Economics Synopsis

Credit and the economy: lessons from a decade of research at Banco de Portugal

Diana Bonfim
Banco de Portugal
Católica-Lisbon SBE

Luísa Farinha
Banco de Portugal

Sónia Félix
Banco de Portugal
Nova SBE

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"Three decades ago, skepticism in the economics profession about the relevance of financial factors for real economic activity prevailed. This view stemmed from the implications of Modigliani and Miller (1958) that in frictionless markets, a firm's cost of capital is independent from its financial structure. Since then, most economists have accepted that the presence of information asymmetries and bankruptcy risk imply that financial factors matter for real economic decisions. Most of the debate is now centered on the quantitative importance of these frictions and the channels through which they operate. The recent global financial crisis, and the global deleveraging process that ensued, offers perhaps the most convincing evidence to date of the economic relevance of financial frictions and their real effects."

Laeven and Valencia (2013)

Introduction

Under the strict hypotheses of perfect capital markets and perfect information, Modigliani and Miller (1958) capital structure irrelevance proposition established that arbitrage between investors should keep

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E-mail: dbonfim@bportugal.pt; lfarinha@bportugal.pt; scfelix@bportugal.pt

the value of a firm independent from its leverage. This provoking theory encouraged a vast literature devoted to refuting the irrelevance proposition in both theoretical and empirical grounds. Theoretical research has shown that in the presence of elements such as taxes, transaction costs, bankruptcy costs, agency costs, asymmetric information, adverse selection and other frictions the original irrelevance result disappears. An important insight of these models is that external finance is more expensive than internal finance. The influential paper of Fazzari, Hubbard, and Petersen (1988) and many subsequent studies have found that firms' balance sheet positions affect their willingness to invest. Models with financial frictions have brought credit and the role of banks to the analysis of economic variables. Holmstrom and Tirole (1997) for example show that firms with weaker balance sheets are more affected by a reduction of credit supply.

The analysis of the relation between credit and the real economy regained importance since the global financial crisis of 2007–2009 and the subsequent sovereign debt crisis. Financial crises always motivate an increase in research on these topics. The recent crisis added important novel aspects arising from the complexity of today's financial institutions and instruments and the remarkable degree of global financial integration. Several interesting questions were raised by economists, policy makers and the general public in the aftermath of the crisis. Which vulnerabilities were responsible for the crisis? Could the crisis have been prevented? What have been the main shocks? How have bank shocks been transmitted to lending to firms? How has the disruption in credit affected the economy? Were there heterogeneous effects among firms? What role did monetary policy play in the process? What role did regulation play? Were there side effects of the monetary policy and regulation? It is economists' responsibility to try to provide the answers to these crucial questions.

Initial contributions to identify the effects of the 2007–2009 financial crisis used data from the syndicated loans for the US. Empirical research using large-scale, comprehensive and good quality data is much less abundant. The availability of rich micro data sets is essential to evaluate the heterogeneous effects of the crisis. This is one of the reasons why Portugal, a bank-dependent economy severely affected by the crisis, is considered an interesting laboratory to study the effects of bank shocks on real outcomes. The Portuguese Credit Register that covers the universe of loans at the bank/firm level can be merged with firm balance sheet and firm/worker databases through common identification codes for firms. Credit Register data can also be merged with bank-level balance sheet data using the common bank identifier. The richness of these databases has been crucial to develop a plausible narrative around the building of imbalances in the Portuguese economy, the impact of the crisis that severely hit the banks and the subsequent adjustment process under regulatory changes, unconventional monetary policy and intrusive prudential

supervision. This article reviews the research developed at Banco de Portugal during the last decade, creating a basis for this narrative.

The remaining of the article (i) briefly overviews recent developments in the Portuguese economy; (ii) reviews the research on misallocation; (iii) presents the research on credit restrictions; (iv) presents the studies on the effects of bank shocks in the economy; (v) reviews the research on the role of monetary policy during the crisis; and (vi) offers some final remarks.

