lagged sales, weighted by the firm's gross profit. The sampling period goes from 2006 to 2018. We restrict the sample to observations with non-negative estimated QFC to sales ratio. N denotes the number of observations, Q1 and Q3 correspond to the first and third quartiles, respectively, and Q2 corresponds to the median. The size of firms is defined according to the European Commission Recommendation of May 6, 2003.

In Table 3 we report the summary statistics of the estimated firm's fixed operating costs by sector of economic activity. The estimates show that fixed operating costs vary substantially across sectors. This heterogeneity reflects the asymmetry in the firm's management flexibility, which is highly dependent on the production scheme of the firms in each sector. According to the estimates, the sectors with higher QFC to sales ratio are mostly related with services, namely accommodation and food services (31%), human health (28%), and other services (23%). High-capital intensive sectors also present high QFC to sales ratios (e.g. real estate, electricity, and water supply). In turn, the sectors with lower ratios are the wholesale and retail trade (9%) and transportation and storage (10%).[8] Recent evidence shows that the pandemic has severely affected the

8. More detail on the estimates by sector of economic activity and size is available upon request.

firms in the accommodation and food services sector, which is one of the sectors with highest QFC to sales ratio (Manteu *et al.* 2020).

Sector of economic activity	N	Mean	St. dev.	Q1	Q2	Q3
Accommodation and food services	141,566	0.31	0.16	0.20	0.29	0.42
Human health	74,629	0.28	0.13	0.18	0.27	0.37
Real estate	24,773	0.26	0.20	0.12	0.22	0.35
Electricity and gas	240	0.25	0.15	0.13	0.22	0.38
Other services	39,188	0.23	0.15	0.12	0.20	0.30
Water supply	2,172	0.21	0.18	0.06	0.13	0.34
Education	13,654	0.20	0.10	0.13	0.19	0.26
Mining and quarrying	3,672	0.18	0.12	0.09	0.16	0.22
Agriculture	38,237	0.17	0.14	0.05	0.14	0.24
Professional, scientific and technical	117,816	0.17	0.16	0.04	0.13	0.27
Construction	89,199	0.13	0.14	0.03	0.06	0.21
Manufacturing	171,127	0.13	0.11	0.05	0.11	0.17
Information and communication	17,652	0.13	0.11	0.05	0.10	0.19
Transportation and storage	55,825	0.10	0.12	0.03	0.05	0.13
Wholesale and retail trade	335,850	0.09	0.08	0.03	0.07	0.14
Total	1,125,600	0.15	0.14	0.04	0.10	0.21

TABLE 3. Main summary statistics by sector of economic activity: QFC to sales ratio

Notes: Estimated QFC scaled by one-period lagged sales, weighted by the firm's gross profit. The sampling period goes from 2006 to 2018. We restrict the sample to observations with non-negative estimated QFC to sales ratio. N denotes the number of observations, Q1 and Q3 correspond to the first and third quartiles, respectively, and Q2 corresponds to the median.

Interestingly, we find that the sectors with higher QFC also have a higher share of employee expenses in total operating costs. Additionally, the sectors with lower QFC have a higher proportion of COGS in total operating costs. Overall, on average, the correlation between the firm's QFC to sales ratio and the share of COGS, supply and external services, employee expenses, and depreciations is approximately -0.23, 0.09, 0.17, and 0.26, respectively. In general, this pattern is also found when we compute average correlations at the sector level. These results are reassuring in the sense that the COGS is more related to the production process while employee expenses are more sticky.

Finally, we compare our estimates with those obtained using the four measures of operating leverage mentioned in the literature review. We find a positive correlation between our measure of quasi-fixed operating costs and the degree of operating leverage measure suggested by García-Feijóo and Jorgensen (2010), the fixed assets to total assets ratio, and the inflexibility measure constructed by Gu *et al.* (2018). In turn, we find a negative significant correlation between the firm's estimated quasi-fixed costs and the cost structure measure proposed by Kahl *et al.* (2019). All in all, these results are consistent with the idea that firms with a higher estimated quasi-fixed costs to sales ratio have more operating leverage and less operating flexibility.

5. To conclude

The current Covid-19 pandemic outbreak has affected firms across the globe. The abrupt decline in sales and the difficulty in adjusting the cost structure has caused cash-flow distress in many firms. This has emphasized the relevance of the cost structure of firms in their capacity to weather adverse shocks.

In this article we measure fixed operating costs at the firm level using granular balance-sheet data for virtually all Portuguese firms. We consider that fixed operating costs are those costs that do not scale with the firm's contemporaneous sales. The estimates show that on average fixed operating costs of Portuguese firms account for approximately 15% of their sales. We also unveil substantial heterogeneity in the estimated fixed operating costs across firms size and sector of economic activity, and document two main findings. First, the fixed operating costs to sales ratio of smaller firms is higher than that of larger firms. Second, this ratio is higher in sectors of economic activity related to services, some of which are among the most affected by the pandemic.

A comparison of the fixed costs estimated at the firm level and the share of the main accounting items in total operating costs unveils interesting results. First, we find a negative correlation between the share of costs of goods sold and the fixed costs to sales ratio, meaning that the higher the weight of the costs of goods sold in operating costs the lower the fixed costs ratio. Second, we find a positive correlation between the share of employee expenses in total operating costs and the ratio of fixed costs to sales. These results are reassuring in the sense that the cost of goods sold are more related to the production scheme of each firm and sector while employee expenses are more sticky.

These findings have important implications for credit risk models, especially in the context of the pandemic, as firms with a high weight of fixed operating costs in total operating costs are likely more affected by the current shock.

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Non-technical summary

January 2021

Portuguese firms' financial vulnerability and excess debt in the context of the COVID-19 shock

Francisco Augusto and Márcio Mateus

The shock associated with the COVID-19 pandemic strongly restricts the Portuguese firms' ability to generate earnings, undermining its capacity to meet credit commitments in the short and medium term, with potential negative effects on financial institutions and other economic agents.

This article assesses the vulnerability of the Portuguese firms' financial debt over the 2020-22 period given two indicators: financial vulnerability and excess debt. Firms whose operating results are less than twice the amount of interest expenses and firms with negative results are considered vulnerable. The difference between the firm's current debt and the amount of debt it can bear without entering into vulnerability is classified as excess debt.

In light of the high level of uncertainty about the economic developments over the coming years, two scenarios were analysed: a central scenario and a severe scenario. Both scenarios are based on the most recent projections for the Portuguese economy (December 2020 issue of the Economic Bulletin of the Banco de Portugal). Different recovery profiles were also assigned to each activity sector, according to the initial intensity of the pandemic shock, given the asymmetric nature of the shock for each activity sector.

The pandemic shock leads to an increase in debt associated with vulnerable firms and in excess debt over the projection horizon. In 2020, vulnerable firms' debt is projected to increase by 9 p.p., reaching 31% of the total firms' debt (graph 1). The increase in excess debt is less sharp (4 p.p.) over the same period, reaching 21% of total debt.

In the central scenario there is a progressive decline of vulnerable firms' debt and excess debt up to 2022, to levels close to those observed in 2019 (22% and 18% respectively). In the severe scenario, the share of vulnerable firms' debt and of excess debt is projected to remain at higher levels in 2022, 26% and 20% respectively. In both scenarios, the debt levels reached are below those observed during the sovereign debt crisis, reflecting the increase in financial robustness of Portuguese firms in the period preceding the pandemic crisis.

The share of vulnerable debt and excess debt is projected to increase more in manufacturing, trade and accommodation and food services sectors. For most sectors, the severe scenario implies an increase in excess debt in 2020 and 2021 and a gradual reduction in 2022 that would be insufficient to return to the levels observed in 2019.

Vulnerable firms have worse liquidity and capitalization ratios than non-vulnerable firms. In 2020, around 50% of the vulnerable firms' debt is in the bottom two quartiles of both ratios, contrasting to non-vulnerable firms whose percentage was around 33%.

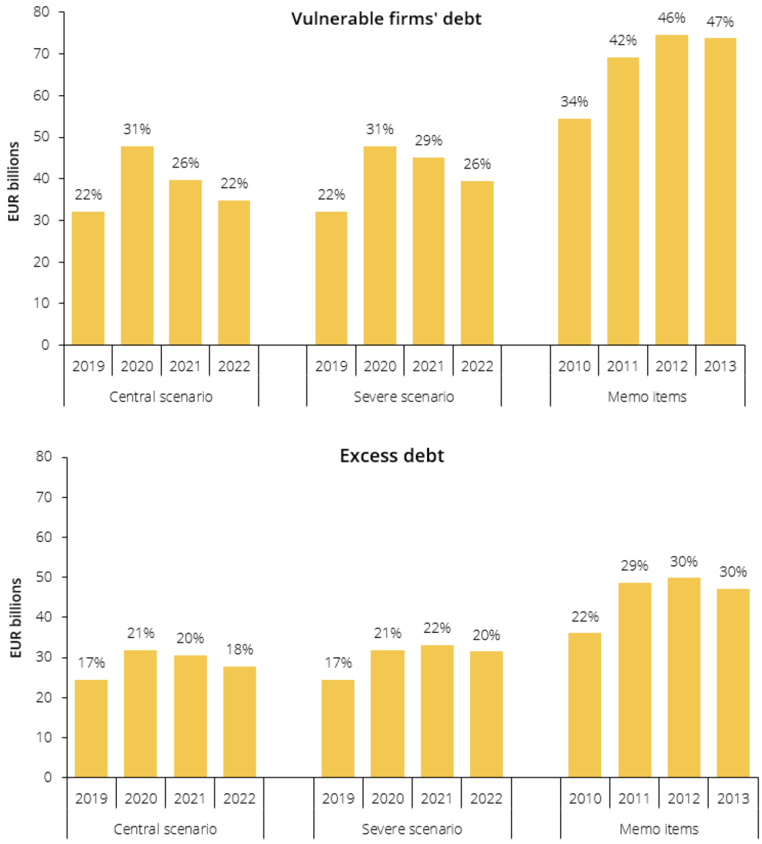

FIGURE 1: Firms in financial vulnerability's debt and excess debt evolution in the two projection scenarios | EUR billions and percentage of total financial debt

Notes: On the y axis, it is possible to observe the evolution over the projection period of the amount of debt associated with vulnerable firms, in the top Figure, and of excess debt, in the bottom Figure, in each scenario. The values above each bar are the shares of vulnerable debt / excess debt in the total financial debt of firms, by year. Thus, in the central scenario the amount of debt associated with vulnerable firms is projected to be just under EUR 50 billion in 2020, which corresponds to 31% of the total firms' debt. The figures for 2019 also correspond to a projection, since firm-level data for 2019 was not available at the time this article was written.

Portuguese firms' financial vulnerability and excess debt in the context of the COVID-19 shock

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Abstract
This article assesses Portuguese firms' financial vulnerability in the 2020-22 horizon given two scenarios of the evolution of the Portuguese economy in the context of the COVID-19 pandemic. Based on two indicators, financial vulnerability and excess debt, and taking advantage of the correlation between financial variables and macroeconomic aggregates, an increase in debt held by companies in financial vulnerability is estimated. This increase is more persistent in the more severe scenario, but falls short of the level recorded during the sovereign debt crisis. The sectors of activity for which the largest increase in the proportion of vulnerable and excess debt is projected are manufacturing, trade and accommodation and food services. Firms projected to be vulnerable in 2020 have lower average liquidity and capitalisation indicators than non-vulnerable firms. (JEL: D22, G32, G33)

1. Introduction

The shock introduced by the COVID-19 pandemic abruptly interrupted the more favourable economic outlook for firms in Portugal following the end of the sovereign debt crisis (2011-13). Faced with a significant and immediate economic shock (GDP changed by -16.4% and -5.7% year on year in the second and third quarters of 2020[1]), the outlook for business activity was strongly conditioned, raising fears about firms' financial resilience in the context of the pandemic crisis uncertain duration.

This article seeks to assess the financial resilience of private firms in Portugal based on two indicators: financial vulnerability and excess debt. Both indicators are based on the interest coverage ratio, which relates firms' EBITDA to the amount of interest expenses. The estimation of these indicators tries to take advantage of the correlation between the firms' financial variables and the macroeconomic aggregates. The simplicity

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1. Based on Statistics Portugal quarterly national accounts of 30 November 2020.

and flexibility of the proposed indicators allow for an explicit assessment of the impact of variations in operating results and interest expenses on firms' vulnerability.

In view of the high level of uncertainty about short and medium-term economic developments, two scenarios were analysed: a central scenario and a severe scenario. Given the heterogeneous nature of the pandemic shock, different recovery profiles were also defined for different sectors of activity.

In both scenarios considered, an increase in financial debt associated with vulnerable firms and in excess debt is estimated for 2020-22 as a result of the pandemic shock. In both scenarios this evolution is mostly associated with an increase in the number of firms with negative operating results.

However, the increase in firms' vulnerability as well as the recovery profile is distinct between scenarios. In both scenarios, the vulnerable firms' financial debt and the excess debt increase in 2020, by 49% and 31% respectively. Nonetheless, the projected recovery in the central scenario is faster. In this scenario, it is estimated that by 2022 the vulnerable and excess debt will reach values close to those observed in 2019.

The slower economic recovery in the severe scenario implies that the amount and proportion of debt held by vulnerable firms and excessive debt will remain at higher levels than those observed in 2019. In this scenario, a reduction in the amount of excess debt is projected only from 2021 onwards.

The sectors of activity for which the largest increase in the proportion of debt held by vulnerable firms and excess debt is projected are manufacturing, trade and accommodation and food services. For most sectors, the severe scenario implies a significant increase in the two indicators in 2020 and 2021 and a gradual reduction in 2022, although insufficient to return to the values observed in 2019.

Despite the estimated increases for the two indicators, the level of vulnerability is expected to fall short of that identified during the period of the sovereign debt crisis in the two projected scenarios. The positive evolution of corporate operating results and the reduction of their financial charges (interest expenses), associated with both the ECB's accommodative policy and the reduction of the Portuguese firms' indebtedness, contributed to the lower vulnerability compared to the previous crisis.

Finally, vulnerable firms have worse liquidity ratios and lower capitalisation levels than non-vulnerable firms, contributing to increase the risk associated with these firms given the current context.

The methodology considered in this article refers to the work of De Socio and Michelangeli (2017), Klein (2016) and Martinis *et al.* (2017), who analyse, respectively, the financial vulnerability of firms in Italy, Ireland and Croatia. For Portugal, this article complements previous studies on credit risk analysis at firm level (Bonfim (2009), Martinho and Antunes (2012) and Antunes *et al.* (2016)).

The article is structured as follows: Section 2 introduces the indicators of firms' financial vulnerability and excess debt; Section 3 addresses the projection methodology and projection scenarios defined for the period 2020-22; Section 4 presents the evolution of debt held by vulnerable firms and of the excess debt over the projection horizon. Section 5 assesses the distribution of debt associated with vulnerable firms against indicators of firms' liquidity and capitalisation. Section 6 concludes.

2. Indicators of debt vulnerability

2.1. Financial vulnerability indicators

The assessment of the financial vulnerability of private non-financial firms is based on a simple indicator which relates each firm's operating income to its interest expenses, the interest coverage ratio (ICR). High values of this ratio indicate difficulties in a firm's ability to meet its credit obligations in the short/medium term.[2] The ratio has been defined as:

$$\textit{Interest coverage ratio (ICR)} = \frac{\textit{Interest expenses}}{\textit{EBITDA}} \tag{1}$$

In particular, a firm i was identified as being vulnerable in a year t if its interest coverage ratio was higher than 0.5 in that year or if its EBITDA was negative:

$$ICR_{it} = \frac{\textit{Interest expenses}_{it}}{EBITDA_{it}} > 0.5 \vee EBITDA_{it} \leq 0 \tag{2}$$

The 0.5 threshold is used as a benchmark in a large number of studies on corporate debt vulnerability and is associated with a probability of default of 20% over a five-year time (IMF (2013)).

Firms' vulnerability implies more than a higher probability of default on the firms' credit obligations. In order to avoid default, firms are commonly forced to resize their activity and reduce the number of employees and investment. In fact, for the period 2006-18[3] and based on the universe of firms considered in this article, it is concluded that, on average, vulnerable firms show less favourable developments than non-vulnerable firms in terms of the number employees, gross fixed capital formation and total cash and bank deposits in the three years following entry into a vulnerability state (Figure 1). This pattern is not identified for GVA, mainly due to the contribution of new companies, which in the initial phase of their life cycle present less robust economic and financial indicators.[4]

With the aim of quantifying each firm's excess debt, a debt threshold has been estimated for each firm, based on the firm's operating results and financial charges. By comparing this threshold with the firm's debt it is possible to assess the existence of excess debt. Thus, the excess debt for a firm i in year t corresponds to the difference

2. An inverse formulation to the one commonly considered (EBITDA/interest expenses) was chosen in order to make the distribution of the interest coverage ratio more concentrated in values closer to 0 and not infinite, as in the article De Socio and Michelangeli (2017)

3. This study is based on financial statement data reported by firms between 2006 and 2018 in the IES (Simplified Corporate Information). Data for 2019 was not available at the time of this study was undertaken.

4. This result is in line with some literature that considers the possibility that firms in early stages of their life cycle present worse financial indicators, regardless of their growth potential. In particular see (McGowan *et al.* (2018)).

