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BANCO DE PORTUGAL
ECONOMIC STUDIES

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Banco de Portugal Economic Studies

Volume IX

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BANCO DE PORTUGAL
EUROSYSTEM

Lisboa, 2023 • www.bportugal.pt

Banco de Portugal Economic Studies | Volume IX – no. 1 | Lisbon 2023 • **Banco de Portugal** Rua do Comércio, 148 | 1100-150 Lisboa • www.bportugal.pt • **Edition** Banco de Portugal • **Design** Communication and Museum Department | Design Unit • **ISSN (*online*)** 2183-5217

Content

Banco de Portugal
Banco de Portugal Economic Studies, Vol. IX, No. 1

Editor's note[1]

Pedro Duarte Neves

January 2023

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1. This issue of Banco de Portugal Economic Studies includes three studies. The first presents evidence on the impact of the allocation of European funds on the performance of Portuguese firms, on variables such as employment, business turnover and export intensity. The second study analyses the premium on price/cost margins of exporting firms compared to non-exporting firms. The third study develops an approach to decompose central banks' incomes, focusing on the euro area.

2. The first study of this issue of Banco de Portugal Economic Studies, written by Cabral and Campos, analyses the performance of Portuguese firms that received European funds. The authors explore a database with information on applications to COMPETE – a programme financed by the European Regional Development Fund under the 2007-2013 financial framework – as well as the Central Balance Sheet Database for the 2006-2019 period, making it possible to identify the persistence of its effects.

This study presents relevant empirical evidence: firms benefiting from these funds have higher levels of employment, sales, added value, productivity, capital and exports compared to the firms denied this support. These impacts last several years for most variables. The authors highlight two particularly significant effects: increases in employment, by 15.7%, and in export intensity, by 3.6 percentage points, three years after the decision to allocate funds. The results essentially confirm the indications of the existing empirical literature for Portugal.

3. The second study in this issue of Banco de Portugal Economic Studies, written by Soares and Sousa, presents empirical evidence that price/cost margins of exporting firms are higher than those of similar firms that only sell to the domestic market: exporting firms earn a premium in the profit margins compared to non-exporting firms. These premia that occur both in the manufacturing sector and in the non-manufacturing sector are characterised by a considerable heterogeneity at the most broken-down level. These results are in line with the existing empirical evidence, confirming the indications of the reference theoretical models of international trade.

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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.

4. In the editor's note of last year's July issue of Banco de Portugal Economic Studies – within the scope of a synopsis then published[2] on the importance of solvency in a central bank to the credibility of monetary policy – some references were made of the past losses incurred by central banks (Chile, Czech Republic and Switzerland) or of cases where probable losses were expected in the near future (United States). Given the strong expansion in the balance sheets since the Great Financial Crisis, this became especially important in the current context of globally rising intervention rates of central banks, with consequences sometimes dissimilar in the remuneration of assets and liabilities.

The developments that followed the July issue of the Banco de Portugal Economic Studies confirmed the opportunity to review the literature published so far. Without being exhaustive, the following examples should be noted, occurring on the second semester of 2022:

- On 4 July, two economists from Sveriges Riksbank (Sweden's central bank) published a document[3] in which they stated as follows: "We note that the recent rapid rise in interest rates means that the Riksbank will probably report a large loss this year. [...] We show an example of a scenario in which the Riksbank reports a loss of SEK 65 billion in 2022, which reduces equity to low levels. Although the increase in interest rates has a strong impact on earnings this year, it is likely that the reported results for coming years will again be positive."
- On 15 July, economists at the Federal Reserve published a document[4] in which they conclude: "In this note, we showed that net income is likely to turn negative temporarily, resulting in a deferred asset to be recorded on the Fed's balance sheet in the near-term under a range of potential macroeconomic outcomes."
- A few days later, on 25 July, economists of De Nederlandsche Bank (DNB) published a study[5] in which they present guidelines to determine adequate levels of capital of a central bank, concluding the following: "Capital adequacy will get significant attention over the next years as many central banks have to draw on their buffers following rising interest rates in line with high inflation. Because many central banks accrued large monetary portfolios with (government) bonds they are exposed to increasing interest rates. Our study offers some guidance here."

2. "On the solvency and credibility of a central bank", José Miguel Cardoso da Costa, Banco de Portugal Economic Studies, July 2022.

3. "The Riksbank's financial result and capital are affected by higher interest rates", David Kjellberg and Magnus Ahl, *Economic Commentary*, Sveriges Riksbank.