A very brief overview of the Portuguese economy

Over the last twenty years the Portuguese economy has gone through several phases (Blanchard and Portugal, 2017). The Portuguese boom that started in the mid–1990s was characterized by large capital inflows, declining nominal and real interest rates, and strong domestic demand, reflecting the low perceived sovereign debt risk and the expectations of future growth emerging from the Portuguese participation in the euro. This triggered a strong and fast increase in households' and corporate debt.

In the beginning of the 2000s, trend growth declined and the future expected growth did not materialize. From 2002 to 2008, the accumulation of private debt was mostly channeled to non-tradable sectors and coexisted with anemic economic growth, low productivity growth, and a decline in investment. During this period external imbalances cumulated to unprecedented levels.

In the subsequent years the Portuguese outlook substantially worsened. The global financial crisis and the European sovereign debt crisis led to a dramatic increase in the cost of funds, with Portuguese banks and the sovereign loosing access to international debt markets. Most of the capital flows in the Portuguese economy were intermediated by banks, which were severely hit by the crisis.[1] This sudden stop implied that Portugal had to ask for international financial assistance in 2011. Between 2011 and 2013 the Portuguese economy went through a severe recession. Concomitantly, there was a sizeable structural adjustment in prevailing imbalances, including an increase in the degree of openness of the economy and marked improvements in the fiscal position.

Since 2014, the Portuguese economy has been recovering, in line with the expansion in the euro area. The position of the Portuguese banking system improved, with banks increasing substantially their solvency and profitability

1. Chen, Milesi-Ferretti, and Tressel (2012) estimate that in 2007 banks accounted for approximately half of the Portuguese foreign debt. Silva (2010) shows that the financial sector had a central role in the way different sectors of the Portuguese economy were connected before the crisis.

ratios. Even though the non-performing loans (NPL) ratio is still high, it has been decreasing steadily over the recent years.

In sum, the Portuguese economy in the last two decades provided material of great interest to evaluate the importance of financial frictions and their effects on the economy. The sequence of developments since the onset of the euro area, with the accumulation of vulnerabilities that clearly showed up during the crisis, until the adjusting process of the economy, stimulated several strands of empirical research. The richness and good quality of the Portuguese data, in particular the granular data at the firm/bank level, was a powerful instrument of analysis. The objective of this article is to present the research conducted in the last decade at Banco de Portugal in a structured (albeit possibly not exhaustive) way. Still, there is no obvious and unique way to achieve this objective. The developments summarised above posed distinct questions for which empirical research tried to find answers. The article is organized around some key questions and tries to build a narrative on the distinct phases the Portuguese economy went through.

Credit (mis)allocation

Over the last years a growing literature on credit misallocation and productivity differentials has emerged. Banerjee and Duflo (2005) review macroeconomic evidence suggesting that capital misallocation due to credit constraints and institutional failures is an important source of productivity differences across countries. The evidence suggests that credit market imperfections can lead to both selection and misallocation effects that may prevent some productive firms from operating or may limit the amount of capital that some productive firms have access to. Restuccia and Rogerson (2013) summarize the empirical evidence on the role of capital misallocation in explaining cross-country differences in productivity. Gopinath, Kalemli-Özcan, Karabarbounis, and Villegas-Sanchez (2017) use firm-level data for European countries and show that scarce capital in South European countries was increasingly misallocated to low productivity firms in the period between 1999 and 2012.

Two of the main questions addressed in the literature on misallocation and financial frictions are the following. First, how is bank credit allocated to firms with different degrees of fragility? And second, what are the implications of credit misallocation for productivity growth?

In order to answer the first of these questions the fragile firms have to be identified. Credit scores, which evaluate the risk that a debtor defaults on its obligations, are an important tool to assess firms' financial fragility especially in the context of the sharp accumulation of corporate debt. Credit scores are important to evaluate the monetary policy transmission mechanism and to assess the quality of the allocation of credit, which has

non-negligible implications for the economy at an aggregate level. Also, credit risk assessment tools are important to identify viable firms that are financially constrained. These tools are of utmost importance during economic downturns, when the materialization of credit risk is higher (Bonfim, 2009).[2]