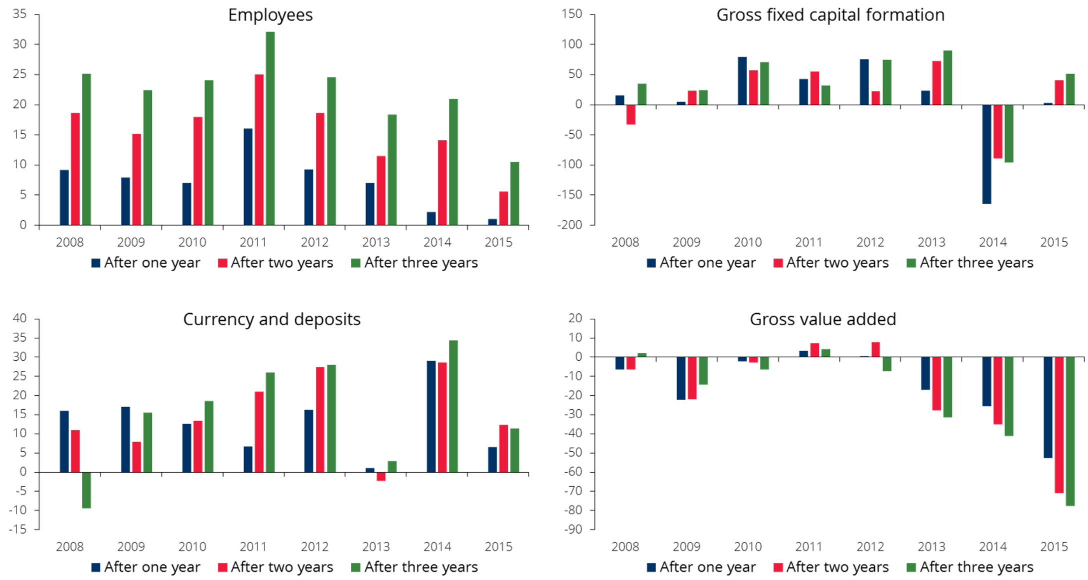


FIGURE 1: Difference between the indices of economic indicators of non-vulnerable and vulnerable firms | In percentage points

Notes: IES (Simplified Corporate Information) data for 2006-18. Firms were grouped into two categories in each year: non-vulnerable firms and firms that became vulnerable in that year. Only firms that were not vulnerable in the three previous years compared to the reference year were considered. At the beginning, the indices of the two groups of enterprises are equal to 100. Positive (negative) values are associated with higher index values for the set of non-vulnerable (vulnerable) firms.

between the firm's debt amount and the estimated debt threshold (equation 3). If the firm's average EBTIDA is negative all its financial debt[5] is considered to be in excess:

$$
\begin{aligned}
&\textit{Excess debt}_{it} \\
&= \begin{cases} max\left\{0; \textit{Financial debt}_{it} - \overline{\textit{Financial debt}_{it}}\right\} & \text{if } \overline{EBITDA_{it}} \geq 0; \\ \textit{Financial debt}_{it} & \text{if } \overline{EBITDA_{it}} < 0. \end{cases}
\end{aligned}
\tag{3}
$$

The financial debt threshold was defined from the firm's implicit interest rate formula[6] as:

5. Throughout this article, corporate debt will be referred to as debt or financial debt indistinctly and it includes loans obtained from the financial system, debt securities issued and intra-group loans.

6. The definition of a firm's financial debt threshold was derived by taking into account the implicit interest rate on firm's financial debt, defined as the ratio of interest expenses to financial debt:

$$\textit{Implicit interest rate}_{it} = \frac{\textit{Interest expenses}_{it}}{\textit{Financial debt}_{it}}$$

This rate can be transformed into the product of the interest coverage ratio and the ratio of EBITDA to financial debt:

$$\overline{\text{Financial debt}_{it}} = ICR * \frac{1}{\text{Implicit interest rate}_{it}} * \overline{EBITDA_{it}} \tag{4}$$

The financial debt threshold is an increasing function of the ICR and of the average EBITDA and decreasing with the implicit interest rate. Two assumptions have been made about this identity:

1. The ICR threshold is 0.5, which is consistent with that considered in identifying the firm's vulnerability state;
2. The firm's implicit interest rate is a material representation of each firm credit risk.[7]

Finally, in the calculation of each firms' excess debt a weighted average of EBITDA over the last three years was considered, with the aim of mitigating the effect of volatility associated with changes in EBITDA on the firms' debt threshold.[8] A larger weight is attributed to more recent periods:

$$\overline{EBITDA_{it}} = 0.2 * EBITDA_{i(t-2)} + 0.3 * EBITDA_{i(t-1)} + 0.5 * EBITDA_{it} \tag{5}$$

When firms' debt outstanding does not exceed the debt threshold (i.e. excess debt is negative), there is no excess debt. This may suggest that firms below their debt threshold would be able to increase their indebtedness without increasing their credit risk. Nevertheless, as pointed out in literature (Martinho and Antunes (2012) e Antunes *et al.* (2016)), a more indebted firm will, ceteris paribus, carry higher credit risk. The debt threshold is thus intended to determine the amount by which the firm's operating activity may be insufficient to support its credit obligations.

The financial and accounting data used within the scope of this article was obtained from the Simplified Corporate Information (IES), which is compulsory for all firms operating in Portugal. Only private companies were considered.

The time period of data (2006-18) involved the use of balance sheet information from two accounting standards. Between 2006 and 2009 the balance sheet information of

$$\text{Implicit interest rate}_{it} = \frac{\text{Interest expenses}_{it}}{EBITDA_{it}} * \frac{EBITDA_{it}}{\text{Financial debt}_{it}}$$

Finally, by putting Financial Debt to the left hand side of the identity one obtains expression (4). .

7. The two assumptions regarding the ICR value and the implicit interest rate calculation used to obtain this threshold have limitations which should be mentioned. The ICR threshold of a firm in a given year was considered a sufficient indicator to define the amount of excess debt. As formulated, the level of debt obtained is independent of the firms' debt structure, its repayment schedule and its composition. In addition, this threshold is common to all firms: the possibility of the ICR threshold to depend on the firms' characteristics has not been explicitly considered.

8. When the EBITDA was not available for all the previous three years, a weighted average of the EBITDA was calculated where for the years for which there was no data the EBITDA was assumed to be 0. This weighting penalises firms without data and new firms to which greater risk is commonly attributed.

firms was based on the National Plan of Accounts (POC in the Portuguese language abbreviation) and between 2010 and 2018 the Accounting Normalisation System (SNC in the Portuguese language abbreviation). The variables' definition has been constructed in such a way as to minimise the changes/incompatibilities between the two standards. The Appendix A.1. details the definitions considered for each variable.

Materiality criteria were also considered when defining the universe of firms. A firm was included in the study if it had met each of the following requirements in at least one of the years: (i) turnover above €5,000, (ii) financial debt above €5,000 and (iii) more than one person employed. This set of requirements meant that about one-quarter of all firms were excluded. However, these firms only account for approximately 10% of total assets, interest expenses and employees, because most of them are small firms. The final dataset comprises 399,621 firms.

2.2. *Historical evolution of the vulnerability and the excess debt indicators*

The number of vulnerable firms, as well as the amount of financial debt of these firms, has declined significantly since 2013, supported on the economic activity recovery which followed the sovereign debt crisis (Figure 2). The share of debt held by vulnerable firms was the lowest in the series in 2018 (23% of total financial debt, compared to 46% in 2013, the highest in the series).

This reflected the gradual improvement in the ICR observed after the economic and financial crisis period and was boosted by both an increase in corporate profitability and a reduction in interest expenses. In 2018, the aggregate ICR was 0.12, down from 0.20 in 2006, the first year for which there was available information. [9]

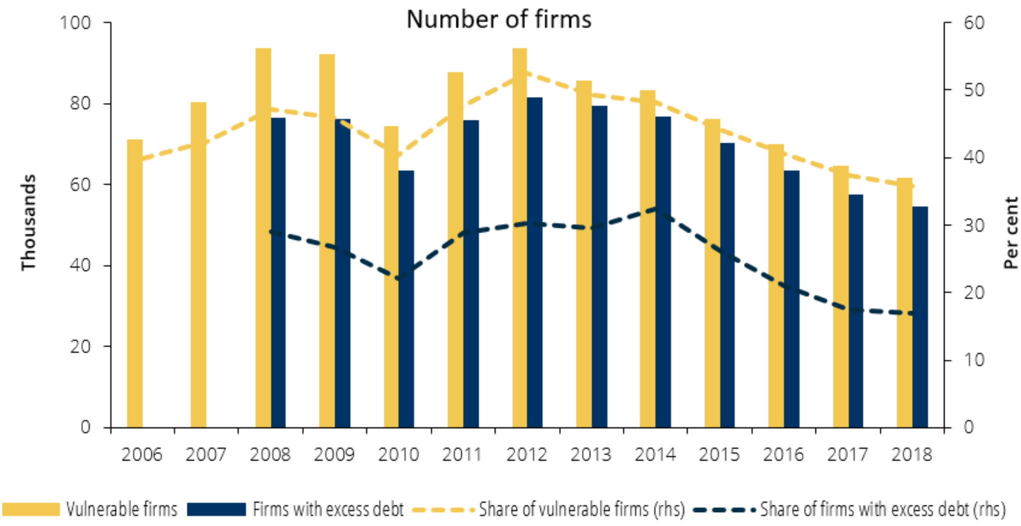
The reduction in the average ICR occurred in both non-vulnerable and vulnerable firms (with the ratio above the vulnerability threshold), which points to a general reduction in the financial vulnerability of Portuguese firms.

The decline in financial debt associated with vulnerable firms and in excess debt was broadly based across firm size classes and sectors of activity. Among the different size classes, SMEs[10] had a higher proportion of financial debt associated with vulnerable firms in the period 2008-18. Among the sectors of activity, two sectors persistently showed a higher proportion of financial debt associated with vulnerable firms: construction and real estate activities and accommodation and food service activities.

In parallel to the decline in financial debt associated with vulnerable firms, the amount of excess debt has declined significantly since 2014, when it totalled 32% of financial debt. In 2018, the excess debt accounted for about 16% of financial debt, the

9. Figures referring to the set of firms considered in this study.

10. SMEs stands for micro, small and medium-sized enterprises. The definition of firm size was based on the European Commission Recommendation 2003/361.



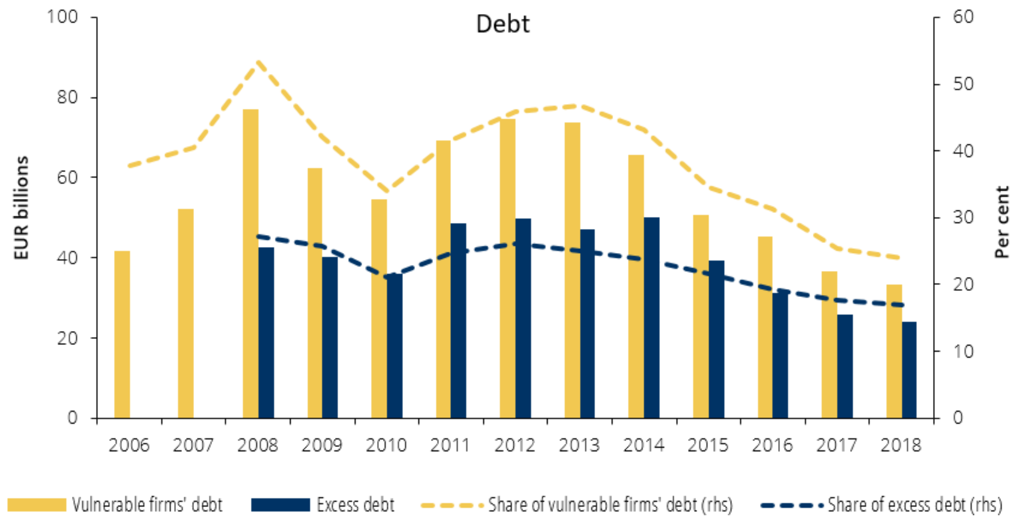


FIGURE 2: Vulnerable firms and firms with excess debt between 2006-18

Notes: The calculation of the amount of excess debt is based on the weighted average EBITDA of each firm in the last three years (equation 5), thus depending on the existence of three consecutive years of accounting data. In this sense, it is only possible to present figures for the amount and number of firms with excess debt from 2008 onwards.

lowest figure since 2008.[11] The reduction in the number of firms with negative operating results (average EBITDA) and the increase in the results of firms with positive operating results contributed to this reduction.

These conclusions reflect the evolution of firms of different sizes and different sectors of activity. For the whole period under review, SMEs recorded higher proportions of excess debt than those observed for large firms.

11. The calculation of a three-year weighted average for EBITDA implied the loss of observations for 2006 and 2007 in the analysis of excess debt.

Firms became vulnerable mainly due to negative variations in EBITDA. On average, between 2006 and 2018, the amount of debt that became vulnerable due to negative variations in operating results totalled 65%.[12] Similarly, the main factor for firms to emerge from a vulnerable condition was the increase in their operating results.

3. Projection methodology and scenarios

3.1. Projecting firms' financial variables from correlations with macroeconomic variables

The estimation of firms' vulnerability and excess debt in future periods is aimed at exploring the correlation between balance sheet and income statement items and changes in macroeconomic aggregates. The availability of regular projections for macroeconomic variables over a three year horizon makes it possible to estimate the evolution of balance sheet items over an identical time horizon. This methodology follows De Socio and Michelangeli (2017).

EBITDA, interest expenses and financial debt were estimated for the projection horizon 2020-22. The estimated values correspond to the sum of the observed/estimated value of the item in the previous period and an estimate of the change in this item, as defined in expressions (6), (7) and (8). Estimates were obtained for the interest coverage ratio and excess debt over the projection horizon, replacing the estimated annual values for each firm i in expressions (1) for the interest coverage ratio and (3) for the excess debt.

$$\widehat{EBITDA}_{it} = EBITDA_{i(t-1)} + \Delta\widehat{EBITDA}_{st} \tag{6}$$

$$\widehat{Interest\ expenses}_{it} = Interest\ expenses_{i(t-1)} + \Delta\widehat{Interest\ expenses}_{st} \tag{7}$$

$$\widehat{Financial\ debt}_{it} = Financial\ debt_{i(t-1)} + \Delta\widehat{Financial\ debt}_{st} \tag{8}$$

The estimation of nominal changes for each item considered 44 firm groups, which resulted from crossing 11 sectors of activity with four firm size categories (the detail of sectors of activity and firm size is available in Table A.2 of the Appendix A.1.).

12. In order to assess the inflow of debt in vulnerability due to variations in EBITDA, the inflow of debt in vulnerability was considered only as a consequence of variations in EBITDA (on average, 49% of the amount of debt that went into vulnerability), by the simultaneous combination of the variation in EBITDA and interest expenses (on average, 7%) and by variations either in EBITDA or interest expenses (on average, 9%). In addition to these changes, there is the contribution of the entry into vulnerability resulting only from interest changes (on average, 13%), the weight of the incumbent firms identified as vulnerable after entering the credit market (on average, 7%) and firms for which there was no information at all in the year prior to their identification as vulnerable (on average, 15%).

Nominal changes in the three variables were initially estimated for the 44 firm groups on the basis of macroeconomic aggregates and firm characteristics for the period 2006-18. The annual variation in EBITDA was estimated as follows:

$$\Delta EBITDA_{ist} = \Delta GVA_{ist} - \Delta Compensation\ of\ employees_{ist} \tag{9}$$

where $\Delta EBITDA_{ist}$, ΔGVA_{ist} and $\Delta Compensation\ of\ employees_{ist}$ correspond respectively to the absolute variation of EBITDA, gross value added and compensation of employees of a firm *i* in group *s* in year *t*. The variations of the gross value added and compensation of employees were estimated as:

$$\begin{aligned} \Delta GVA_{ist} =& \beta_{0s} + \beta_{1s} * yoy\ GVA_t \\ &+ \beta_{2s} * yoy\ GVA_t * D_{\{Incumbentfirm=1\}t} \\ &+ \beta_{3s} * yoy\ GVA_t * D_{\{Exp.activity=1\}t} + \varepsilon_{st} \end{aligned} \tag{10}$$

$$\begin{aligned} \Delta Compensation\ of\ employees_{ist} =& \eta_{0s} + \eta_{1s} * yoy\ Com\ Emp_t \\ &+ \eta_{2s} * yoy\ Com\ Emp_t * D_{\{Incumbentfirm=1\}t} \\ &+ \eta_{3s} * yoy\ Com\ Emp_t * D_{\{Exp.activity=1\}t} + \varepsilon_{st} \end{aligned} \tag{11}$$

where $yoy\ GVA_t$ and $yoy\ Com\ emp_t$ correspond to the year-on-year rate of change in gross value added and compensation of employees respectively of the total economy in year *t*, $D_{\{Incumbentfirm=1\}t}$ is a dummy variable that assumes the value of one if the firm has more than five years of activity in year *t* and zero otherwise, and $D_{\{Exp.activity=1\}t}$ a dummy variable that assumes the value of one when the firm has export activity in year t, and zero otherwise.[13] The identification of firms already established in the market (defined as having more than five years of activity) and firms with exporting activities is aimed at identifying distinct evolution patterns in firms that have been in business for longer and companies with direct exposure to international markets.

The sign of the two variables is broadly in line with economic intuition: the fact that a firm is already established in the market reduces EBITDA variability, and the exporting activity of firms increases their results, but also their variability (in particular, regarding the results' variability of firms with exporting activity see (Vannoorenberghe (2012)).[14] The annual change of interest expenses was estimated from the following equation:

13. National accounts aggregates of the total economy were used, instead of those of the institutional sector Non-financial corporations, in order to be compatible with the available macroeconomic forecasts. Correlations between total economy aggregates and NFC aggregates were high in the period 2006-19: the correlation between the gross value added of the total economy and the gross value added of the non-financial corporations in the period 2006-19 was 96%. The correlation between the compensation of employees of the total economy and the compensation of employees of the non-financial corporations in the period 2006-19 was 95%.

14. The identification of a firm as an exporter from 2019 onwards replicates the status observed for 2018.

$$
\begin{aligned}
\Delta \textit{Interest expenses}_{ist} = & \gamma_{0s} + \gamma_{1s} * \textit{yoy fin debt}_t + \gamma_{2s} * \Delta \textit{new loans rate}_t \\
& + \gamma_{3s} * \Delta \textit{new loans rate}_t * D_{\{Vuln.Ind=1\}t-1} + \varepsilon_{st}
\end{aligned}
\tag{12}
$$

where $\Delta \textit{Interest expenses}_{ist}$ corresponds to the absolute change in interest expenses of a firm i in group s in year t, $\textit{yoy fin debt}_t$ corresponds to the year-on-year rate of change in the consolidated financial debt[15] of non-financial corporations, $\Delta \textit{new loans rate}_t$ corresponds to the annual absolute change in the weighted interest rate on new loans granted by monetary financial institutions to non-financial corporations and $D_{\{Vuln.Ind=1\}t-1}$ is a dummy variable that takes the value of one when firm i was identified as vulnerable in the previous year and zero otherwise. Finally, the annual change in financial debt was estimated as:

$$
\begin{aligned}
\Delta \textit{Financial Debt}_{ist} = & \delta_{0s} + \delta_{1s} * \textit{yoy fin debt}_t + \delta_{2s} * \Delta \textit{new loans rate}_t \\
& + \delta_{3s} * D_{\{Vuln.Ind=1\}t-1} + \varepsilon_{st}
\end{aligned}
\tag{13}
$$

where $\Delta \textit{Financial Debt}_{ist}$ corresponds to the annual change in financial debt of a firm i in group s in year t. The equations of interest expenses and financial debt include a dummy variable that identifies if a firm was vulnerable in the previous year. The results suggest that the state of financial vulnerability is generally associated with an increase of the funding cost in the following year and with a decrease in financial debt.