4. "An Analysis of the Interest Rate Risk of the Federal Reserve's Balance Sheet, Part 2: Projections under Alternative Interest Rate Path", Alyssa Anderson, Philippa Marks, Dave Na, Bernd Schlusche and Zeynep Senyuz, *FEDS Notes*, 15 July 2022.

5. "On the capitalisation of central banks", Paul Wessels and Dirk Broeders, *Occasional Studies* Volume 20-4, De Nederlandsche Bank, 25 July 2022.

- On 9 September, the Governor of the DNB sent a letter[6] to the Minister of Finance, in which the following is highlighted: "DNB is experiencing the financial consequences of this reversal of monetary policy. As the unexpectedly swift reversal of the inflation pattern takes place and key policy rates rise, DNB is facing increases in the rates it pays on deposits which banks hold with DNB. At the same time, its income on the purchased bonds is not rising in parallel. [...] All central banks implementing purchase programmes, both in the euro area and beyond, are facing these negative consequences. [...] Losses are greater for national central banks that have purchased bonds from governments that enjoy relatively high credit ratings – as is the case for DNB. After all, government bonds from these countries carry the lowest interest rates and are therefore more likely to be loss-making when financing costs rise. [...] Although the buffers available to DNB can absorb substantial shocks, they are not infinite."
- On 21 September, as a direct consequence of this letter, the Nationale Bank van België/Banque Nationale de Belgique stated in a press release,[7] that: "Based on its most recent risk scenarios, the Bank expects to end financial year 2022 with a loss. Moreover, the risk assessment indicates that losses will continue to mount in the coming financial years. This is due in part to revaluation [sic] of the Bank's investment portfolios. However, the main contributing factor is the rising cost of financing monetary policy portfolios: interest expenses on the deposits held by credit institutions with the Bank have increased, against the low yields at which the – mostly long-term – securities in those portfolios were acquired."
- On 31 October, the Swiss National Bank announced losses amounting to CHF 142.2 billion in the first nine months of the year, following the effects of the increase in interest rates and appreciation of the Swiss franc on investment assets.
- In the United Kingdom in November, the Office for Budget Responsibility[8] announced that "[the] Bank Rate has now risen above the average interest rate earned on the APF's gilt holdings. This raises debt interest spending net of the APF [Asset Purchase Facility] and, when added to losses that are crystallised as gilts redeem or are sold, will mean cash starts flowing from the Treasury to the APF. Across the forecast, the Treasury pays £133 billion to cover these losses, more than reversing the previous 13 years' gains [a total of GBP 120 billion]."[9]

5. The possibility of losses in central banks is, therefore, a highly topical matter. The third study in this issue of Banco de Portugal Economic Studies, written by Costa and Silva, identifies the main sources of financing of central banks, focusing on the Eurosystem. The study's main contribution lies in the decomposition of income

6. Letter available on DNB's website.

7. Press release available on the Nationale Bank van België/Banque Nationale de Belgique's website.

8. "Economic and Fiscal Outlook", Office for Budget Responsibility, November 2022.

9. Expressions inside square brackets were a choice made by the author to achieve better readability and provide context to this quotation.

generated by monetary policy decisions into two components – one which is shared by all central banks and another resulting from assets with non shared returns – whose relative weight has changed significantly in quantitative terms. A better understanding of the determinants of central bank profits is particularly relevant in a context where increasing reference interest rates has, as previously mentioned, an impact on the net profitability of long-term securities portfolios held by banks.

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Non-technical summary

January 2023

European structural funds and the performance of Portuguese firms

Sónia Cabral and Maria Manuel Campos

This article analyses the impact of receiving European structural funds on the performance of Portuguese firms, showing positive effects - particularly as regards employment and export intensity - for those benefiting from such support.

The empirical evidence is based on the analysis of COMPETE, a programme financed by the European Regional Development Fund under the 2007-2013 financial framework. This programme supported projects with a focus on technological R&D, innovation and the internationalisation of SMEs.

The analysis draws on a new dataset on applications for funding under COMPETE, covering both successful and unsuccessful bids. This information is merged with a longitudinal dataset highly representative of Portuguese firms covering the 2006-2019 period. The empirical analysis contrasts the performance of firms with at least one project supported to that of comparable counterparts which were not successful in their bids. This comparison is made over several years, both before and after the funding decision. performance.