Antunes and Martinho (2012b) develop an econometric model to explain the probability of default based on idiosyncratic characteristics of Portuguese firms. The estimated model suggests that larger, more profitable, and more liquid firms have lower probabilities of default and shows that the estimated z-score is substantially heterogenous across sectors. In turn, more indebted firms have a higher predicted probability of default. Some years later, Antunes, Gonçalves, and Prego (2016) revisited the scoring model and developed a more complex framework to assess the creditworthiness of the Portuguese non-financial firms. This methodology is used to classify firms in terms of one-year probability of default in bank debt. According to the estimated models, firms are mostly allocated to low rating classes and micro-firms have higher probabilities of default. The estimates also suggest that firms in the construction and real estate sectors have on average higher probabilities of default.

The materialization of credit risk ultimately affects the economy. The extent of this impact largely depends on what happens to firms that default on credit. The increase in credit defaults in the aftermath of the financial crisis made this question even more relevant. Bonfim, Dias, and Richmond (2012) show that after loan default, many firms are permanently excluded from credit markets, especially if they were borrowing from only one bank. With a different perspective Antunes, Mata, and Portugal (2010) also study firms' probability of exit. The authors distinguish failure and voluntary exit and analyze the effect of credit upon these two modes of exit. The authors find that leverage and the reliance on short-term debt affect the probability that a firm goes bankrupt, though leverage also affects voluntary exit.

Building on credit score models, Santos and Silva (2019) estimate a credit risk model for the loan portfolio of Portuguese banks. Using a one-period simulation-based multi-factor model, the authors estimate the loss distribution and other risk metrics for the period between 2006 and 2017. The model differs from the Basel IRB framework by explicitly incorporating sector concentration and interdependencies between economic sectors. In particular, this study suggests that the high level of portfolio concentration on

2. The research summarized in this article is focused on the corporate sector. However, credit risk for households has also been studied by Farinha and Lacerda (2010), who found that borrowers with mortgages are less likely to default than those that only have non-mortgage debt. Using data from the Household Finance and Consumption Survey from 2010, Costa and Farinha (2012) show that low income and young households who have taken mortgages are the most vulnerable groups, for which the probability of materialisation of credit risk is higher. Using the same database, Costa (2012) shows that the occurrence of adverse shocks to the households' financial situation is a necessary, though not sufficient, condition for credit default events.

the construction and real estate sectors has led to an increase in the probability of banks registering large losses, something that end up occurring. In the last years, the results point to diversification gains thanks to a lower concentration in the construction sector and not due to an allocation into sectors with lower interdependency.

The question of credit allocation to firms with different degrees of financial fragility is of primary interest in Portugal. Azevedo, Mateus, and Pina (2018) use a measure of fragility based on productivity and show that in the period between 2008 and 2016 the share of credit granted to low productivity firms was substantial, peaking at 44% in 2013. The authors also find that misallocation is associated with slower reallocation, *i.e.* the change in credit growth towards more productive firms is substantially lower in sectors and banks with larger shares of misallocated credit in their loan portfolios.

Dias and Marques (2018) analyse the effect of the financial crisis on productivity dynamics. Using firm-level data the authors show that the Portuguese financial crisis had a cleansing effect on productivity. The authors also show that the crisis reduced the probability of survival for both high and low productivity firms, but hit low productivity firms disproportionately harder, in line with the cleansing hypothesis. Also, the probability of exit increased disproportionately for firms operating in more financially dependent industries, but there is no evidence of a scarring effect on productivity stemming from changing credit conditions.

At the center of the discussion on misallocation are the banks. Weak banks are often associated with lending to low productivity firms, contributing to amplify the problem of misallocation by reducing the ability of productive firms to expand. Reis (2013) argues that the Portuguese slump was the combined result of the large capital flows that followed the participation in the euro and the underdeveloped Portuguese financial market. The author argues that the weaknesses of the Portuguese financial system caused the capital flows to be largely misallocated, leading to the expansion of low productivity sectors. More recently, Blattner, Farinha, and Rebelo (2018) provide evidence that a weak banking sector has contributed to low productivity growth following the European sovereign debt crisis. Portuguese banks that were affected by new capital requirements in 2011 responded not only by cutting back on lending but also by reallocating credit to firms in financial distress. The partial equilibrium analysis suggests that the factor misallocation accounts for 20% of the decline in productivity in 2012.[3]