Changes in the balance sheet items of each firm are considered as an additive relationship of the macroeconomic variables defined as explanatory variables. This gives rise to an important limitation regarding this methodology: the firms' financial variables variability is significantly lower than that observed in macroeconomic variables, which translates into low coefficients of determination. The projection generated by each equation will imply an identical value for all firms in each group, decreasing the heterogeneity in the evolution of firms.[16]

This limitation is partly mitigated by two factors. The first is the definition of groups, which helps to adjust the estimated variations to the intrinsic reality of the firms belonging to each of the groups. The second is the fact that the estimate for each firm results from the combination of its individual starting point with a common estimate between groups of firms. This is a passive heterogeneity dimension. The two vectors will characterise the heterogeneity of the firms over the projection horizon.

After estimating the coefficients of equations (10), (11), (12) and (13), it was observed that some of the coefficients were not statistically significant in several of

15. Estimated financial debt for individual firms is unconsolidated, which could be a source of error in the estimation of changes in interest rates and financial debt. However, the available macroeconomic projection takes into account consolidated data, so the year-on-year change in this variable has been considered.

16. Our approach is simpler than that used by De Socio and Michelangeli (2017). Those authors also included quintiles of firm volatility for each group in addition to the combination by sector of activity and firm size.

the groups considered. In order to circumvent this limitation, the equations were re-estimated excluding the variables without statistical significance. In cases where none of the explanatory variables were statistically significant, equations estimated by firm size were considered, thus obtaining a projection formulation applicable to all firms belonging to a given size class.[17] Details on the variables included in the estimation of each group (Tables A.3. and Table A.4.), as well as the estimation results (Table A.5. to Table A.12.), are presented in the Appendix A.2.

In addition, for a small number of sectors, countercyclical developments in GVA and EBITDA were identified.[18] In these cases, the estimates of the specification by firm size was considered. This option takes into consideration the following factors: (i) the sectors of activity used are relatively aggregated, (ii) inconsistency in the countercyclical evolution between the sectors and size classes (i.e. not all the size classes are countercyclical within each sector of activity), (iii) assuming a countercyclical variation for a given group of firms implies a countercyclical change for all firms within that group.

It should be noted that the estimates made have a small number of degrees of freedom associated, mainly due to the short time span available for the analysis (IES information is only available since 2006). The small number of degrees of freedom may imply a problem of estimation consistency, which under the considered approach would only be corrected over a longer time period.

Based on this approach it is possible to assess the ability to identify the state of vulnerability of each firm in the period 2007-18 (in-sample). Table 1 presents the results of a confusion matrix, which summarises the ability to identify the firms' vulnerability status.

Based on one-year estimates of the model for the period 2007-18, 77% of firms were correctly categorised, a percentage that rises to 85% if the amount of financial debt of these firms is considered.[19] However, the share of firms that were vulnerable and were correctly identified as being vulnerable was 72%, or 80% if the allocation by amount of financial debt is considered. These results suggest that the model has greater ability to identify the state of vulnerability in firms with larger amounts of financial debt.

17. Considering groups of firms on the basis of the breakdown sector of activity and firm size or only by firm size took was a choice which took into account preliminary studies that assessed the out-of-sample predictive capacity of various specifications and explanatory variables. This exercise concluded that simpler approaches (with lower granularity on the groups of firms) and fewer explanatory variables had better predictive ability compared to a benchmark considering the variation observed in the previous period as the change estimate.

18. Countercyclical variations in GVA have been identified for large companies in agriculture, forestry and fishing. Countercyclical variations in EBITDA have been identified for medium-sized firms in the mining and quarrying, electricity, gas and water, small firms in the construction and real estate activities, small firms in information and communication sector and small firms in other services.

19. If only the ability to identify transitions into the vulnerability state were considered, these proportions would be lower. However, it should be noted that the main inability to identify transitions from the model was associated with transitions from vulnerability to non-vulnerability and not with transitions from non-vulnerability to vulnerability.

Number of firms		
Observed / Estimated	Non-vulnerable	Vulnerable
Non-vulnerable	82%	18%
Vulnerable	28%	72%
Overall accuracy	77%	

Debt		
Observed / Estimated	Non-vulnerable	Vulnerable
Non-vulnerable	88%	12%
Vulnerable	20%	80%
Overall accuracy	85%	

TABLE 1. Confusion matrices by number of firms and financial debt amount | In percentage

Notes: The confusion matrix summarises the predictive capability of the model by comparing the observed vulnerability state (left column) with the estimated vulnerability state (top row). The predictive capability of the model will be all the better, the fewer false positives (or type 1 errors, non-vulnerable firms that the model identified as vulnerable), and false negatives (or type 2 errors, vulnerable firms that the model wrongly classified as non-vulnerable). The figures in the confusion matrices correspond to the average weight of each set of firms in each year in the period 2007-18.

3.2. *Definition of macroeconomic projection scenarios*

The starting point for the projections in this exercise are the macroeconomic projections of the Banco de Portugal, with reference to December 2020 issue of the *Economic Bulletin* (BdP (2020a)). Two scenarios were analysed: a central scenario and a severe scenario. Based on those projections, the economic shock in 2020 was around -8%. In a central scenario, recovery is faster, with the economy recovering from the 2019 level by the end of 2022. In a severe scenario, the recovery is slower, with no full recovery of the output level in 2022.

This study also considers a heterogeneous evolution of GVA by sector of activity, which is particularly important in a shock with asymmetric sectoral consequences. The initial shocks on each sector correspond to those presented in the Special issue: "The economic impact of the pandemic crisis", from the *Economic Bulletin* May 2020 issue of (BdP (2020b)).[20] Given these shocks, three recovery profiles were defined: a rapid recovery, an intermediate recovery and a slow recovery. The recovery profile, assigned to each sector of activity refers to the shock intensity in April: sectors with GVA falling 20% or less in April 2020 will show a rapid recovery, sectors with GVA falling above 20%

20. In particular, see Table C1.1 of the Special issue: "The economic impact of the pandemic crisis" from the May 2020 issue of the *Economic Bulletin* of the Banco de Portugal.

but less than 40% will present an intermediate recovery and sectors with GVA falling more than 40% will present a slow recovery.[21]

The three profiles define a sharp negative shock in 2020, with a recovery in the third quarter followed by a further drop in the fourth quarter. In 2021 and 2022 there is a gradual recovery in all three profiles, assuming that the recovery will be complete more quickly for the firm groups in sectors less affected by the pandemic crisis.[22]

The combination of heterogeneity in the GVA of firms and the aggregate evolution of the other variables (compensation of employees, financial debt and interest rates on new loans to non-financial corporations) presents some limitations that should be taken into account when reading the results. When considering a heterogeneous evolution of the results, the evolution by sector of activity is superimposed on the overall evolution of the economy in equation 10. This assumption is of upmost importance, as it allows to take into account a significant shock that has no parallel in the historical period considered in the estimation. On the other hand, heterogeneous developments are only considered in GVA and not in the other projected variables (which will still be distinct by the different estimation groups), in particular for compensation of employees.

Regarding changes in compensation of employees, financial debt and interest rates on new loans to non-financial corporations, the projections considered for each of these variables are such that they are coherent with the evolution of GDP in each scenario.

4. Assessment of financial vulnerability and excess debt in 2020-22

The two scenarios analysed in this article point to an increase in financial vulnerability and excess debt as a consequence of the economic contraction caused by the pandemic (Figure 3). However, neither of the scenarios leads to levels like those observed during the sovereign debt crisis (2011-13).

The evolution of financial vulnerability and excess debt varies according to the scenario considered for the period 2020-22. In the central scenario, financial debt associated with vulnerable firms increases in 2020 (to 31% of total financial debt) and decreases in the following two years. For the excess debt, the central scenario also estimates an increase in 2020 (to 21% of total financial debt), followed by a gradual decline up to 2022, when it accounts for 18% of financial debt (1 p.p. higher than that estimated for 2019).

21. The allocation of a recovery profile according to the magnitude of the shock in April 2020 ignores a greater/lower capacity of some sectors to reallocate activity on the new economic/health environment during the pandemic period.

22. Chart 1 of the Special Issue: "The vulnerability of non-financial corporations' debt in the pandemic crisis" from the December 2020 issue of the *Financial Stability Report* of the Banco de Portugal details the evolution for each profile. The profiles were created in such a way that the aggregate change in corporate GVA (annual change) was identical to that projected for the economy's GDP, once the evolution of each sector of activity was weighted by the weight of that sector's GVA in the period 2010-2017. The weighting for GVA considered the average weight of each sector's GVA in total GVA between 2010 and 2017 based on the information available in Table C.1.1.14 - Gross value added by industry of Statistics Portugal.

The severe scenario has more serious implications for firms. Total financial debt associated with vulnerable firms increases similarly to the central scenario in 2020; however, by 2021 the debt reduction associated with vulnerable firms is of a smaller magnitude. In excess debt the increase persists into 2021 and the decline projected for 2022 is insufficient to reverse the initial shock estimated for 2020.

In both scenarios, increased financial vulnerability and excessive debt[23] is mainly associated with firms that, because of the economic shock caused by the pandemic, are now experiencing negative results. In fact, the contribution to the growth of the excess debt of firms with negative EBITDA more than doubles that of the contribution of firms that maintain positive results above the vulnerability threshold in the two scenarios considered.

The breakdown of excess debt by firm size over the 2020-22 horizon reproduces the debt structure observed over the period preceding the pandemic's economic impact (Figure 4). In both scenarios, about half of the amount of excess debt is associated with micro firms. An increase in the share of large firms in total excess debt is estimated, which is associated with a higher growth in the amount of excess debt in 2020 compared to other size classes. Nevertheless, the share of large firms in excess debt remains lower than in other size classes.

The pandemic shock's aggregate impact on debt held by vulnerable firms and excess debt is projected to be less negative than that observed during the sovereign debt crisis (2011-13).[24] The increased financial robustness of Portuguese firms in the period preceding the pandemic crisis, compared to 2010, contributed to this result: the continuous decline of the interest coverage ratio since the sovereign debt crisis, both through the increase in firms' results and through the reduction of interest expenses, was reflected in a shift in the distribution of financial debt to lower interest coverage ratios.[25] It should be noted that the reduction in interest expenses was associated with both the accommodative monetary policy (an exogenous factor to firms) and the decrease in corporate indebtedness.

The pandemic shock's impact on the evolution of activity sectors is heterogeneous (Figure 5). In both scenarios, the shocks are particularly adverse for manufacturing,

23. In order to characterise the vulnerability and excess debt of firms in the period 2019-22 more sparingly, it was decided to present only estimates of excess debt in the remainder of this section. The complete results for the evolution of financial debt associated with vulnerable firms are available upon request to the authors.

24. In a recent update of the study by De Socio and Michelangeli (2017), the Banca d'Italia points to a conclusion similar to that identified for Portugal with regard to the negative economic shock resulting from the pandemic. The increased vulnerability of corporate debt will not imply reaching the amount of debt at risk observed in 2008. In particular, see Financial Stability Report, April 2020, Banca d'Italia, page 26.

25. For comparison purposes, 2010 was considered the year before the impact of the sovereign debt crisis in Portugal. The economic situation of firms in 2010 shows significant differences from 2018. The financial crisis that started in 2008 had increased the risks to global financial stability. However, in aggregate terms for firms in Portugal, 2010 was the year with the highest value in the historical aggregate of the EBITDA series (2006-18).

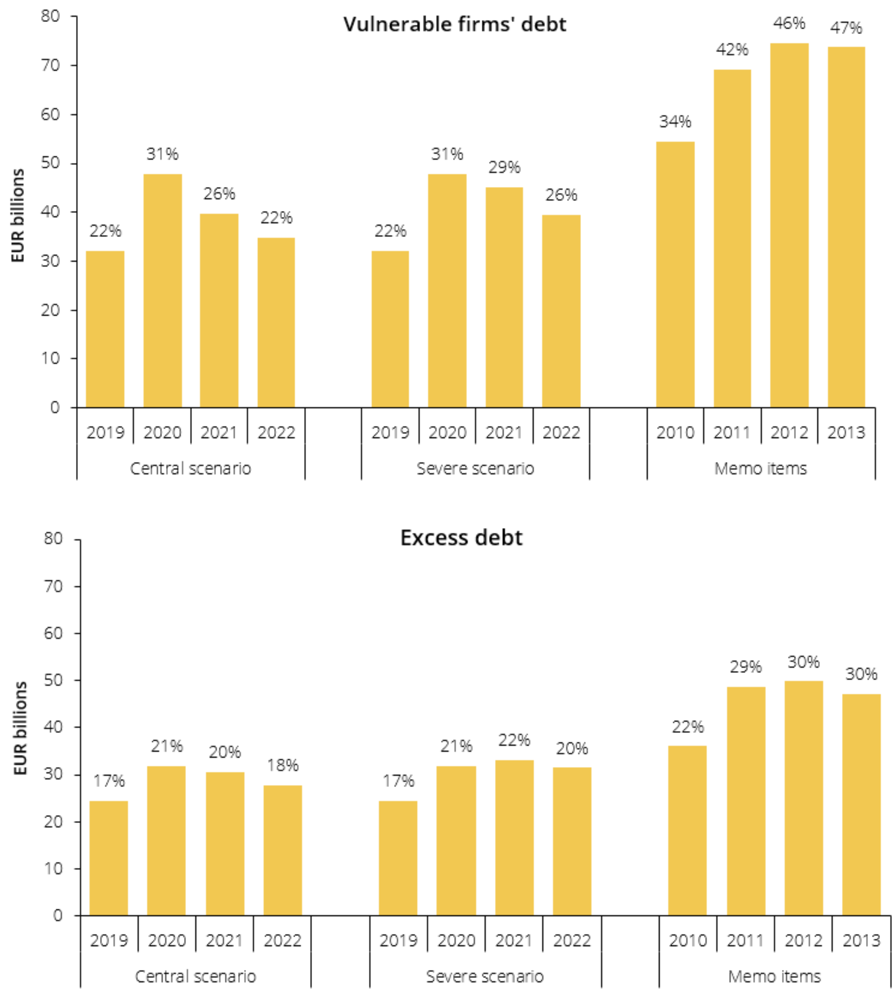


FIGURE 3: Firms in financial vulnerability's debt and excess debt evolution in the two projection scenarios | EUR billions and percentage of total financial debt

Notes: On the y axis, it is possible to observe the evolution over the projection period of the amount of debt associated with vulnerable firms, in the top Figure, and of excess debt, in the bottom Figure, in each scenario. The values above each bar are the shares of vulnerable debt / excess debt in the total financial debt of firms, by year. Thus, in the central scenario the amount of debt associated with vulnerable firms is projected to be just under EUR 50 billion in 2020, which corresponds to 31% of the total firms' debt. The figures for 2019 also correspond to a projection, since firm-level data for 2019 was not available at the time this article was written.

trade, accommodation and food service activities, and professional, scientific, technical and administrative activities.

In the central scenario, from 2019 to 2020, the negative effect is mainly reflected in the increase of the weight of excess debt in the manufacturing (5 p.p. increase), trade (5 p.p.), accommodation and food (9 p.p.) and professional, scientific, technical and administrative activities (11 p.p.) sectors.[26] In most sectors, the weight of excess debt

26. For the professional, scientific, technical and administrative activities sector, the conclusion obtained is associated with a small number of firms.

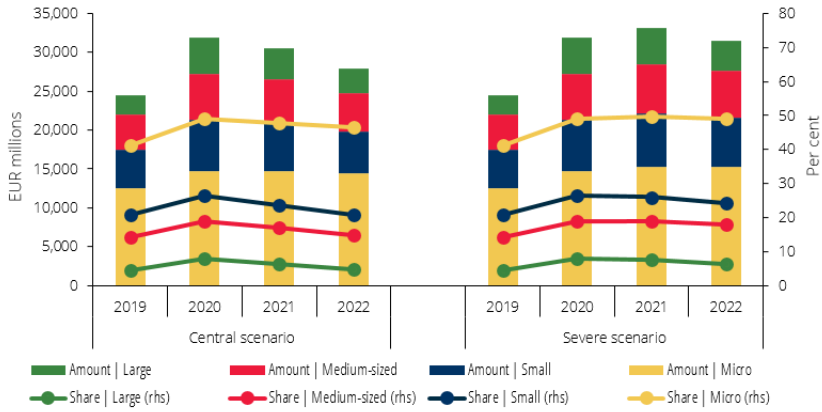


FIGURE 4: Excess debt evolution in the central and severe scenarios by firm size

Notes: Bars, with reference to the left-hand scale, depict the evolution of the amount of excess debt over the projection period by firm size. Lines, with reference to the right-hand scale, depict the weight of excess debt in total financial debt for each firm size. Thus, in the central scenario and for 2020, it is estimated that the amount of excess debt of micro firms is around EUR 15 billion, which corresponds to approximately 50% of the total debt of micro firms.

is reduced in 2022 to levels close to those observed in 2019. This evolution can also be observed in the financial debt associated with vulnerable firms.

In the severe scenario, the share of debt in excess in total financial debt reaches higher levels. In this scenario, the sector of activity with the highest share of excess debt is accommodation and food services: an increase of 13 p.p. between 2019 and 2021, reaching a maximum of 40% that year. Moreover, for most sectors of activity, the share of debt in excess in 2022 significantly exceeds that observed in 2019.