We use a dynamic "difference-in-differences" setup to show that, ahead of the decision, the characteristics of firms evolved in a similar manner in the two groups. Though it is not possible to distinguish the impact of the funding *per se* from that arising from the selection of the best projects, there are effects benefiting firms with an approved project in its aftermath. Firms with support from COMPETE show, after the decision, higher levels of employment, turnover, value added, productivity, capital, and exports than those of unsuccessful bidders. The effects on labour productivity are smaller than on the other variables.

In most cases, the impacts last for several years. However, in the case of capital, the effects start decaying after three years. The impacts are especially noteworthy - in terms of magnitude and persistence - for employment and export intensity: three years after the funding decision, employment is 15.7% higher and export intensity stands 3.6 percentage points above. These differentials remain broadly stable in the following years (Figure 1).

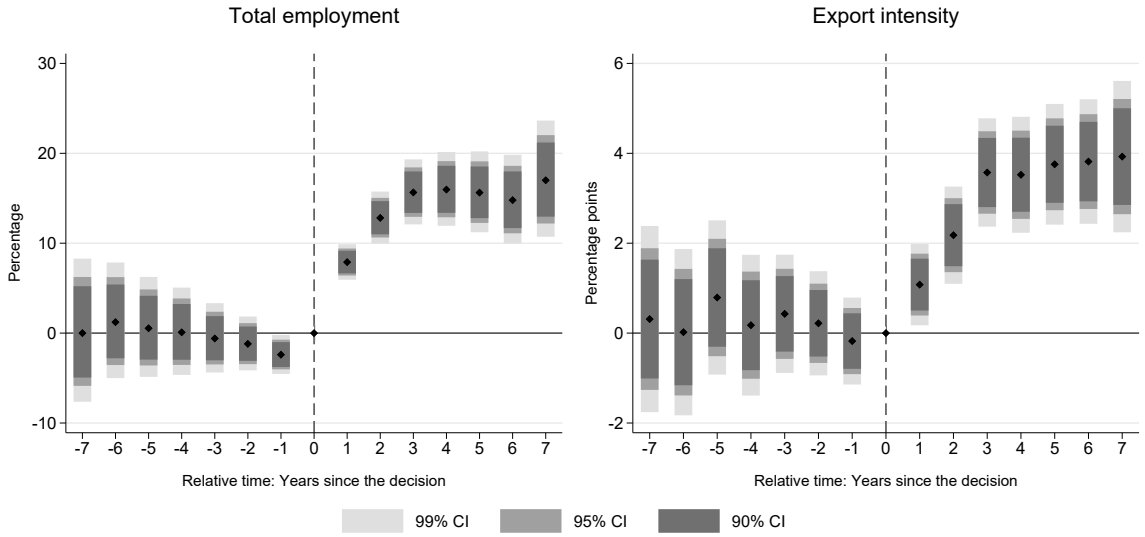

FIGURE 1: Impact of receiving European structural funds on employment and export intensity

Notes: For each variable, the charts depict estimates for the difference between successful and unsuccessful firms, in distinct moments relative to the year in which the funding decision was taken. CI stands for confidence intervals, which are computed from robust standard-errors clustered at the firm level. Export intensity is measured as exports in percentage of turnover.

Against the backdrop of the start of the implementation of the Recovery and Resilience Plan (RRP), it is important to understand the possible effects of this programme on the performance of Portuguese firms. All in all, this article shows that receiving support under COMPETE contributed to create jobs, expand the productive capacity of firms and foster their internationalisation. Whether similar outcomes can be achieved through RRP funds is an empirical question requiring future investigation, but our results suggest encouraging prospects.

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European structural funds and the performance of Portuguese firms

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January 2023

Abstract
This article provides new evidence on the impact of receiving European structural funds on Portuguese firms. It explores a novel dataset, covering the universe of projects submitted to the COMPETE programme under the 2007-2013 framework, combined with rich longitudinal firm-level data for 2006-2019. This long time span allows contrasting firms that were granted financial support with comparable firms that also applied but were unsuccessful, for several years both before and after the bid. By employing a dynamic difference-in-differences setup focused on various firms' performance indicators, we identify positive and persistent effects in firms receiving financial support. Though to varying degrees, firms with backed projects have higher employment, turnover, gross value added, productivity, capital, and exports. These differences vis-à-vis unsupported firms prevail for several years. (JEL: D04 D22 H43)

1. Introduction

The establishment of the Recovery and Resilience Facility (RRF) rekindled interest in the role of structural funds in promoting growth and development across Europe. The RRF and, more broadly, the NextGenerationEU (NGEU) initiative represent important milestones in European integration in many dimensions. However, their overarching objectives of fostering growth, job creation and competitiveness while reducing asymmetries across Member States are not novelties. The EU has been pursuing these goals for the last decades by distributing structural and investment funds financed through national contributions to the Community Budget.