3. There is further evidence on the impacts of a weak banking sector. Bonfim, Nogueira, and Ongena (2016) show that bank branch closures have negative implications on firms' financing costs, though not on their access to credit. The effect comes essentially from a shock in the information privately shared between borrowers and lenders. Beck, Da-Rocha-Lopes, and Silva (2017) analyze the effect of bank bail-ins and find that the most affected Portuguese banks decreased credit supply, leading to negative effects on investment and employment.

In this context, a crucial question is: what is the role of bank supervision in limiting credit allocation to low productivity firms? Bonfim, Cerqueiro, Degryse, and Ongena (2019) use Portuguese data to explore the role of on-site inspections in mitigating zombie lending and find evidence that following an on-site inspection, the probability of granting credit to a zombie firm decreases on average by 3 to 6 p.p.

Overall, the empirical evidence for Portugal suggests that frictions in the banking system induced credit misallocation and slower productivity growth in the aftermath of the crisis. Importantly, bank supervision can limit the allocation of credit to low-productivity firms. This evidence brings into closer focus the importance of policies that affect banks' health, bank supervision, and productivity growth.

Credit restrictions

Were Portuguese non-financial corporations credit constrained during the economic and financial crises? The amount of credit granted to non-financial corporations sharply decreased in the aftermath of the financial crisis. According to the Bank Lending Survey (BLS), the credit decline was a result of increased restrictiveness in credit standards and conditions applied on loans as well as of decreased loan demand by firms. Understanding the importance of demand-side and supply-side conditions in explaining credit developments becomes a central question.

Antunes and Martinho (2012a) use credit registry data and develop a method to examine the presence of credit restrictions in the period between 1995 and 2012. Even though this analysis does not allow the authors to unequivocally identify the relative contribution of credit demand and credit supply in explaining the credit decline, the results suggest that the access to credit by Portuguese firms worsened after 2009 and that credit restrictions were particularly relevant for firms seeking credit for the first time.

Farinha and Prego (2013) examine the relationship between firms' financial health and their investment decisions and find evidence of financing constraints. The authors find that firms' investment, particularly for the smaller firms, is negatively affected by their debt burden and positively affected by their profitability. The authors also find that these results were amplified during the crisis. Farinha and Prego (2014) analyse liquidity management decisions by firms as a tool to investigate firms' financial constraints. Firms facing funding constraints need to accumulate more cash in order to insure against the possibility of not being able to finance viable investment projects in the presence of negative shocks. The authors show that the share of liquid assets in total assets is positively affected by current cash flows and its past volatility, which suggests that Portuguese firms are in fact subject to liquidity constraints. In addition, the results suggest that the need

to accumulate funds as a protection against future shocks is more pronounced for the smallest firms.

Farinha and Félix (2015) estimate a disequilibrium model for the period between 2010 and 2012 and document that approximately 15% of Portuguese small and medium-sized enterprises (SMEs) were partially credit constrained. In particular, the smaller and the younger firms were the most credit constrained in this period. Moreover, the authors estimate that Portuguese SMEs searched for bank loans mainly to finance their operational activity and not for investment. The smaller firms and those with smaller amounts of internal resources are estimated to have higher demand for bank loans. In turn, firms with a higher capacity to generate cash-flows and pay their debt and with more assets to pledge as collateral are estimated to borrow more from banks. These findings contrast with the evidence presented by Kremp and Sevestre (2013) for French SMEs. These authors show that French SMEs do not appear to have been strongly affected by credit rationing in the crisis period. Two possible explanations can be put forward to explain this divergence: first, the sharp decrease in bank credit granted to Portuguese SMEs has no parallel in France;[4] and second, Portuguese SMEs seem to rely significantly more on bank loans as source of financing than their French counterparts.[5]