Between 2019 and 2021, manufacturing (6 p.p. increase), trade (6 p.p.) and professional, scientific, technical and administrative activities (10 p.p. increase) sectors also recorded significant increases. In view of this increase, the estimated reduction is slow and, for most sectors, insufficient to reverse the variation that occurred during this period.

Finally, the moderate growth of excess debt in the mining and quarrying, electricity, gas and water sectors and in the information and communication sector in the two scenarios is noteworthy.

Based on the projected evolution for the different sectors, it is possible to identify a change in the distribution of excess debt by sector of activity. Figure 6 details the distribution of excess debt across different sectors based on the projection of excess debt in 2020 and 2019. The construction and real estate sector, which continues to record the largest amount of excess debt in either scenario, loses relative share in total excess debt compared to 2019 (-5 p.p.). By contrast, manufacturing (+2 p.p.), trade (+2 p.p.), accommodation and food (+1 p.p.) and scientific, technical and administrative activities (+3 p.p.) would increase their share.

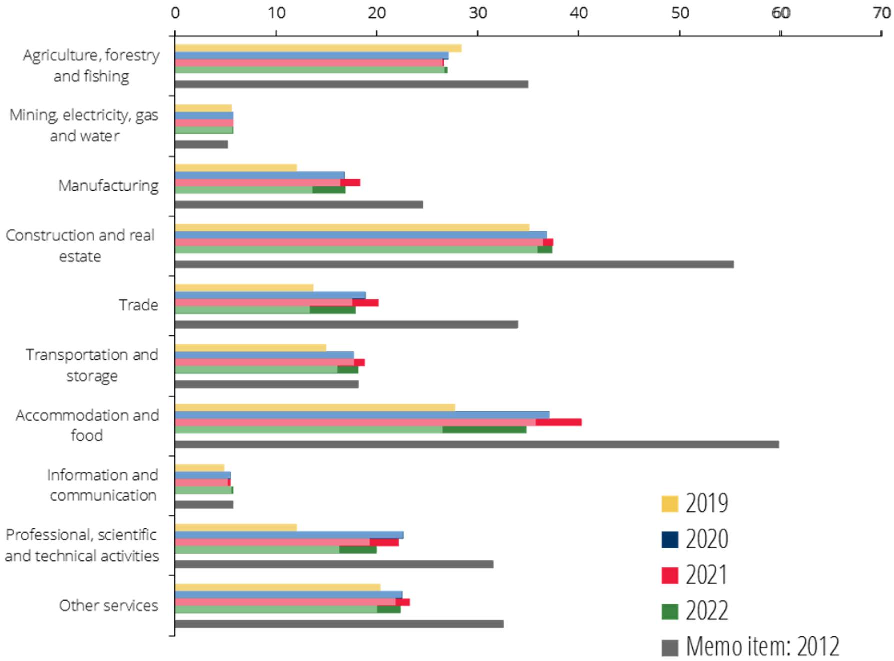


FIGURE 5: Share of excess debt to total debt by sector of activity in the central and severe scenarios | Percentage

Notes: Each bar details the central scenario (in a lighter colour) and the severe scenario (in a darker colour). The proportion of excess debt in the severe scenario exceeds the proportion in the central scenario over the entire projection horizon.

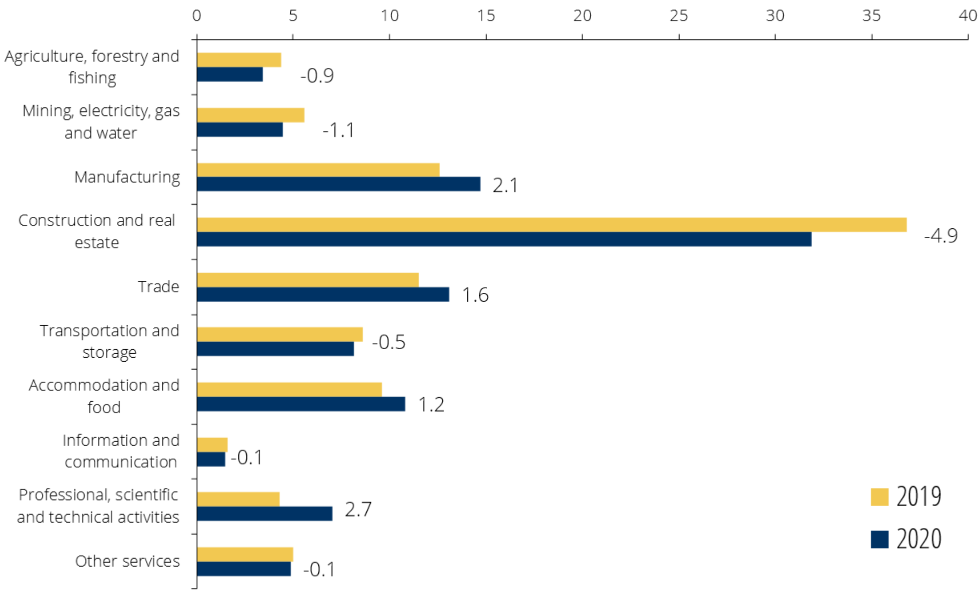


FIGURE 6: Share of each sector's excess debt to total excess debt | Percentage

Notes: The values presented at the top of each bar correspond to the difference in percentage points between the estimated share for 2020 and the estimated share for 2019.

5. Vulnerability, liquidity and capitalisation of firms

Financial vulnerability is enhanced or mitigated by the level of liquidity and capitalisation of firms. Firms with higher liquidity levels own more resources to limit the negative impact of shocks in the short term. In turn, more capitalised firms have, all other things being equal, more room to avoid insolvency if they experience prolonged losses in their activity.

Around 50% of the vulnerable firms' debt is concentrated in firms at the bottom two quartiles of the liquidity and capitalisation ratios in 2020 (Table 2). In turn, non-vulnerable firms' debt is more concentrated in firms in the intermediate capitalisation and liquidity quartiles. This pattern can also be observed by different activity sectors.

The conclusions are the same when analysing the distribution of the bank loan stock[27] in September 2020, as an alternative to the projected total debt stock, by capitalisation and liquidity quartiles (Table 3). Bank loans to vulnerable firms are more concentrated in the less liquid and capitalised quartiles and bank loans to non-vulnerable firms are more concentrated in the intermediate quartiles. The results also show a lower exposure of bank loans to less liquid and capitalised quartiles compared to the total debt stock, a pattern also visible when the different sectors of activity are analysed. This finding suggest that the creditworthiness of firms with bank loans, assessed purely on the basis of these two indicators, is superior to the creditworthiness of firms that do not use this source of financing.

This set of results reinforces the fragility of firms identified as vulnerable. The difficulty in generating results to service their debt, combined with the low level of liquidity and capitalisation, contributes to significantly increase the default risk associated with this set of firms in the context of the pandemic shock.

Vulnerable firms				
	Q1 - Lower capitalisation	Q2	Q3	Q4 - Larger capitalisation
Q1 - Lower liquidity	14	16	6	1
Q2	10	11	6	1
Q3	3	8	4	1
Q4 - Larger liquidity	4	12	3	1

Non-vulnerable firms				
	Q1 - Lower capitalisation	Q2	Q3	Q4 - Larger capitalisation
Q1 - Lower liquidity	1	20	11	1
Q2	1	11	24	2
Q3	1	6	7	2
Q4 - Higher liquidity	1	7	3	2

TABLE 2. Distribution of vulnerable and non-vulnerable firms' debt by liquidity and capitalisation ratios' quartiles | As a percentage of debt projected for end-2020

Notes: Capitalisation and liquidity quartiles are based on data from the IES for 2018. The liquidity ratio corresponds to the ratio of cash and deposits to current liabilities. The capitalisation ratio is the equity-to-assets ratio of each firm.

27. The information on bank loans was obtained from the Central Credit Register with reference to the end of September 2020.

Vulnerable firms	Q1 - Lower capitalisation	Q2	Q3	Q4 - Larger capitalisation
Q1 - Lower liquidity	10	21	8	1
Q2	5	15	7	1
Q3	2	7	4	1
Q4 - Higher liquidity	1	15	2	1

Non-vulnerable firms	Q1 - Lower capitalisation	Q2	Q3	Q4 - Larger capitalisation
Q1 - Lower liquidity	1	13	12	1
Q2	1	15	18	3
Q3	1	8	12	3
Q4 - Larger liquidity	0	3	5	3

TABLE 3. Distribution of vulnerable and non-vulnerable firms' bank loans by liquidity and capitalisation ratios' quartiles | As a percentage of bank loans observed in September 2020 at the Central Credit Register

Notes: Capitalisation and liquidity quartiles are based on data from the IES for 2018. The liquidity ratio corresponds to the ratio of cash and deposits to current liabilities. The capitalisation ratio is the equity-to-assets ratio of each firm. The data on bank loans was obtained from the Central Credit Register with reference to the end of September 2020. It was not possible to determine the state of vulnerability associated with some firms because no balance sheet information was available (new firms or firms that had already given up business) or because they reported no interest expenses. Firms for which the vulnerability state was not defined weighed about 25% of the bank loan stock in September 2020.

6. Conclusion

This article presents projections for the financial vulnerability and excess debt of firms in Portugal for the period 2020-22, following the COVID-19 pandemic's negative economic shock. This shock has unique characteristics, both because of the uncertainty in its intensity and duration, and because of its heterogeneous impact among sectors of activity.

Based on two economic scenarios with different degrees of severity and recovery profiles, it is estimated an increase in the debt held by financially vulnerable firms and in excess debt over the projection horizon. In both scenarios, vulnerable firms' debt is expected to increase in 2020, and to decrease in 2021 and 2022. In a severe scenario, excess debt increases in 2020 and 2021. The recovery is faster in the central scenario, although insufficient to reach the values observed in 2019, in contrast to the slower recovery in the severe scenario.

Despite the increases projected, the share of financial debt held by firms in vulnerability remains below the peak observed during the sovereign debt crisis. The greater resilience of Portuguese firms follows from an increase in the firms' operating results and the reduction of interest paid in the period preceding the pandemic crisis, driven by accommodative monetary policy and the fall in firms' indebtedness.

The sectors of activity with the greatest increases in vulnerability and excess debt in 2020 are manufacturing, trade and accommodation and food. Among this sectors, the accommodation and food sector is the one with the most negative evolution in the severe scenario, as it is associated with a slower recovery profile.

The difficulty in generating results to service their debt, coupled with the low level of liquidity and capitalisation, contributes to increasing the risk associated with vulnerable firms in the context of the current pandemic shock. Nevertheless, the creditworthiness of firms with bank loans seems to be superior to the average creditworthiness of Portuguese firms.

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Appendix

A.1. *Methodology for the selection of variables*

This section provides a summary of the assumptions considered in the compilation of the three balance sheet items required to estimate the vulnerability and excess debt indicators.

1. EBITDA – In order to create a historical series with economic meaning for this period (2006-18), the IES items of each accounting standard were selected so as to obtain a consistent variable over the entire period analysed. In addition, the impact that changes in this variable will reproduce in the concept of Interest Expenses was considered, in particular, to avoid that an expense already assumed in EBITDA was again included in Interest Expenses.

   Correcting for these inconsistencies (by adding and subtracting the components in relation to the definition of EBITDA in SNC), the EBITDA was defined as

   EBITDA = Operating income - Operating costs
   + Financial income - Financial expenses - Funding costs (except interest expenses).

2. Interest expenses - The definition of interest expenses includes the interest on obtained financing and other interest expenses incurred by the company. It excludes other financing costs and losses, such as those associated with unfavourable currency exchange rates in order to be compatible with the changes implied in EBITDA.

3. Financial debt - Financial debt was defined as obtained financing and corresponds to the sum of credit granted by credit institutions, debt securities issued and intragroup credits obtained.

On the **economic and financial materiality of a firm**: a firm has been considered in the study if it had met each of the following requirements in at least one of the years in the dataset: (i) turnover above €5,000, (ii) financial debt above €5,000 and (iii) more than one person employed. This set of requirements implied the exclusion of about a quarter of all firms from the database. However, and because they are mostly small firms, they only account for approximately 10% of total assets, interest expenses and employees (Table A.1). The final set includes 399,621 enterprises.

On **firm groups by sector of activity and size**: the different combinations of size and sector of activity considered for the estimation process presented in section 3.1 considered eleven sectors of activity and four different firm sizes. Table A.2 summarises both dimensions.

Variable	Restrictions
Turnover	More than €5.000
Financial debt	More than €5.000
Employees	More than 1 (one) employee
Measuring restrictions impact	
Variable	***Proportion***
EBITDA	92%
Interest expenses	89%
Financial debt	87%
Employees	93%
Total assets	88%
Equity	88%
Liabilities	87%
Number of firms	71%

TABLE A.1. Firms selection criteria and assessment of the impact of each criteria | Percentage

Note: Firms which have satisfied each of the conditions at least once over 2006-18. Proportion stands for average ratio of selected firms to the total number of firms in IES in each year. The lower proportion associated to the variable *number of firms* reflects a larger impact of the restrictions on smaller firms.

Sectors of activity		
1	A	Agriculture, Forestry and Fishing
2	B+D+E	Mining and quarrying, Electricity, Gas and Water
3	C	Manufacturing
4	F (41) + L	Construction and Real estate activities
5	F (42+43)	Other construction
6	G	Trade
7	H	Transportation and storage
8	I	Accomodation and food service activities
9	J	Information and communication
10	M+N	Professional, scientific, technical and administrative activities
11	Other sectors	Other services

Firm size	
1	Micro firms
2	Small firms
3	Medium firms
4	Large firms

TABLE A.2. Activity sectors and Firm size

Notes: The activity sectors were built based on the Portuguese Classification of Economic Activities (CAE) - 3rd Revision. The Construction and Real estate activities sector comprises divisions 41 and 68 and the Other construction sector comprises divisions 42 and 43. This decomposition of the Construction sector segments between construction and real estate activities and engineering activities and is designed to distinguish between the two sectors' different behaviours: the maximum for the overdue loans ratio was around 33% in divisions 41 and 68, in contrast to around 21% in divisions 42 and 43. Also the behaviour between the two sets of divisions was unsynchronised during the sovereign debt crisis, having stabilised sooner in divisions 42 and 43. However, since this only affects the estimation process, the final results may be considered in aggregate form. The firm size definition takes Recommendation of the European Commission 2003/361/EC as reference. NFCs with activities of head offices were excluded.

A.2. *Specifications and results' tables*

Group	Activity sector	Firm size	GVA					*Compensation of employees*				
			Total	With an export activity dummy	With an incumbent firm dummy	Without dummy variables	Equation by firm size only	*Total*	With an export activity dummy	With an incumbent firm dummy	Without dummy variables	Equation by firm size only
1	A	1	x					*x*				
2	A	2				x				*x*		
3	A	3					x					*x*
4	A	4					x					*x*
5	B+D+E	1			x			*x*				
6	B+D+E	2	x							*x*		
7	B+D+E	3					x					*x*
8	B+D+E	4					x					*x*
9	C	1	x							*x*		
10	C	2	x					*x*				
11	C	3	x					*x*				
12	C	4		x							*x*	
13	F (41) + L	1					x					*x*
14	F (41) + L	2			x					*x*		
15	F (41) + L	3	x							*x*		
16	F (41) + L	4					x					*x*
17	F(42+43)	1			x			*x*				
18	F(42+43)	2				x				*x*		
19	F(42+43)	3			x					*x*		
20	F(42+43)	4					x					*x*
21	G	1	x					*x*				
22	G	2	x					*x*				
23	G	3			x			*x*				
24	G	4				x					*x*	
25	H	1		x				*x*				
26	H	2					x					*x*
27	H	3				x		*x*				
28	H	4					x					*x*
29	I	1			x			*x*				
30	I	2	x					*x*				
31	I	3	x							*x*		
32	I	4				x					*x*	
33	J	1					x					*x*
34	J	2					x					*x*
35	J	3			x			*x*				
36	J	4					x					*x*
37	M+N	1	x							*x*		
38	M+N	2		x				*x*				
39	M+N	3			x					*x*		
40	M+N	4				x					*x*	
41	Other sectors	1			x					*x*		
42	Other sectors	2					x					*x*
43	Other sectors	3	x							*x*		
44	Other sectors	4					x					*x*

TABLE A.3. Allocation of groups by type of specification: GVA and compensation of employees

Notes: The full definition considers the definitions in equations (10) and (11), the reduced definitions consider equations that exclude one or all of the categorical variables, and the overall definition by firm size considers firms in groups not allocated to the remaining equations. For groups 4, 7, 13, 34 and 42, the overall specification by firm size was chosen because the evolution implied by EBITDA is counter-cyclical to the evolution of GDP, with the largest positive change corresponding hypothetically to the 2020 shock. Finally, if the specification chosen for GVA was an aggregate change by firm size, a similar choice was made for employee compensation, even if there was a statistically significant specification for this variable.

Group	Activity sector	Firm size	Interest expenses		*Financial debt*		
			Total	Equation by firm size only	*Total*	*Without changes on the interest rate on new loans*	Equation by firm size only
1	A	1	x				*x*
2	A	2	x				*x*
3	A	3		x			*x*
4	A	4		x			*x*
5	B+D+E	1		x			*x*
6	B+D+E	2		x			*x*
7	B+D+E	3		x			*x*
8	B+D+E	4		x			*x*
9	C	1		x		*x*	
10	C	2	x		*x*		
11	C	3	x			*x*	
12	C	4	x			*x*	
13	F (41) + L	1	x		*x*		
14	F (41) + L	2	x			*x*	
15	F (41) + L	3		x		*x*	
16	F (41) + L	4		x			*x*
17	F(42+43)	1		x			*x*
18	F(42+43)	2		x			*x*
19	F(42+43)	3		x		*x*	
20	F(42+43)	4		x			*x*
21	G	1	x		*x*		
22	G	2		x		*x*	
23	G	3		x			*x*
24	G	4		x		*x*	
25	H	1		x			*x*
26	H	2		x			*x*
27	H	3		x			*x*
28	H	4		x			*x*
29	I	1		x			*x*
30	I	2		x			*x*
31	I	3	x				*x*
32	I	4		x			*x*
33	J	1		x			*x*
34	J	2		x			*x*
35	J	3		x			*x*
36	J	4		x			*x*
37	M+N	1		x			*x*
38	M+N	2		x			*x*
39	M+N	3		x			*x*
40	M+N	4		x			*x*
41	Other sectors	1	x				*x*
42	Other sectors	2	x				*x*
43	Other sectors	3		x			*x*
44	Other sectors	4		x			*x*

TABLE A.4. Allocation of groups by type of specification: Interest expenses and financial debt

Notes: The full definition considers the definitions in equations (12) and (13), the reduced definitions consider equations that exclude one or all of the categorical variables, and the overall definition by firm size considers firms in groups not allocated to the remaining equations.

Dependent variables	GVA (1)	GVA (2)	GVA (5)	GVA (6)	GVA (9)	GVA (10)	GVA (11)	GVA (12)	GVA (14)	GVA (15)	GVA (17)	GVA (18)	GVA (19)	GVA (21)	GVA (22)
yoy_GVA	133,918***	250,480**	503,178***	2.887e+06***	232,435***	1.126e+06***	6.583e+06***	1.967e+07**	2.494e+06***	1.853e+07***	283,869***	1.023e+06***	1.150e+07***	175,341***	1.414e+06***
	(13,083)	(106,610)	(128,428)	(763,620)	(7,781)	(54,948)	(1.077e+06)	(9.515e+06)	(169,921)	(4.615e+06)	(27,898)	(148,430)	(2.617e+06)	(5,249)	(88,811)
yoy_GVA*Dummy(Incumbent firm=1)	-147,293***	-	-460,571***	-2.514e+06***	-160,676***	-753,704***	-4.641e+06***	-	-984,420***	-1.063e+07***	-106,301***	-	-6.320e+06**	-96,301***	-708,788***
	(19,488)		(137,846)	(800,532)	(8,934)	(58,141)	(1.063e+06)		(185,388)	(3.844e+06)	(31,078)		(2.765e+06)	(6,802)	(91,811)
yoy_GVA*Dummy(Exp.activity=1)	225,390***	-		972,839**	137,191***	448,113***	986,510***	2.007e+07*	-	-4.541e+06*	-	-	-	51,734*	266,866***
	(85,435)			(451,573)	(29,169)	(49,967)	(355,255)	(1.132e+07)		(2.708e+06)				(28,508)	(103,474)
Constant	968.7***	17,688***	-5,041*	11,819	-2,965***	964.3	20,177**	-193,128	-15,048***	43,672	-6,305***	-11,314**	-98,081***	-2,007***	-2,132**
	(363.2)	(4,149)	(2,921)	(8,642)	(222.3)	(778.8)	(8,527)	(379,822)	(3,969)	(61,176)	(622.8)	(4,950)	(35,033)	(227.1)	(967.1)
Observations	86,680	11,148	11,923	5,383	229,931	112,246	25,631	3,615	40,078	3,642	119,314	27,366	3,590	742,902	102,387
R^2	0.001	0.000	0.001	0.005	0.002	0.009	0.008	0.003	0.007	0.013	0.001	0.004	0.011	0.001	0.009

Dependent variables	GVA (23)	GVA (24)	GVA (25)	GVA (27)	GVA (29)	GVA (30)	GVA (31)	GVA (32)	GVA (35)	GVA (37)	GVA (38)	GVA (39)	GVA (40)	GVA (41)	GVA (43)
yoy_GVA	1.004e+07***	3.575e+07***	51,721***	6.487e+06***	205,537***	1.379e+06***	7.226e+06***	2.946e+07***	2.222e+07***	243,619***	613,903***	9.847e+06***	2.447e+07***	135,202***	5.870e+06**
	(1.506e+06)	(6.901e+06)	(15,442)	(1.728e+06)	(6,300)	(63,995)	(891,762)	(4.915e+06)	(4.969e+06)	(32,530)	(227,922)	(1.310e+06)	(7.974e+06)	(5,856)	(2.529e+06)
yoy_GVA*Dummy(Incumbent firm=1)	-5.542e+06***	-	-	-	-92,879***	-638,847***	-3.234e+06***	-	-1.751e+07***	-114,775***	-	-4.051e+06***	-	-88,068***	-5.261e+06*
	(1.532e+06)				(6,873)	(66,420)	(899,198)		(5.130e+06)	(27,646)		(1.406e+06)		(4,763)	(2.776e+06)
yoy_GVA*Dummy(Exp.activity=1)	-	-	146,747***	-	-	1.280e+06***	2.993e+06**	-	-	165,885*	819,731***	-	-	-	1.389e+07***
			(25,612)			(344,230)	(1.356e+06)			(86,323)	(270,434)				(4.191e+06)
Constant	-21,634	226,432	-1,249*	-82,593	-1,770***	4,908**	72,661***	166,907	126,139***	-4,062***	16,454**	16,256	680,645**	-341.9	120,724***
	(13,201)	(230,580)	(697.9)	(73,271)	(117.4)	(2,200)	(12,314)	(157,978)	(46,333)	(1,023)	(7,108)	(25,230)	(282,056)	(324.7)	(42,631)
Observations	12,766	2,192	135,528	3,314	231,890	38,761	4,446	515	1,955	181,498	24,127	5,188	1,785	331,469	3,601
R^2	0.015	0.012	0.000	0.004	0.008	0.016	0.045	0.061	0.022	0.000	0.001	0.018	0.005	0.000	0.003

Robust standard deviation in brackets.
*** p<0.01, ** p<0.05, * p<0.1

TABLE A.5. Results of the regressions used in the projection of balance sheet items by group | GVA

Notes: The results are for the period 2007-18. Only estimates for which a specification at the group level has been considered are presented.

Dependent variables	Com_Emp (1)	Com_Emp (2)	Com_Emp (5)	Com_Emp (6)	Com_Emp (9)	Com_Emp (10)	Com_Emp (11)	Com_Emp (12)	Com_Emp (14)	Com_Emp (15)	Com_Emp (17)	Com_Emp (18)	Com_Emp (19)	Com_Emp (21)	Com_Emp (22)
yoy_Com_Emp	47,753***	490,974***	126,342***	726,344***	111,074***	503,902***	3.761e+06***	5.589e+06***	852,925***	5.129e+06***	117,827***	662,348***	6.531e+06***	66,834***	499,238***
	(3,105)	(63,736)	(17,946)	(203,007)	(4,311)	(25,052)	(483,354)	(1.102e+06)	(98,375)	(856,110)	(7,788)	(80,137)	(1.242e+06)	(1,295)	(25,421)
yoy_Com_Emp*Dummy(Incumbent firm=	-34,099***	-420,277***	-106,049***	-431,786**	-70,704***	-360,712***	-3.214e+06***	-	-505,664***	-3.572e+06***	-38,859***	-283,914***	-3.319e+06**	-38,029***	-271,420***
	(3,638)	(67,417)	(20,512)	(209,177)	(5,345)	(26,879)	(495,871)		(102,596)	(900,255)	(8,594)	(84,114)	(1.312e+06)	(1,534)	(26,262)
yoy_Com_Emp*Dummy(Exp.activity=1)	37,856**	-	-97,923**	-	-	138,654***	463,137***	-	-	-	-73,540***	-	-	18,159***	76,673***
	(16,207)		(45,820)			(19,117)	(126,182)				(27,493)			(5,619)	(26,694)
Constant	941.0***	12,742***	-1,093***	4,365***	-1,702***	8,110***	49,633***	265,069***	1,446	75,026***	-2,922***	3,234***	9,878	-268.6***	7,636***
	(80.04)	(950.9)	(397.0)	(1,690)	(125.6)	(347.4)	(2,771)	(43,607)	(945.8)	(12,368)	(154.4)	(989.5)	(17,136)	(30.33)	(326.0)
Observations	74,560	11,138	9,707	5,224	210,425	112,212	25,615	3,605	39,386	3,595	110,430	27,332	3,586	673,939	102,233
R^2	0.004	0.009	0.006	0.015	0.003	0.010	0.015	0.007	0.010	0.021	0.005	0.010	0.026	0.005	0.013

Dependent variables	Com_Emp (23)	Com_Emp (24)	Com_Emp (25)	Com_Emp (27)	Com_Emp (29)	Com_Emp (30)	Com_Emp (31)	Com_Emp (32)	Com_Emp (35)	Com_Emp (37)	Com_Emp (38)	Com_Emp (39)	Com_Emp (40)	Com_Emp (41)	Com_Emp (43)
yoy_Com_Emp	3.603e+06***	8.405e+06***	95,684***	4.223e+06***	81,362***	591,501***	4.061e+06***	1.160e+07***	1.087e+07***	92,104***	650,487***	4.388e+06***	1.269e+07***	51,477***	4.115e+06***
	(564,522)	(1.948e+06)	(4,769)	(1.377e+06)	(2,106)	(26,298)	(450,596)	(2.263e+06)	(2.522e+06)	(4,775)	(87,291)	(777,062)	(2.604e+06)	(2,274)	(1.064e+06)
yoy_Com_Emp*Dummy(Incumbent firm=	-2.070e+06***	-	-76,272***	-3.462e+06**	-48,410***	-352,979***	-2.683e+06***	-	-1.020e+07***	-39,784***	-317,355***	-2.426e+06***	-	-28,550***	-3.192e+06***
	(571,970)		(5,225)	(1.390e+06)	(2,438)	(29,950)	(462,256)		(2.590e+06)	(6,906)	(96,682)	(815,174)		(1,856)	(1.081e+06)
yoy_Com_Emp*Dummy(Exp.activity=1)	-666,778***	-	49,908***	1.334e+06***	30,240**	223,406**	-	-	1.973e+06	-	217,729*	-	-	-	-
	(237,268)		(11,346)	(408,410)	(13,982)	(105,462)			(1.245e+06)		(117,398)				
Constant	32,392***	458,987***	84.49	73,465***	-60.03	9,817***	53,491***	210,697**	169,949***	-535.2***	13,337***	78,671***	725,599***	610.1***	108,606***
	(4,928)	(93,417)	(79.50)	(9,017)	(43.36)	(626.9)	(6,356)	(94,006)	(24,790)	(162.6)	(1,506)	(13,136)	(109,412)	(220.4)	(12,505)
Observations	12,731	2,187	126,766	3,312	209,071	38,733	4,446	515	1,954	158,495	24,087	5,164	1,781	298,981	3,585
R^2	0.016	0.005	0.005	0.021	0.010	0.023	0.043	0.048	0.028	0.002	0.006	0.014	0.009	0.000	0.008

Robust standard deviation in brackets.
*** p<0.01, ** p<0.05, * p<0.1

TABLE A.6. Results of the regressions used in the projection of balance sheet items by group | Compensation of employees

Notes: The results are for the period 2007-18. Only estimates for which a specification at the group level has been considered are presented. For group 35 (medium-sized firms in the Information and communication sector), it was decided to maintain the specification with the two categorical dimensions (incumbent firms and exporting firms), as both categories are significant in individual regressions (although at a different level of significance).

Dependent variables	Interests (1)	Interests (2)	Interests (10)	Interests (11)	Interests (12)	Interests (13)	Interests (14)	Interests (21)	Interests (31)	Interests (41)	Interests (42)
yoy_fin_debt	9,172***	22,311*	17,861***	106,207***	2.173e+06***	51,819***	172,974***	4,383***	248,019**	4,856**	13,136**
	(2,492)	(12,864)	(5,477)	(27,638)	(838,613)	(3,802)	(30,540)	(645.2)	(119,650)	(2,120)	(5,227)
Δ_new_loans_rate	63,463***	357,359***	287,806***	2.548e+06***	1.661e+07***	42,076**	324,212**	40,787***	1.700e+06***	37,602***	265,678***
	(12,037)	(68,218)	(20,121)	(161,481)	(6.068e+06)	(18,891)	(127,936)	(4,305)	(485,894)	(4,082)	(25,234)
Δ_new_loans_rate*Dummy(Vuln.I	114,694***	778,721***	401,757***	2.822e+06***	2.897e+07**	591,417***	3.937e+06***	64,134***	9.191e+06***	58,020***	341,211***
	(38,637)	(284,646)	(103,623)	(527,025)	(1.474e+07)	(38,801)	(452,852)	(6,139)	(1.719e+06)	(16,892)	(92,789)
Constant	582.8***	1,822***	247.2	4,064***	52,635	-1,648***	-4,419***	-107.4***	8,698	174.5***	598.6**
	(125.6)	(704.4)	(157.3)	(1,331)	(73,427)	(249.5)	(1,666)	(37.51)	(6,640)	(40.08)	(286.1)
Observations	52,887	9,246	95,659	23,044	3,199	178,318	33,307	459,259	3,882	180,150	24,846
R^2	0.003	0.010	0.005	0.032	0.005	0.005	0.011	0.002	0.027	0.001	0.008

Robust standard deviation in brackets.

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

TABLE A.7. Results of the regressions used in the projection of balance sheet items by group | Interest expenses

Notes: The results are for the period 2007-18. Only estimates for which a specification at the group level has been considered are presented.

Dependent variables	fin_debt (9)	fin_debt (10)	fin_debt (11)	fin_debt (12)	fin_debt (13)	fin_debt (14)	fin_debt (15)	fin_debt (19)	fin_debt (21)	fin_debt (22)	fin_debt (24)
yoy_fin_debt	43,151**	232,527***	1.845e+06***	5.017e+07**	724,235***	2.760e+06***	1.856e+07***	2.667e+06***	57,919***	288,761***	2.949e+07*
	(20,086)	(44,165)	(311,187)	(2.358e+07)	(44,415)	(404,843)	(6.566e+06)	(797,266)	(4,426)	(53,375)	(1.739e+07)
Δ_new_loans_rate	-	-1.678e+06***	-	-	-698,846***	-	-	-	-187,847***	-	-
		(388,699)			(247,231)				(33,169)		
Dummy(Vuln.Ind=1)	-8,103***	-17,088*	-155,575**	-6.219e+06*	-43,681***	-350,385***	-2.405e+06**	-579,225**	-10,318***	-84,513***	-4.016e+06**
	(2,579)	(10,289)	(64,421)	(3.521e+06)	(4,891)	(53,968)	(1.056e+06)	(227,397)	(442.6)	(20,042)	(1.832e+06)
Constant	9,373***	28,615***	185,093***	2.081e+06***	25,212***	-30,698*	64,987	269,228***	6,396***	45,884***	1.556e+06**
	(759.1)	(1,842)	(17,910)	(789,085)	(3,230)	(16,607)	(346,700)	(60,181)	(264.7)	(4,793)	(775,583)
Observations	179,592	100,577	23,664	3,319	243,094	35,581	3,381	3,384	580,728	92,034	1,831
R^2	0.000	0.000	0.002	0.004	0.001	0.004	0.006	0.006	0.001	0.000	0.005

Robust standard deviation in brackets.

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

TABLE A.8. Results of the regressions used in the projections of balance sheet items by group | Financial debt

Notes: The results are for the period 2007-18. Only estimates for which a specification at the group level has been considered are presented.

Dependent variables	GVA Micro	GVA Small	GVA Medium-sized	GVA Large
yoy_GVA	212,463***	1.554e+06***	1.067e+07***	2.851e+07***
	(5,063)	(80,937)	(716,730)	(4.813e+06)
yoy_GVA*Dummy(Incumbent firm=1)	-120,288***	-851,293***	-6.966e+06***	-
	(6,092)	(73,532)	(714,595)	
yoy_GVA*Dummy(Exp.activity=1)	-	-	-	-
Constant	-3,327***	315.9	20,458***	313,180*
	(152.2)	(996.6)	(7,858)	(183,681)
Observations	2,442,136	418,376	66,411	11,150
R^2	0.000	0.004	0.008	0.002

Robust standard deviation in brackets.
*** p<0.01, ** p<0.05, * p<0.1

TABLE A.9. Results of the regressions used in the projection of balance sheet items by firm size | GVA

Note: The results refer to the period 2007-18.

Dependent variables	Com_Emp Micro	Com_Emp Small	Com_Emp Medium-sized	Com_Emp Large
yoy_Com_Emp	81,523***	619,015***	4.623e+06***	9.862e+06***
	(1,087)	(18,255)	(268,901)	(1.002e+06)
yoy_Com_Emp*Dummy(Incumbent firm=1)	-43,167***	-378,894***	-3.344e+06***	-
	(1,298)	(18,895)	(272,980)	
yoy_Com_Emp*Dummy(Exp.activity=1)	-	-	-	-
Constant	-694.6***	8,683***	56,397***	394,002***
	(40.82)	(213.5)	(2,448)	(47,848)
Observations	2,144,336	417,159	66,228	11,117
R^2	0.001	0.010	0.016	0.006

Robust standard deviation in brackets.
*** p<0.01, ** p<0.05, * p<0.1

TABLE A.10. Results of the regressions used in the projection of balance sheet items by firm size | Compensation of employees

Note: The results refer to the period 2007-2018.

Dependent variables	Interests Micro	Interests Small	Interests Medium-sized	Interests Large
yoy_fin_debt	4,962***	19,922***	161,404***	1.867e+06
	(503.1)	(4,645)	(39,675)	(1.477e+06)
Δ_new_loans_rate	58,843***	444,648***	3.358e+06***	4.722e+07***
	(2,537)	(36,943)	(320,668)	(1.234e+07)
Dummy(Vuln.Ind=1)	-1,094***	-6,006***	-30,573***	-
	(190.9)	(1,273)	(8,485)	
yoy_fin_debt*Dummy(Vuln.Ind=1)	13,105***	83,221***	630,965***	-
	(2,652)	(20,151)	(187,036)	
Δ_new_loans_rate*Dummy(Vuln.Ind=1)	118,427***	662,807***	3.862e+06***	1.445e+07
	(14,532)	(143,035)	(1.314e+06)	(1.666e+07)
Constant	351.3***	2,012***	10,343***	144,666
	(25.74)	(271.5)	(2,261)	(89,934)
Observations	1,413,959	349,314	58,250	9,693
R^2	0.001	0.003	0.011	0.006

Robust standard deviation in brackets.

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

TABLE A.11. Results of the regressions used in the projection of balance sheet items by firm size | Interest expenses

Note: The results are for the period 2007-18. In contrast to the specification considered for the groups, the estimation of interest expenses included two additional categorical variables, which were statistically significant in aggregate terms, but were generally not at the group level. These two dimensions detail the impact of a firm having been vulnerable in the previous period.