The implications of borrowing constraints for firm dynamics, namely investment and firm survival, are well established in the literature. Firms may be forced to operate at a smaller scale than desired, may forego investment opportunities, and may not be able to overcome temporary liquidity needs in the presence of negative shocks. Amador and Nagengast (2016) use the framework proposed by Amiti and Weinstein (2018) to decompose loan growth rates into bank, firm, industry, and economy-wide components in the period between 2005 and 2013 and show that granular shocks in the banking system account for approximately 20% of the variation in aggregate lending and between 20 to 40% of aggregate investment dynamics in Portugal. Félix (2018) estimates how firm's investment and probability of survival responded to the firm's credit conditions in Portugal in the period between 2010 and 2012. The results suggest that financial market frictions are important to explain firms' dynamics. Firms that were estimated to have been partially credit constrained are less likely to survive, *ceteris paribus*. The estimates also suggest that a firm's investment is negatively correlated with the presence of financing constraints. Carneiro, Portugal, and Varejão (2014) and Martins (2016) show that financing restrictions had a key role in explaining job destruction in Portugal during the financial crisis. More recently, Blattner, Farinha, and

4. The annual rate of change of total credit granted to Portuguese SMEs was about 10% by the end of 2008 and -5% in mid–2012.

5. The ratio between bank loans and total assets equals 0.27 and 0.18 for the sample of Portuguese and French SMEs in 2010, respectively.

Rebelo (2019) proxy debt frictions by an index based on different debt-to-earnings ratios and show that the response of firms to an investment tax credit is very heterogenous and non-linear. Firms in the lower two quartiles of the debt-to-earnings index distribution have roughly equal predicted take-up probabilities, while for firms in the third quartile predicted take-up drops by 50%. Moreover, firms in the highest debt-to-earnings quartile have a predicted take-up rate close to zero.

All in all, the available evidence for Portugal suggests that credit conditions worsened in the wake of the global financial crisis and, more importantly, the euro area sovereign debt crisis. This evidence highlights the importance of a diversification of the sources of corporate financing.

Bank liquidity and capital shocks

The global financial crisis reminded us that the financial system plays a key role in the smooth functioning of an economy. An unstable and mal-functioning financial system does not allow the financing of corporate activities, the consumption smoothing over the life-cycle for households or, in the case of severe disruptions, the ability to store savings and make payments. This has led to a clear understanding that the financial sector has crucial linkages with the economy, having a role both as a trigger of shocks and as a vehicle for their propagation. As a consequence, research on these links has significantly expanded in the last decade.

Macro models have changed in order to take on board more explicitly the role of the financial system as a trigger and propagation mechanism for shocks. The New-Keynesian dynamic general equilibrium model of Gomes (2017) is an example of this new trend in macro modelling. The author uses the EAGLE-FLI (Euro Area and Global Economy with Financial Linkages) model and calibrates it to the Portuguese economy. The model includes financial frictions and country-specific banking sectors and allows for the assessment of domestic and cross-country macroeconomic effects of financial shocks. The author shows that the impact of monetary policy shocks can be amplified due to the presence of financial frictions. Júlio and Maria (2017) present a medium-scale small-open DSGE model encompassing a financial accelerator mechanism and find that the 2011–2013 recession was precipitated by financial and fiscal factors. More recently, Júlio and Maria (2018) present a DSGE model for a small euro area economy comprising a banking sector empowered with regulatory capital requirements, defaulted loans and occasionally binding endogenous credit restrictions. The authors show that under moderately-sized "bad" financial-based shocks, defaulted loans increase and banks' value drop. As a result, credit supply becomes constrained for some time, severely amplifying and protracting output downfalls.Endogenous inertia implies a

slow recovery in banks' capital and thus an enduring fragility of the banking system.

The granular and high quality data available in Portugal on lending allowed for the development of a deep analysis of how financial shocks affected the real economy, both as a source of instability or as a propagation mechanism. We can group these contributions around two types of shocks: liquidity and capital.