Dependent variables	fin_debt Micro	fin_debt Small	fin_debt Medium-sized	fin_debt Large
yoy_fin_debt	147,438***	593,097***	4.585e+06***	5.153e+07**
	(12,302)	(65,046)	(590,504)	(2.312e+07)
Δ_new_loans_rate	-	-	-	1.725e+08**
				(8.116e+07)
Dummy(Vuln.Ind=1)	-6,703***	-74,320***	-412,708***	-5.629e+06***
	(1,550)	(11,534)	(123,292)	(2.105e+06)
Constant	10,307***	32,482***	221,188***	3.164e+06**
	(544.9)	(2,955)	(61,217)	(1.271e+06)
Observations	1,835,051	370,472	60,244	10,036
R^2	0.000	0.000	0.000	0.002

Robust standard deviation in brackets.

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

TABLE A.12. Results of the regressions used in the projection of balance sheet items by firm size | Financial debt

Note: The results refer to the period 2007-18.

Non-technical summary

January 2021

Lessons from a finitely-lived agents structural model

Paulo Júlio and José R. Maria

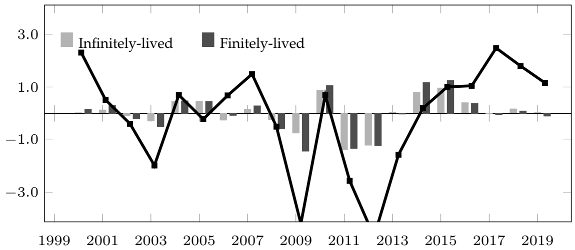
Different structural models may offer distinct interpretations of business cycle fluctuations when brought against the data. In this article, we use two alternative models—identical in all dimensions except the households structure—to interpret recent history in light of structural shocks. The infinitely-lived agents model follows standard practice in the literature, with households valuing events along an infinite horizon. In the finitely-lived agents model, households have finite lifetimes, and the relevant decision horizon is shifted towards the short run.

Our choice of models allows us to evaluate whether the events shaping the Portuguese economy are endowed with distinct implications as far as the economic narrative is concerned. Two crisis periods stand out in the recent past: the 2009 downturn, after the bankruptcy of Lehman Brothers and the large fall in world trade; and the 2011–2012 collapse, amidst a sovereign debt crisis in the euro area. The built up of significant macroeconomic imbalances until then was at the origin of the economic and financial assistance programme that came into force in 2011, which, among other measures targeted to correct fiscal imbalances, triggered the most severe increase in taxation in recent history.

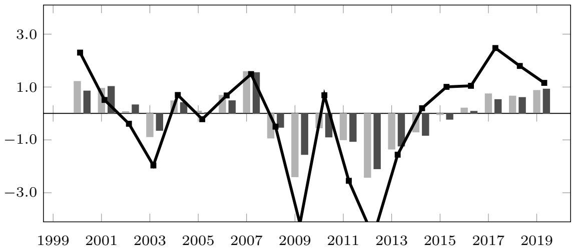
Fiscal developments may trigger stronger wealth effects in finitely-lived agents model due to the shorter planning horizon, when compared with the infinitely-lived agents model, since deficits will be partially supported by future taxes that will be paid by yet-to-be-born generations. This could trigger larger contributions of fiscal developments to GDP fluctuations in the finitely-lived model, which the infinitely-lived agents model could attribute to alternative mechanisms, such as demand or technology perturbations.

Our results suggest that shifting the relevant decision horizon of households towards the short run does not bring about qualitatively different interpretations. The contributions of demand, technology, markup, foreign, fiscal and financial shocks to the growth rate of Gross Domestic Product (GDP) are all relatively close across both models over the last twenty years (Figure 1). The recent two crisis period are no different. The active fiscal policy ensuring debt stability and the presence of households consuming all their income in each period, who in the infinitely-lived agents model play a more prominent role, are pivotal for the models' results.

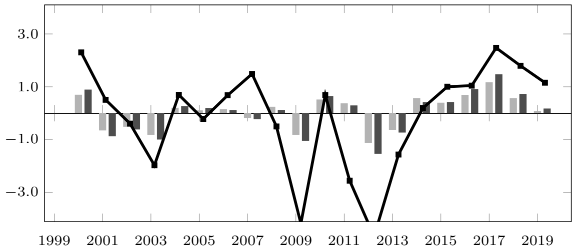
Nevertheless, some divergences stand out. Technology shocks play a more important role on GDP developments in the infinitely-lived agents model, with the largest



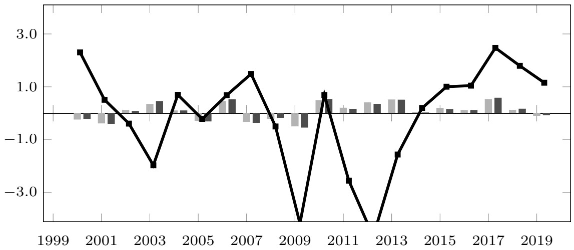
(A) Demand.



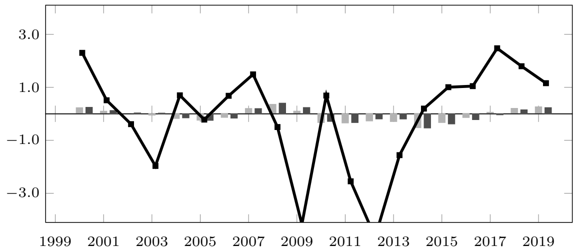
(B) Technology.



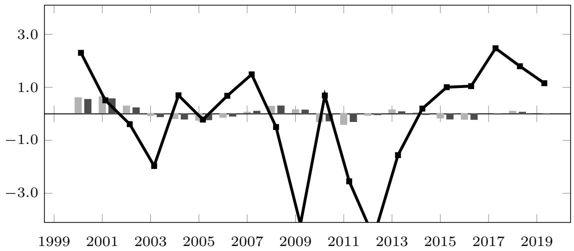
(C) Markup.



(D) Foreign.



(E) Fiscal.



(F) Financial.

FIGURE 1: Historical decomposition of the Portuguese GDP growth.

Notes: GDP growth rates in percentage (black line), and contributions of components in percentage points.

contributions to GDP growth taking place in the downturns of 2009 and 2012. On the opposite direction, demand plays a more important role in the finitely-lived agents model, with the largest contributions taking place during the 2011–2012 downturn and the 2014's recovery. In addition, we detected a small but positive co-movement between public and private consumption in the finitely-lived agents model, in contrast with the infinitely-lived case. Contributions of fiscal shocks to GDP growth—where we expected more important differences across models—are in general close, and play a second-order role in recent business cycle developments.

Lessons from a finitely-lived agents structural model

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January 2021

Abstract
We aim at identifying differences in the narrative for the Portuguese economy brought about by two estimated structural models, identical in all dimensions except the households structure. In the finitely-lived agents model, households live according to the overlapping-generations scheme. They have have stochastic finite lifetimes, attributing greater economic value to near-term events. The infinitely-lived agents model follows standard practice in the literature. We show that the households structure triggers little quantitative differences in the narrative. When exist, they work mostly through the effects of demand shocks, which play a more prominent role in economic developments in the finitely-lived agents model, and which are alternatively channeled to technological perturbations in the infinitely-lived agents model. These differences do not convey an alternative narrative in qualitative terms and fail to deliver a dramatically different overview for the Portuguese economy over the 1999–2019 period. Two important components in this outcome are the presence of hand-to-mouth households in the infinitely-lived agents model—which creates non-negligible non-Ricardian effects—and the always active fiscal rule—which greatly limits debt financing of public expenditures. (JEL: C11, C13, E20, E32)

Keywords: DSGE models, euro area, small-open economy, Bayesian estimation, OLG, finitely-lived, infinitely-lived.

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1. Introduction

In the last two decades (1999–2019), the Portuguese economy depicted a rich set of perturbations, from distinct origins. Economic developments were shaped by several driving forces—external events, financing conditions or discretionary fiscal policy, amongst others—alternating between favorable and unfavorable environments. Two crisis periods stand out in the recent period: the 2009 downturn, after the bankruptcy of Lehman Brothers and the large fall in world trade; and the 2011–2012 collapse, amidst a sovereign debt crisis in the euro area. The built up of significant economic imbalances until then was at the origin of the economic and financial assistance programme that came into force in 2011, which, among other measures, triggered the most severe increase in taxation in recent history.

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Estimated Dynamic Stochastic General Equilibrium (DSGE) models provide a structural interpretation of business cycle fluctuations, and estimation byproducts—of which the most important are historical and variance decompositions and impulse response functions—constitute powerful storytelling devices and instruments of policy analysis.[1] However, the view provided by these models greatly depends on their structure, and different underlying characteristics may lead to competing interpretations of history. One key dimension in which these models may differ is with respect to the household structure, which greatly affects the intrinsic Ricardian features and results in different interpretations of fiscal developments, such as those related with the accumulation of large fiscal imbalances prior to 2011 and those triggered by the financial assistance programme onwards.

This article is related with a long tradition in economics concerning model misspecification, and the DSGE empirical literature places an important focus on shock dynamics.[2] Herein we focus on the narrative produced by two estimated models for Portugal, identical in all dimensions except the households structure. Both are medium-scale models for an economy integrated in a monetary union, embodying imperfect market competition and frictions, as most influential references in the field do (*e.g.* Smets and Wouters 2003; Christiano *et al.* 2005; Adolfson *et al.* 2007). The financial sector is modeled along the lines in Bernanke *et al.* (1999) and Christiano *et al.* (2014).

The infinitely-lived agents model (henceforth *INF model*) follows standard practice in the literature. Households can be of two types: asset holders or hand-to-mouth. The consumption decision of asset holders is to a great extent based on the permanent income hypothesis. They are able in general to smooth out consumption over time, accessing financial markets to buy and sell assets as required. Intrinsic Ricardian features generate an indifference between tax and debt financing of public expenditures, since

1. The implementation and estimation of DSGE models has assumed an important role amongst a number of policy-making institutions, such as the *Riksbank* (Adolfson *et al.* 2008), the *Suomen Pankki* (Kilponen *et al.* 2016), the *Bundesbank* (Gadatsch *et al.* 2015), the European Central Bank (Christoffel *et al.* 2008), the *Banco Central do Brasil* (De Castro *et al.* 2015), or the European Commission (Ratto *et al.* 2009). Several episodes affecting the Portuguese economy have already been identified and analyzed in light of DSGE models. Almeida *et al.* (2009) use a calibrated overlapping-generations model—the PESSOA model—to evaluate, in the European context, the effects of several disturbances on the Portuguese economy. Technical details can be found in Almeida *et al.* 2013a. Castro *et al.* (2015) evaluate the economic environment under which a fiscal consolidation policy may lead to an higher debt in the short run, in percentage of Gross Domestic Product (GDP). Other examples of applications in a calibrated framework include Almeida *et al.* (2010, 2013b) and Castro *et al.* (2013). Júlio and Maria (2017) present an estimated version of the PESSOA model to address the post-2008 period. This version has also been used to identify the main determinants behind GDP projectons of Banco de Portugal over 2020–2022 (Banco de Portugal 2020).

2. For instance, Ireland (2004) admits that the reduced-form equations of a DSGE have measurement errors that follow a VAR; Cúrdia and Reis (2010) consider that the exogenous disturbances may not be independent autoregressive processes of order one; Schmitt-Grohé and Uribe (2011) favor the inclusion of a common stochastic trend in neutral and investment-specific productivity; Justiniano and Preston (2010) claim that correlated cross-country shocks is an adequate step to account for the variability observed in the data. More recently, Den Haan and Drechsel (2020) post severe alerts on the conclusions drawn from estimated models since these can be severely distorted if structural disturbances enter the model in an incorrect way.

the latter instrument is equivalent to future taxes and therefore severely impacts present wealth. Since the level of net foreign assets (NFA) is not pinned down to a particular long-run equilibrium level (Harrison *et al.* 2005), it is common to assume that higher NFA drives a wedge between domestic and foreign interest rates (Schmitt-Grohe and Uribe 2003) in order to pin down the steady state. Admitting that some households do not have asset to financial markets and consume all their income in each period (hand-to-mouth households) introduces some "sand in wheels" in the above-mentioned Ricardian features (Galí *et al.* 2007).

The finitely-lived agents model, on the other hand, has intrinsic non-Ricardian features. Households evolve according to an Overlapping Generations (OLG) scheme, along the lines initially suggested by Blanchard (1985) and Yaari (1965), and are subject to stochastic finite lifetimes and decaying labor productivity. They strongly prefer to finance government expenditure through public debt issuance, since future taxes will be charged largely on yet-to-be born generations or paid later in life, when labor income is lower due to decaying labor productivity. The model should therefore more easily generate realistic private consumption responses to government expenditure shocks (Blanchard 1985; Galí *et al.* 2007). Instead of biological death, the household structure can be interpreted as an indicator of the degree of "myopia," where the future is a period of lower economic relevance (Bayoumi and Sgherri 2006). Adding hand-to-mouth households in this framework creates another layer of non-Ricardian effects. Finally, NFA is by nature a stationary and endogenously defined variable (Harrison *et al.* 2005).[3]

Our aim is to ascertain whether these two models provide a different interpretation of recent history for the Portuguese economy. Our choice of models is motivated by the large fiscal imbalances accumulated during the first decade of 2000's, and the fiscal adjustment that followed the 2011-12 sovereign debt crisis. This environment triggers a rich set of fiscal perturbations, which each model may address differently. Specifically, the shorter planning horizon of the overlapping-generations model may induce stronger wealth effects in the aftermath of fiscal developments when compared with the infinitely-lived agents model, as deficits will be supported by future taxes that may possibly be paid by yet-to-be-born generations. This could trigger larger contributions of fiscal developments to GDP fluctuations in the former model, which the latter one could attribute to alternative mechanisms, such as demand or technology perturbations.

Both models are estimated using Bayesian methods and quarterly observations for twenty four observable time series, over the 1999:1–2019:4 period. These include real, nominal and financial variables. The stochastic behavior is driven by twenty four structural shocks, grouped into six distinct categories: demand (public and private), technology, markup, financial, fiscal, and external. We show that the household structure does imply some quantitative differences in the narrative, particularly in the technology

3. Examples of models featuring stochastic finite lifetimes include Smets and Wouters (2002) or Kumhof *et al.* (2010).

and demand categories, but not for fiscal variables. Technology shocks play a more prominent role on GDP developments in the infinitely-lived agents model, with the largest contributions to GDP growth taking place in the downturns of 2009 and 2012. On the opposite direction, demand plays a more important role in the finitely-lived agents model, with the largest contributions taking place during the 2011–2012 downturn and the 2014's recovery. GDP forecast error variance decomposition suggests that technology shocks are a more important source of fluctuations in the infinitely-lived agents model, whereas the demand component plays a greater role in the finitely-lived agents model. Impulse response functions suggest that higher public consumption increases GDP by less in the infinitely-lived agents model, while crowding out private consumption. This contrasts with the finitely-lived agents model, where private consumption increases. Disturbances in technology lead to greater GDP levels in the infinitely-lived agents case, while depicting a jump on impact.

These quantitative differences are small and insufficient to convey a qualitatively different story. The binding fiscal policy rule ensuring debt stability and the presence of hand-to-mouth households, particularly in the infinitely-lived agents model, seems to play a key role in results. The private consumption responses in the face of a public demand disturbance is an important difference, but the effects are small and do not create an alternative economic analysis over the sample period. Furthermore, there are also important quantitative similarities in both models, of which the ability to reproduce the variance of the data and the path depicted by shocks are two examples.

The remainder of the article is organized as follows. The next section provides a short description of both models. We continue by presenting the database and the stochastic content. This is followed by a section highlighting the main differences in terms of narrative between both models. The last section concludes.

2. The infinitely and finitely-lived agents models

The infinitely and finitely-lived agents models estimated and analyzed in this article are as far as possible equivalent.[4] Both are New-Keynesian DSGE models for a monetarily-integrated small open economy, featuring identical multi-sectoral production structures, imperfect market competition, and nominal and real rigidities. In addition, both models embody financial frictions, whereby financial shocks are transmitted and propagated to the real economy. Trade and financial flows are restricted to euro area countries, and the euro area is immune to domestic shocks, a consequence of the small-open economy framework. The law of one price implies that domestic prices are tied down by the euro-area price level in the long run.

The domestic economy is composed of nine types of agents: households, capital goods producers, entrepreneurs, banks, intermediate goods producers (manufacturers),

4. The finitely-lived agents model presented herein is similar to that presented in Júlio and Maria (2017), with the exception of a few details. The infinitely-lived agents model is identical is all aspects except the households structure, which is replaced by a more familiar framework very close to the standard practice in the literature.

final goods producers (distributors), the government, importers, and foreign agents (the remaining euro area). Two household types coexist in the model: asset holders or type-$\mathcal{A}$ households, who are able to smooth consumption over lifetime by trading assets; and hand-to-mouth or type-$\mathcal{B}$ households, who have no access to asset markets and therefore consume all their income in each and every period. Let $\mathcal{H} \in \{\mathcal{A}, \mathcal{B}\}$ denote the household type. The differences between both models arise at the household level, with the finitely-lived OLG structure superimposing powerful non-Ricardian characteristics.

The infinitely-lived agents model follows closely standard practice in the literature. Expected lifetime utility is

$$\mathrm{E}_t \sum_{s=0}^{\infty} \beta^s U^{\mathcal{H}}_{t+s}(C_{t+s}, L_{t+s})$$

where β is the discount factor, $U^{\mathcal{H}}$ is the utility function of the representative agent $\mathcal{H}$, C_t is the aggregate consumption level, and L_t stands for total hours worked.

In the finitely-lived agents model, households $\mathcal{H}$ evolve according to the overlapping generations scheme first proposed in Blanchard (1985) and Yaari (1965). They are subject to stochastic finite lifetimes and face an identical and constant probability of death, independent of age (see Frenkel and Razin 1996; Harrison *et al.* 2005; Bayoumi and Sgherri 2006). Population is constant, implying that in each period the number of newborns equals those who perish. A perfectly competitive life insurance company collects the wealth of those agents who did not survive and distributes it to those that survived, assuring in this way that households do not leave bequests. In this framework asset holders strongly prefer to finance government expenditure through public debt issuance, since future taxes will be charged largely on yet-to-be born generations (Buiter 1988). Non-Ricardian effects are magnified by the life-cycle income profile, which shifts the proneness of agents towards paying taxes later, when labor income is lower. Expected lifetime utility is

$$\mathrm{E}_t \sum_{s=0}^{\infty} (\beta\theta)^s U^{\mathcal{H}}_{a+s,t+s}(C_{a+s,t+s}, L_{a+s,t+s})$$

where θ is the probability os staying alive (independent of time), and therefore the average life expectancy at any time is constant at $(1-\theta)^{-1}$. In this formulation consumption and hours worked are age dependent, and therefore $U^{\mathcal{H}}_{a+s,t+s}$ is the utility function of the representative agent $\mathcal{H}$ of generation $a+s$.[5]

The wage-setting mechanism is also identical in both models. Unions hire labor-specific varieties from households, to be supplied to manufacturers. The resulting

5. Technical details on the aggregation method across generations can be found in Almeida *et al.* (2013a). Instead of biological death, $(1-\theta)$ can also be interpreted as the relevant economic horizon behind agents' decisions, *i.e.* the probability of "economic death" or an indicator of the degree of "myopia." In this case, $(1-\theta)^{-1}$ is interpreted as the "average planning horizon" (Bayoumi and Sgherri 2006), where the present can be seen as a period of higher economic relevance.

equilibrium wage equations are similar, embodying a markup charged to manufacturers which reflects a wedge between the marginal disutility from work and the wage received by households.

Manufacturers combine capital, rented from entrepreneurs, with labor services (which are directly affected by unit-root and stationary technological elements), to produce an intermediate good, which is thereafter sold to distributors. Manufacturers are perfectly competitive in the input market and monopolistically competitive in the output market, and face quadratic adjustment costs on price changes. They pay social security taxes on their payroll and capital income taxes on profits.

The financial accelerator mechanism—whereby financial frictions affect the after-tax return on capital and therefore capital demand—comprises capital goods producers, entrepreneurs, and banks, along the lines of Bernanke *et al.* (1999) and Christiano *et al.* (2014). Capital goods producers are the exclusive producers of capital. Before each production cycle, they buy the undepreciated capital from entrepreneurs and combine it with investment goods bought from distributors to produce new installed capital, which is thereafter sold to entrepreneurs. Capital goods producers face quadratic adjustment costs when changing investment levels and are assumed to operate in a perfectly competitive environment in both input and output markets.

Entrepreneurs' actions have a direct effect on the capital accumulation of the economy. They do not have sufficient funds to finance desired capital purchases, but can cover the funding gap by borrowing from banks.[6] With net worth taken as given, they decide capital holdings—bought from capital goods producers—and concomitantly balance sheet composition and leverage. Entrepreneurs face a risky environment in which idiosyncratic shocks change the value of the capital stock (after the balance sheet composition has been decided). They rent the capital stock to manufacturers for usage in the production process, receiving a rental rate in return, and pay a capital income tax on their profits.

Banks operate in a perfectly competitive environment, and their sole role is to borrow funds from asset holders and lend them to entrepreneurs. If an entrepreneur goes bankrupt, due to an adverse idiosyncratic shock, the bank must hire monitoring services from households. Since capital acquisitions are risky, so are the loans of banks, who therefore charge a spread over the nationwide interest rate to cover for bankruptcy losses. Even though individual loans are risky, aggregate banks' portfolio is risk free since each bank holds a fully diversified portfolio of loans. The contract celebrated between the entrepreneur and the bank features a menu of state contingent interest rates that ensures zero profits for banks in each period and in all possible states of the world. All households loans are therefore secure at all times.

Distributors combine domestic intermediate goods with imported goods to produce final goods. Consumption goods are acquired by households, investment goods by capital goods producers, public consumption goods by the government, and export

6. Dividend distribution prevents net worth accumulation beyond which external finance is no longer required.

goods by foreign distributors. They are perfectly competitive in the input market and monopolistically competitive in the output market, face quadratic adjustment costs on price changes, and pay capital income taxes on profits.

Government spending comprises not only the above-mentioned acquisition of public consumption goods from distributors but also lumpsum transfers to households and interest outlays. These activities are financed through tax levies on wage income, capital income, and households' consumption. The government may issue one-period bonds to finance expenditure, paying an interest rate on public debt. Wage income taxes include the contributions paid by employees (henceforth referred to as labor taxes) and the payroll tax paid by manufacturers. Labor taxes ensure that debt follows a nonexplosive path, although automatic stabilization policies allow for the fiscal balance to temporarily deviate from the pre-determined target level.

The rest of the world corresponds to the rest of the monetary union, and thus the nominal effective exchange rate is irrevocably set to unity. The domestic economy interacts with the foreign one via the goods and financial markets. Domestic interest rates may differ from foreign interest rates due to the existence of a nationwide risk premium. In the goods market, importers buy imported goods from abroad to be used in the production of final goods, paying quadratic adjustment costs on price changes. In the international financial market, asset holders trade assets to smooth out consumption.

3. Shocks and data

The stochastic behavior of the main model is driven by twenty one structural shocks affecting directly the domestic economy and following first-order autoregressive processes. The parameters and additional three shock processes for the rest of the euro area are jointly estimated with those of the small euro area economy. We categorize the twenty four structural shocks into six branches

1. Two demand shocks, on households' consumption (private component), and on public consumption and investment (public component);
2. Four technology shocks, on the unit root (worldwide) labor-augmenting technology, the stationary labor-augmenting technology, imports efficiency, and private investment efficiency;
3. Six markup shocks, on wages, and the prices of consumption, investment, government, export, and import goods;
4. Five fiscal shocks, on household transfers, fiscal rule (or equivalently on labor taxes), and tax rates over consumption, capital, and payroll;
5. Three financial shocks, on borrowers' riskiness, entrepreneurial net worth and the nationwide risk premium; and
6. Four external/foreign shocks, on the export market share, and on euro-area inflation, output, and interest rate.

We estimate the model for the Portuguese economy, using quarterly observations for the 1999:1–2019:4 period for twenty four observable time series. All endogenous variables and their transformation, prior to estimation follow standard practice in the literature (*e.g.* Ratto *et al.* 2009; Christiano *et al.* 2011) and are reported in Table 1. It should be noted that observed data transformations isolate the estimation from exogenous influences not directly accounted by the model's structure. The revenue-to-GDP ratio from payroll taxes and the social benefits-to-GDP ratio are two examples of observed data endowed with in-sample trends that are to a great extent related with a protracted increase in social protection and with aging. The model is not designed to capture these features, which assume a structural nature. To properly take into account their high frequency movement we computed the first (log) difference. We also demean most time series—thus suppressing exogenous trend growth differences or level differences—to favor the business cycle content of observed data and to avoid trending exogenous processes that affect the great ratios. All quarterly observations are seasonally adjusted. Whenever adjusted official series were not available, the transformation was performed using X12 ARIMA. The variance of measurement errors is calibrated at 5 percent of the variance of each data series for real data and 25 percent for nominal and financial data.[7]

We follow common practice in the literature and calibrate several non-identifiable or weakly identified parameters according to related empirical studies or micro evidence, or by matching "great ratios" or any other quantifiable steady-state measure. The remaining parameters are estimated through Bayesian methods. Prior information is combined with the likelihood to obtain the posterior kernel, which is maximized through a numerical optimization routine to obtain an estimate for the posterior mode and the corresponding variance-covariance matrix. This information is used as an input to initialize the Random-Walk Metropolis-Hastings algorithm, yielding a sample from the posterior density of model parameters. We compute 3 parallel chains of 1 million draws each and discard the first 500 thousand as the burn-in phase. Convergence of the simulation is assessed through the diagnostics suggested by Brooks and Gelman (1998). All estimation byproducts are evaluated at the posterior mean. Observed data series used in estimation and smoothed variables without measurement error are, in general, virtually identical, with the exception of noisier variables, such as credit growth and implicit tax rates.

4. Lessons from an OLG-based narrative for the Portuguese economy

In this section we address some key differences in the narrative for the Portuguese economy, brought about by the infinitely and finitely-lived agents models. Our focuses here relies mostly on a comparative perspective. Throughout the section we use several estimation byproduts, all evaluated at the posterior mean and each providing a specific view over the data.[8]

Both models reproduce relatively well actual volatility (see Table 2). This includes the higher volatility of private consumption in comparison with GDP. The nominal side

7. Measurement errors allow for the inclusion of data for all GDP components in addition to GDP itself, while avoiding stochastic singularity in the resource constraint.

8. All results are available from the authors upon request.

Observed variables	Transformation
Real side	
GDP, per capita	First log difference, demeaned
Private consumption, per capita	First log difference, demeaned
Public consumption and investment, per capita	First log difference, demeaned
Private investment, per capita	First log difference, demeaned
Exports, per capita	First log difference, demeaned
Imports, per capita	First log difference, demeaned
Real wages, per capita	First log difference, demeaned
Hours worked, per capita	First log difference, demeaned
Nominal side	
Private consumption deflator	First log difference, demeaned
Public consumption and investment deflator	First log difference, demeaned
Private investment deflator	First log difference, demeaned
Exports deflator	First log difference, demeaned
Imports deflator	First log difference, demeaned
Fiscal policy	
Revenue-to-GDP ratio: indirect taxes	Level, demeaned
Revenue-to-GDP ratio: household income taxes	Level, demeaned
Revenue-to-GDP ratio: corporate taxes	Level, demeaned
Revenue-to-GDP ratio: Payroll taxes	First log difference, demeaned
Expenditure-to-GDP ratio: social benefits	First log difference, demeaned
Financial side	
Real loans to Non-financial corporations, per capita	First log difference, demeaned
Corporate interest rate spread	Level, demeaned
Nationwide risk premium	Level, demeaned
Euro area data	
Real GDP, per capita	First log difference, demeaned
GDP deflator	First log difference, demeaned
3-month EURIBOR	Level, demeaned

TABLE 1. Observed variables.

Source: Statistics Portugal, EUROSTAT and Banco de Portugal.

Notes: *Per capita* aggregates are computed with the overall population. Real wages are deflated by the private consumption deflator. Real loans are deflated by the GDP deflator. The corporate interest rate spread is computed as the difference between the interest rate paid by non-financial corporations on new loans and the 3-month EURIBOR. The nationwide risk premium is measured by the differencial between Portuguese and German short-term Treasury bills (except over 1999–2002, a period where we assumed a nil risk premium, and over 2011–2012, a period where we used the differential between Portuguese and German corporate interest rates).

of the domestic economy is slightly more volatile than that generated by both models, with the exception of consumer price inflation. Measurement errors contribute to this outcome, absorbing some noise present in the data. The highest discrepancy in volatility between data and models is registered in the labor tax revenue-GDP ratio. The fiscal rule is designed to close persistent deficits through an increase in labor taxes. If the data is not compatible with such a path, the estimation procedure compensates deviations from the fiscal rule with exogenous perturbations, reflected into the estimated standard error of the respective innovation and hence in model volatility. In this respect, the infinitely-lived agents model performs worse, yielding a higher volatility in the labor tax revenue-GDP ratio.

Variable	Data	Inf-model	OLG-model
GDP growth	0.76	0.79	0.81
Private consumption growth	0.94	1.05	1.16
Private investment growth	4.53	5.06	5.14
Public cons. & inv. growth	1.43	1.46	1.45
Exports growth	2.61	2.64	2.62
Imports growth	2.58	2.89	3.02
Labor growth	0.87	0.65	0.70
Wage growth	0.74	0.79	0.78
Private consumption inflation	0.48	0.50	0.50
Private investment inflation	2.81	2.37	2.40
Public cons. & inv. Inflation	0.98	0.90	0.91
Exports inflation	1.04	0.72	0.73
Imports inflation	1.72	1.25	1.27
GDP growth, euro area	0.60	0.56	0.54
GDP inflation, euro area	0.11	0.24	0.18
Interest rate	0.43	0.43	0.34
Consumption tax revenue-GDP ratio	0.72	0.53	0.54
Labor tax revenue-GDP ratio	1.14	2.18	1.82
Payroll tax revenue-GDP ratio	0.28	0.22	0.22
Capital tax revenue-GDP ratio	0.51	0.41	0.40
HH transfers-GDP ratio	0.56	0.52	0.51
External finance premium	0.21	0.25	0.26
Corporate loans growth	1.60	1.59	1.62
Nationwide risk premium	0.13	0.09	0.10

TABLE 2. Standard deviation of actual data and those generated by models.

The implied evolution of smoothed shock processes is in most cases relatively close across models, and different impacts on endogenous variables potentially arise from distinct mechanisms within the model rather than from important differences in the size of perturbations. One of the most important shock processes driving economic developments in the past two decades is the technological growth rate, shared by both Portugal and the euro area, and which triggers region-specific cycles (Figure 1). Results show a high degree of similarity across both models, implying identical trend-cycle extractions. The economic environment that characterizes the 2009–2017 period is for instance interpreted as including a persistent technological effect. The resulting trend is relatively smooth and delivers meaningful cycles under both models, positive before the turmoil and featuring a double dip recession afterwards. The cycle becomes positive again towards the end of the sample, a period influenced by more resilient trend growth.

The similarities across models extends to other smoothed shocks as well (Figure 2). Labor and consumption tax processes are virtually identical over the entire sample period. Government consumption levels are also very close, particularly after 2008, whereas household transfers have a slight upward shift in the infinitely-lived agents

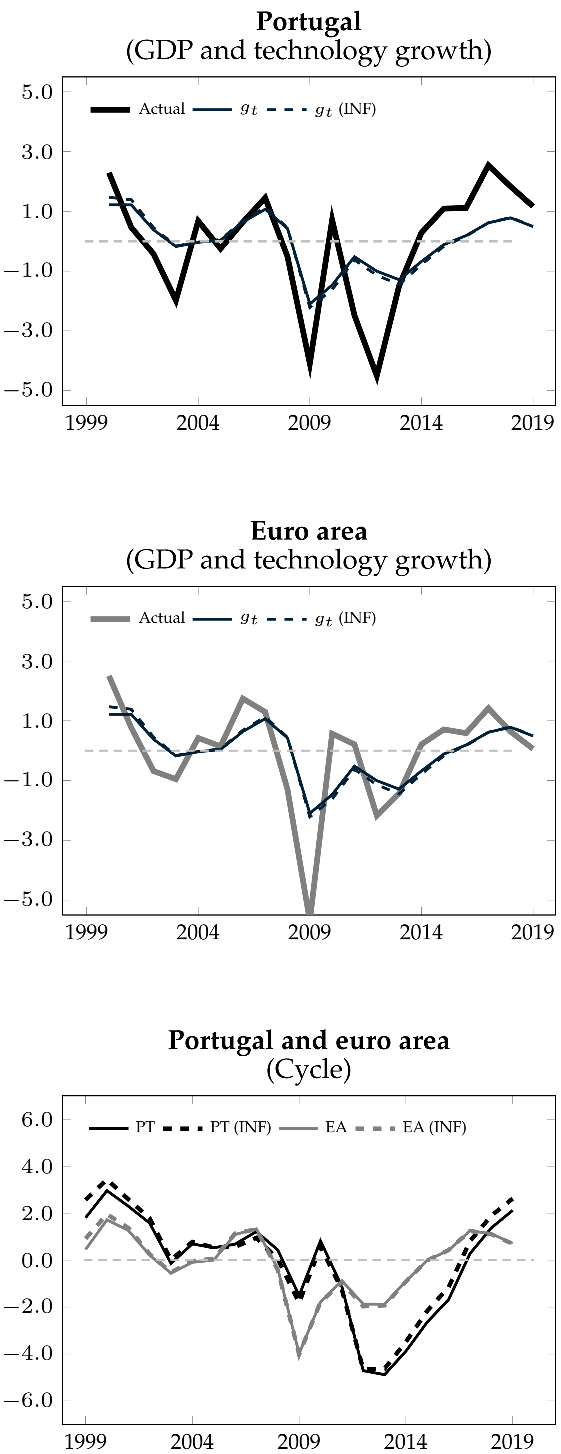


FIGURE 1: GDP and technology.

Notes: The technology growth rate is identified with g_t, which is the (logarythmic) change of the labor-augmenting technology level shared by both Portugal and the euro area. Identifier "INF" refers to the infinitely-lived agents model and "OLG" to the overlapping-generations (finitely-lived agents) model. Portugal and the euro area are identified with "PT" and "EA." All cycles are measured in percentage against steady-state levels. All data is demeaned.

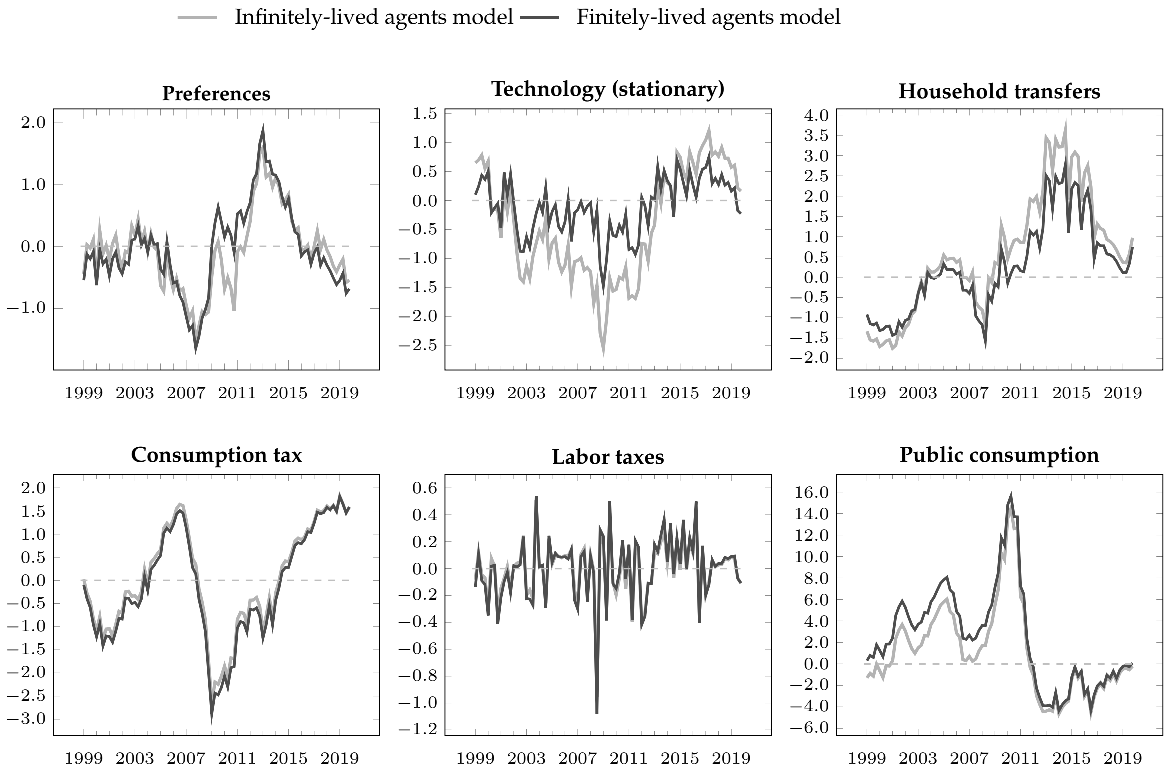


FIGURE 2: Selected smoothed shock processes.