On liquidity shocks, Iyer, Peydró, da Rocha-Lopes, and Schoar (2013) were the first to explore the granularity of the data to study the effects of the collapse of interbank markets in the summer of 2007 on lending to Portuguese firms.[6] The authors find that banks that obtained more funding from interbank markets before this liquidity shock decreased their credit supply more during the global financial crisis. The contraction in loan supply is stronger for firms that are smaller and that hold weaker relationships with banks. Looking into the effects at the firm level, the authors find that small firms are not able to substitute the lost bank funding with other sources of debt. The authors also show that banks with lower capital ratios are more affected by this liquidity shock.

Barbosa (2017), Buera and Karmakar (2018) and Farinha, Spaliara, and Tsoukas (2019) examine liquidity shocks in a later period: the euro area sovereign debt crisis (2010–2012). Barbosa (2017) explores the heterogeneity between banks in their funding structure, sovereign exposures, solvency, and availability of collateral. The author finds that firms' investment and employment decisions were significantly affected if their lenders relied more heavily on interbank and wholesale market funding. By looking into assets that are eligible for collateral in monetary policy operations, the author also documents the existence of sovereign-bank links, showing that a deterioration in the sovereign creditworthiness affects the real economy through the banking sector.

Buera and Karmakar (2018) also analyze the real effects of the sovereign debt crisis on the Portuguese economy, emphasizing the role of heterogeneity in the way financial shocks influence firms' behavior. They examine this question both from a theoretical and an empirical perspective. They show that firms with high leverage ratios and with a larger share of short-term debt were more affected by the euro area sovereign debt crisis. The authors use this evidence to develop a standard model that looks into the conditions under which leverage and the maturity of debt affect firms' investment decisions when faced with financial shocks. The authors find that the empirical findings are consistent with the existence of long-term investment projects and frictions on the ability to issue long-term debt.

6. For details on the implications of the crisis in interbank markets in Portugal, see Saldanha and Soares (2015).

Finally, Farinha, Spaliara, and Tsoukas (2019) also look into the consequences of the euro area sovereign debt crisis in Portugal, focusing on firms' survival. The authors confirm that liquidity shocks have led to a contraction in credit supply. Firms that borrow from the banks that are more exposed to these liquidity shocks are significantly more likely to fail. Again, the granularity of the data allows the authors to uncover the heterogeneity behind these aggregate effects. The authors find that the effects of a negative funding shock for banks are stronger for younger and riskier firms, as well as for those that have exhausted their potential lines of bank credit.

Sforza (2018) takes a different perspective on the role of liquidity shocks and compares the effects of a credit shock (stemming from the global financial crisis) to the effects of a trade shock (coming from the entry of China in the World Trade Organization). The author matches employer-employee data with firm loans and bank balance sheets and finds that firms' internal organizational structure is a key channel in the transmission of shocks to the real economy. The effects are different for credit and trade shocks. On the former, firms reduce employment of high-skilled workers, but there is no adjustment on wages. In contrast, a trade shock affects the entire hierarchy of the firm. Firms rescale the organization and reduce employment at all levels of the hierarchy.

Portuguese banks also suffered sizeable capital shocks, both as a consequence of tighter regulation during and after the crisis, as well as due to the accumulation of losses. Augusto and Félix (2014) examine the impact of bank recapitalizations during the euro area sovereign debt crisis and find that bank bailouts during the adjustment program contributed to mitigate the contraction of credit supply to firms. The effect is larger for banks with a lower capital buffer (before the recapitalization). The results are valid for firms in the manufacturing and trade sectors, but not in the construction sector, which was more significantly affected during the recession.

Degryse, Karapetyan, and Karmakar (2018) study the impact of the 2011 EBA capital exercise, which required some banks to build additional capital buffers against sovereign risks, on banks' decision to grant collateralized loans rather than uncollateralized ones. The shock makes secured lending more attractive, given that it requires less regulatory capital. The authors find that banks that had to increase their capital are more likely to require collateral when granting loans. However, relationship borrowers are more insulated from this shock.

Barbosa, Bilan, and Celerier (2019) examine another type of capital shocks, stemming from a change in accounting norms. This change affected the value of pension obligations of Portuguese banks, thus affecting banks' capital ratios. The authors identify the effects of this credit shock on the ability of firms to attract and retain skilled workers. By matching bank/firm credit exposures with employer/employee data, the authors show that firms borrowing from banks affected by the capital shock are able to borrow less and

decrease employment, most notably of more skilled workers. These workers become more likely to exit affected firms (and less likely to join these firms). This shows that credit shocks may have long-term effects on firm productivity and growth.