Notes: All shocks are in scaled deviations from steady state levels. "Technology (stationary)" identifies shocks with temporary effects on the domestic labour-augmenting technology level. "Consumption taxes" and "labour taxes" are implicit tax rates. Household transfers are in percentage of GDP.

model. Models are using measurement errors in order to improve the fit to the data, and different mechanisms within each model lead to distinct noise-extraction outcomes. This contributes to different smoothed shock processes across models, even when these are highly related with observables, as it is the case of transfers or public consumption. Note that the government/fiscal response to the 2008 turmoil was swift, with increases in public consumption and declines in taxes over consumption and labor. On the opposite direction, the 2011–2013 sovereign debt crisis implied corrective government/fiscal measures which radiated nearly till the end of the sample period. Public consumption and household transfers were pushed downwards, whereas taxes on consumption and labor faced historically large increases. The collapse in euro area GDP—a proxy for world demand in the model's export equation—reflects the business-cycle spillover effect of the worldwide crisis on the domestic environment.

The labor-augmenting stationary technology component is one important exception. The finitely-lived agents model brings forward a less volatile and slightly less persistent smoothed shock than the infinitely-lived agents model. Although both models feature a large fall during 2008–2009 period, the latter takes place from substantially lower levels. The decaying labor productivity built in the OLG framework, by affecting the consumption-labor choice, may contribute decisively towards this result.

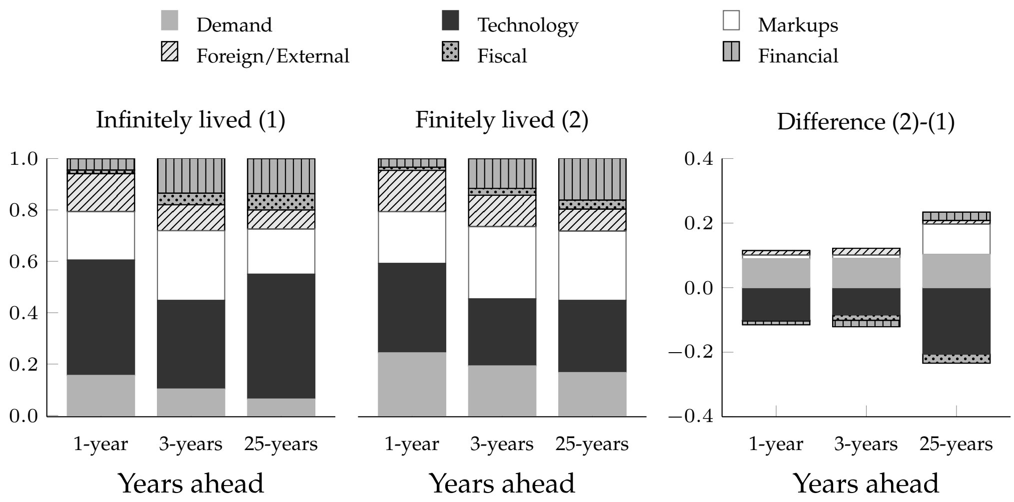
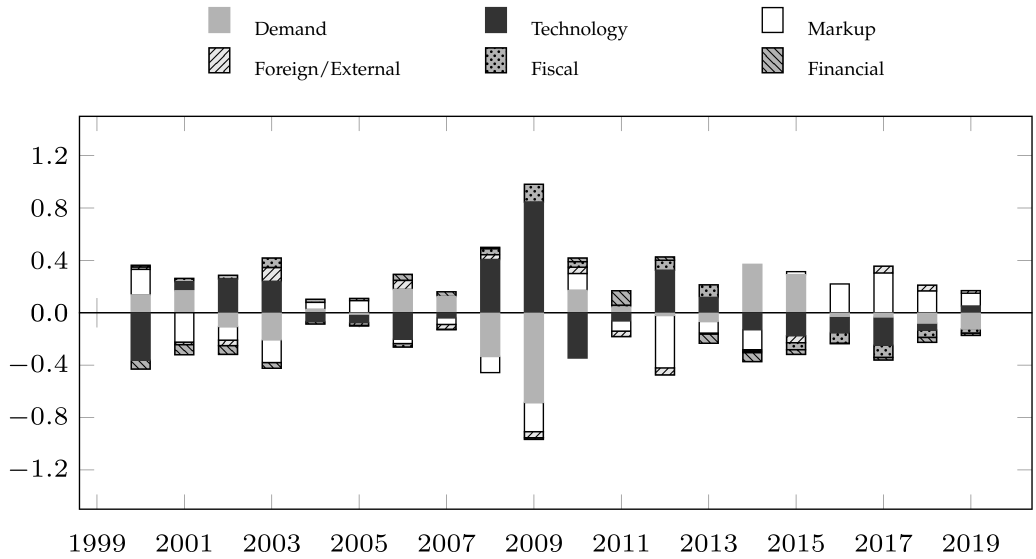


FIGURE 3: GDP forecast error variance decomposition.

Differences in the endogenous transmission mechanisms may result not only in slightly different smoothed shocks, but also in possibly distinct interpretations of recent history. These conclusions splash onto the GDP variance decomposition, with the demand category gaining a higher importance in explaining GDP fluctuations in the finitely-lived agents model *vis-à-vis* the infinitely-lived framework (Figure 3). Differences are persistent across different horizons. On the opposite direction, the technology category is downplayed by the finitely-lived agents model, and the contribution is systematically below that of the infinitely-lived agents model. The less volatile labor-augmenting technology smoothed shock in the OLG model finds echo here, delivering a less sizable contribution of technology factors to GDP fluctuations. The model compensates this by attributing a greater role to preference shocks. Differences in the remaining categories are relatively minor.

The historical decomposition of GDP growth confirms the existence of some quantitative differences, particularly in the technology and demand components. However, their magnitude is small, amounting at best to 0.4 percentage points (pp) in absolute terms (Figure 4). The only exception is the 2009 crisis, when the differential between both models reaches 0.8 pp in the technology aggregate and 0.7 pp in the demand aggregate, the former in favor of the infinitely-lived agents model and the latter in favor of the finitely-lived agents one. A similar conclusion emerges on the crises of 2003 and 2012, but to a lesser extent.

When we juxtapose the contributions of each model, the narrative in qualitative terms is broadly similar (Figure 5). The contributions from technology are indeed larger in the infinitely-lived agents model, but they are also important and with the same sign in the finitely-lived agents model. The same conclusion is valid for the demand shocks, as well as for the remaining categories. When we decompose demand (Figure 6), the divergence emerges from preference shocks, and not from the public component, despite the presence of crowding out/in effects on consumption in the infinite/finite lived



(A) GDP growth, difference between infinite and finitely lived models.

FIGURE 4: Historical decomposition.

Notes: A positive bar means that the contribution of shocks to GDP growth in the corresponding category in the infinitely-lived agents model outweighs that depicted by the finitely-lived agents model, and *vice-versa.*

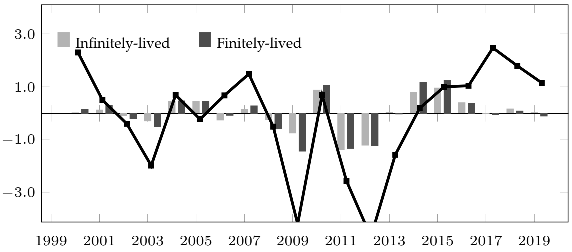
agents models. An important component for this results lies in the presence of hand-to-mouth households in the infinitely-lived agents model, which creates non-negligible non-Ricardian effects.

These differences are also reflected in impulse responses, important tools of policy analysis and simulation (Figure 7). The OLG structure tends to generate more powerful short-run effects when in the presence of stronger wealth impacts superimposed by the non-Ricardian framework. This is noticeable in government consumption shocks, where we detect a crowding-in effect on private consumption—in contrast with the crowding-out efect in the infinitely-lived agents model.

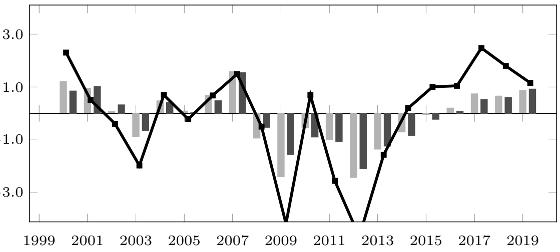
The growth shock triggers a more marked increase in technology and concomitantly a more powerful long-run impact of all non-stationary variables in the infinitely-lived agents model. The shorter planning horizon associated with finitely-lived agents augments wealth impacts, and therefore the estimation process attributes less persistence to growth shocks, as compared with the infinitely-lived agents model. We failed to find important divergences in the remaining responses worth highlighting.

5. Concluding remarks

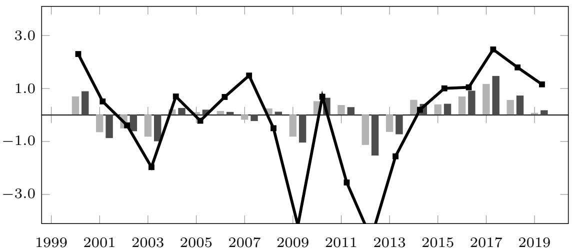
This article shows how different are the narratives produced by two estimated medium-scale small-open Dynamic Stochastic General Equilibrium models, identical in all respects except the household structure. Both models are estimated for the Portuguese economy, for the 1999-2019 period. The infinitely-lived agents model follows closely standard practice in the literature, whereas in the finitely-lived agents model households



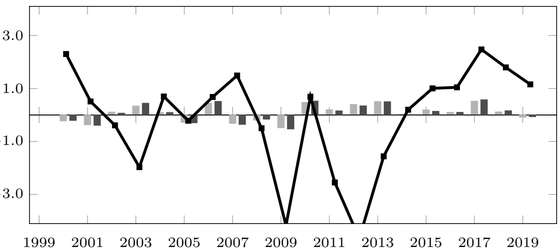
(A) Demand.



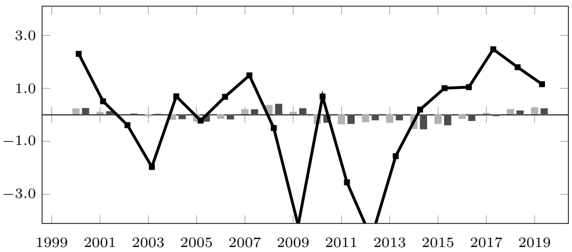
(B) Technology.



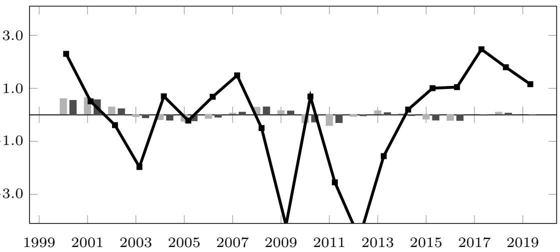
(C) Markup.



(D) Foreign.

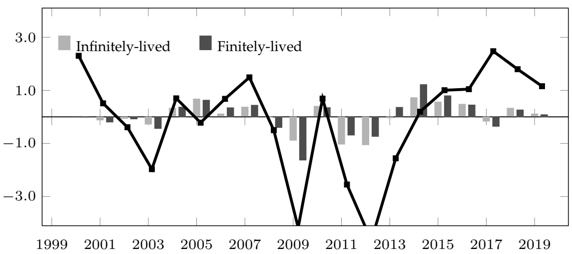


(E) Fiscal.

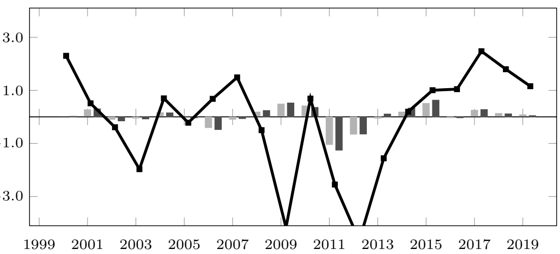


(F) Financial.

FIGURE 5: Historical decomposition of the Portuguese GDP growth.
Notes: GDP growth rates in percentage (black line), and contributions of components in percentage points.



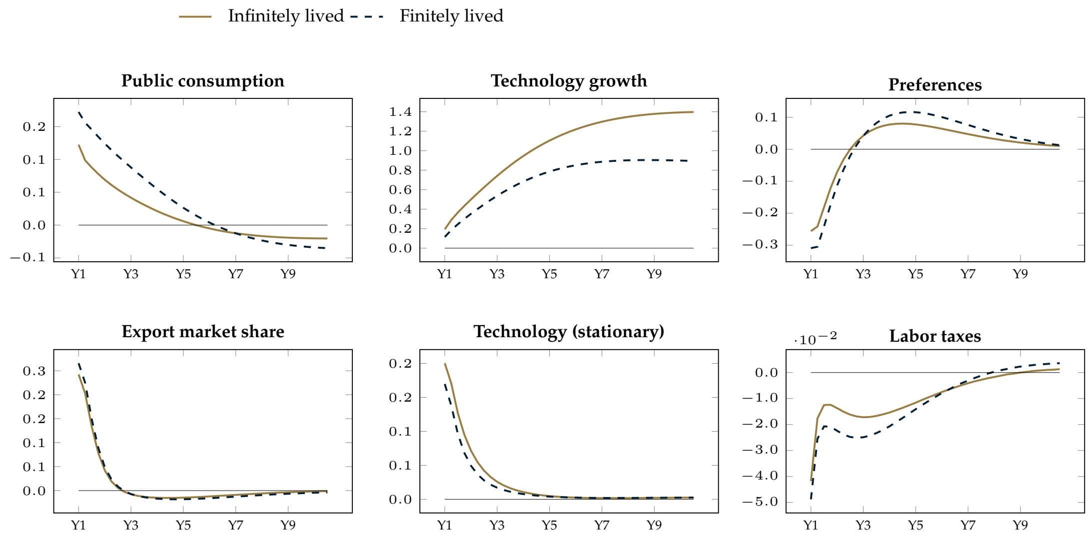
(A) Private component.



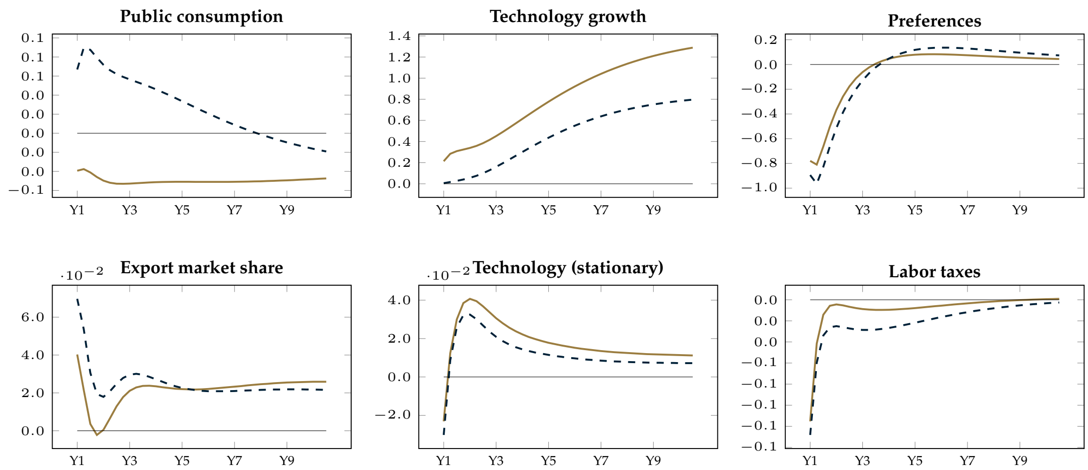
(B) Public component.

FIGURE 6: Historical decomposition of the Portuguese GDP growth: the demand component.
Notes: GDP growth rates in percentage (black line), and contributions of components in percentage points.

are subject to stochastic finite lifetimes and face decaying labor productivity. Both models feature hand-to-mouth households, to which the estimation process attributes a greater role in the infinitely-lived world, and which creates an important non-Ricardian source in that model.



(A) GDP



(B) Private Consumption

FIGURE 7: Impulse response functions.

Notes: All impacts are in deviations from steady state.

Our findings suggest that both models filter the data in identical ways, producing in general very similar smoothed shock processes. The differences, when exist, jointly with distinct mechanics within models, imply a slightly different narrative for the Portuguese economy over the 1999-2019 period, but fail to deliver a dramatically different overview. The non-Ricardian features embodied in the finitely-lived agents model deliver more powerful demand-side impacts—effects which are alternatively channeled towards technology-side perturbations in the infinitely-lived agents model. This affects mostly historical and variance decompositions, though the effects are not sufficiently different in quantitative terms to convey an alternative interpretation of history. The impulse response functions to a public consumption perturbation are also affected, with the infinitely-lived agents model depicting crowding-out and the finitely-lived agents model crowding-in effects in private consumption. The former model also depicts more persistent growth effects. In many other dimensions analyzed herein, such as moment comparison, trend-cycle decomposition, and other impulse responses, we fail to find divergences worth highlighting.

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