The role of monetary policy

Monetary policy plays a key role in the link between credit and the economy. Banks are central in the transmission of monetary policy, most notably through their lending decisions. According to the bank lending channel, when monetary policy tightens, bank reserves will shrink, thus reducing banks' willingness to grant loans (Bernanke and Gertler, 1995; Kashyap and Stein, 2000).

Against this background, there is an undisputable consensus in the theoretical and empirical literature that monetary policy decisions affect credit growth. These effects can even spill over across borders, as shown in a recent paper by Barbosa, Bonfim, Costa, and Everett (2018). The authors show that monetary policy decisions adopted in the US and in the UK affect credit growth in Portugal and in Ireland. The authors find that before the sovereign debt crisis, funding frictions play a role in the cross-border transmission of monetary policy in both economies. In this period, banks in these two countries borrowed extensively in international wholesale debt markets, thus enhancing the pass-through of foreign monetary policy decisions to domestic markets. Banks that held more liquid assets were better able to offset the impact of funding shocks driven by changes in foreign monetary policy. When looking into the crisis period, the authors find that the cross-border transmission of monetary policy changes in many dimensions. The two countries analyzed, Portugal and Ireland, were in the eye of the storm during the euro area sovereign debt crisis. A strong deleveraging trend in the two banking systems, combined with ample provision of central bank liquidity, significantly reduced the influence of the cross-border transmission of monetary policy during the crisis.

The shocks that hit the financial system since 2007/2008 led to a major overhaul in the way monetary policy is conducted. Central bankers were called in to adopt unprecedented measures to restore the smooth functioning of the financial system. Alves, Bonfim, and Soares (2016) illustrate the critical role played by the ECB in avoiding a collapse in the Portuguese financial system when banks suddenly lost access to international wholesale debt markets in the Spring of 2010. Banks were heavily reliant on this type of funding. The loan-to-deposit ratio stood at values close to 160%. After Greece and Ireland asked for a bailout, in the early days of the euro area sovereign debt crisis, international investors believed that Portugal would be the next country to request financial assistance and became entirely unwilling to

rollover the maturing debt of Portuguese banks. The ECB played a key role as a lender of last resort. In a very short time-window, the equivalent of around 20% of Portugal's GDP was refinanced through the ECB. The authors show that despite the magnitude of this shock, credit continued to flow to the economy without any major disruptions.

The monetary policy toolkit adopted by the ECB and other central banks in advanced economies during the crisis was substantially enhanced. A wide array of unconventional monetary policy measures was adopted and researchers have been analyzing their impacts (see for example Acharya and Mora, 2015; Chodorow-Reich, 2014; Morais, Peydro, and Ruiz, 2019). Using granular data on loans and securities in the balance sheet of Portuguese banks, Blattner, Farinha, and Nogueira (2016) study the effects of quantitative easing. The authors find that the ECB's Expanded Asset Purchase Program (EAPP) led to a drop of 64 b.p. in the interest rates on loans granted by banks exposed to this program. The identification comes from the fact that not all banks were exposed to the EAPP, given that they did not hold eligible securities for the program. They also find that loans granted to existing customers increase by 1 p.p. more for exposed banks, relative the non-exposed ones. At the extensive margin, banks that held securities eligible for this asset purchase program became 1 p.p. more likely to grant loans to new corporate customers. Together, these results show that by purchasing assets, the ECB was able to promote loan growth and to decrease funding costs in the economy, in line with what has been found in other countries.

More recently, Jasova, Mendicino, and Supera (2018) studied the impact of a decrease in Portuguese banks' rollover risk on their credit supply decisions. The authors analyse the impact of the provision of long-term funding by the ECB in 2011 through the Very Long-Term Refinancing Operations (vLTRO). Again, using granular data on loans and security holdings, the authors find that the extension of bank's debt maturity has a positive impact on bank lending, in line with what has been found in other European countries (see for example Andrade, Cahn, Fraisse, and Mésonnier, 2019; Carpinelli and Crosignani, 2018; Darracq-Paries and De Santis, 2015; Garcia-Posada and Marchetti, 2016). Loan growth was stronger for smaller, younger and riskier firms, as well as for firms with shorter lending relationships. This additional lending is able to generate real effects, fostering employment and investment in small firms. However, the authors document that unrestricted liquidity provisions allowed banks to purchase more securities, instead of channeling all the additional liquidity to the firms and households. This supports the use of more targeted monetary policy tools, such as the Targeted Long-Term Refinancing Operations (TLTRO).

Crosignani, Faria-e-Castro, and Fonseca (2019) also study the vLTROs in Portugal. Their results emphasize the side effects documented by Jasova,

Mendicino, and Supera (2018). The authors find that the provision of long-term funding by the ECB provides incentives for banks to purchase high-yield short-term securities. The authors argue that banks purchased these securities to pledge them as collateral to obtain even more central bank liquidity (collateral trade effect).

The side effects of monetary policy documented by Jasova, Mendicino, and Supera (2018) and Crosignani, Faria-e-Castro, and Fonseca (2019) have further support on the literature on the risk-taking channel of monetary policy. It has been extensively documented that when monetary policy is (too) accommodative, banks tend to adopt riskier lending strategies (see for example Bruno and Shin, 2015). Bonfim and Soares (2018) show that this risk-taking channel is at work also in Portugal. By examining the transmission of monetary policy before the global financial crisis, the authors find that when interest rates are low, ex ante riskier borrowers are more likely to receive funding. However, when examining the ex post performance of the loans granted in low interest rate periods, they do not find significant differences in their performance, thus suggesting that the risk-taking channel does not entail sizeable risks to financial stability. However, the loans granted in periods of very low and stable interest rates show higher default rates once interest rates start to increase. This finding has relevant policy implications for what we might expect once monetary policy becomes tighter in the euro area, after a long period of ample liquidity and extremely low funding costs.

Final remarks

Recent research has made significant progress in dealing with the difficulty in establishing a causal link between bank shocks and real economic variables. Khwaja and Mian (2008) draw the attention to the importance of separating the bank lending channel and the firm borrowing channel in understanding how bank shocks affect lending to the economy. This paper influenced many other papers in a strand of the literature that has tried to find shocks that reproduce "natural experiment" conditions. Using the "exogenous" variation in banks' liquidity generated by the 2007–2009 crisis, many papers robustly find that banks affected by shocks decrease lending (see for example Ivashina and Scharfstein, 2010). Other studies, such as the Chodorow-Reich (2013) seminal paper, analyse the causal effects of bank supply shocks on real variables.

Despite the importance of these concerns there is a trade-off between a precise identification of the shocks and the generality of the results. It is important to understand whether the conclusions apply only in a particular scenario or whether they may have general implications. This is why observing non-causal patterns in the data can be an important complement of the analysis, even though policy decisions should ideally be anchored on

the identification of causal effects. In any case, the availability of good quality micro data is essential when the presence of heterogeneity is relevant.

This article surveys the empirical research that has been developed at Banco de Portugal in the last decade, most of which uses the micro databases available. Some of these studies focus on the identification of causal relationships between bank shocks, credit and real economic variables. Other studies analyse non-causal patterns and relationships between these variables and also make important contributions to the understanding of the adjustment process of the Portuguese economy. Overall, this research documents that bank liquidity and capital shocks during the crisis had a negative impact on investment, employment, human capital, firm survival and productivity. These impacts were heterogeneous in the sense that they vary with the characteristics of the firms and the banks. During the adjustment period, very low monetary policy rates induced some risk-taking behaviour by the banks but unconventional monetary policy measures reduced the roll-over risk and avoided disruption in the financing of the Portuguese economy. Moreover intrusive supervision under the adjustment program mitigated zombie lending.

For sure many important questions remain unanswered and researchers, both inside and outside Banco de Portugal, continue to thoroughly examine the available data to address them.

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