The European Structural and Investment Funds (ESIF) are one of the largest items of the EU Budget, encompassing instruments supporting rural development and the Structural and Cohesion Funds (SCF). The latter are the centrepiece of the

Acknowledgements: The authors are especially grateful to Marta Silva for her comments and invaluable help with the Incentives Systems data and to Miguel Portela for his useful comments and suggestions. We also thank the editor, Pedro Duarte Neves, and Nuno Alves, Diana Bonfim, Cláudia Braz, Sónia Félix, Álvaro Novo, João Pereira dos Santos and participants in an internal seminar at Banco de Portugal for their comments. The analyses, opinions, and findings expressed in this article are those of the authors and do not necessarily coincide with those of Banco de Portugal or the Eurosystem. Any errors and omissions are the sole responsibility of the authors.

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cohesion policy and comprise three financial instruments: the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund. Each instrument has specific, albeit complementary, strategic objectives focusing on economic, social and territorial cohesion by reducing gaps between EU regions. The ERDF supports programmes addressing regional development, competitiveness and territorial cooperation throughout the EU. The cross-country allocation of the ERDF reflects the level of GDP *per capita* of their regions (defined at level 2 of the common classification of territorial units for statistics - NUTS 2).

The cohesion policy is structured around the multiannual financial frameworks (MFF), spanning seven-year budget cycles. The latest MFF, approved in December 2020, covers the 2021-2027 period. The previous MFF was adopted in December 2013 and, while spanning the 2014-2020 period, the absorption of available resources can be extended up to 2023. Therefore, the most recent closed MFF is the one referring to 2007-2013, whose commitments could be extended up to 2015. In the 2007-2013 programming period, the EU made EUR 347 billion available through SCF.

The cohesion policy is jointly implemented through Partnership Agreements between the European Commission and national authorities. Considering the eligible regions and the guidelines set at the EU level, Member States allocate the funds to Operational Programmes (OP), which co-finance projects aligned with priorities and targets agreed upon by European and national (or sub-national) managing authorities.

Portugal has been a net beneficiary of European funds since EU accession. Starting with the 1989-1995 programming period, Portugal is estimated to have received SCF amounting to 1.7% of GDP per year, on average, until 2021. Within the 2007-2013 MFF, Portugal received EUR 21.4 billion worth of Cohesion Funds (1.2% of GDP per year), of which approximately half was channelled through the ERDF: EUR 11.5 billion (0.7% of GDP per year), well above the EU average.

At the national level, the implementation of the cohesion policy for the 2007-2013 programming period was framed by QREN - a Portuguese acronym for the National Strategic Reference Framework, *Quadro de Referência Estratégico Nacional*. QREN established three policy priorities: strengthening the potential of human resources; fostering national competitiveness; and reinforcing territorial development. These were implemented through seven regional OP, three multi-region thematic OP (Human Potential, Competitiveness Factors and Territorial Valorisation), and a Technical Assistance OP. Regarding specifically the ERDF, 88% of the resources were directed to the regional OPs and the Competitiveness Factors OP - the COMPETE Programme.[1] These are complementary in co-financing projects focusing on the following dimensions: technological R&D; innovation; and the qualification and internationalisation of micro, small and medium firms (SMEs). Each of these dimensions corresponds to a system of incentives (SI) among which the proposed projects were framed. Approximately 32%

1. In practice, COMPETE was jointly managed by the Competitiveness Factors OP (in charge of projects by medium and large firms) and the regional OPs for mainland Portugal (in the case of micro and small firms).

of total ERDF resources distributed under QREN were channelled for the purpose of enterprise support and innovation (European Commission 2016).

Despite the relevance of EU funds for the Portuguese economy and their focus on business support, research on their actual impacts is scarce, especially at the firm-level. This can be explained by the lack of proper granular data allowing for micro-level counterfactual impact evaluations. This article complements the existing evidence for Portugal by combining firm-level data from the Central Balance Sheet Harmonised Panel (CBHP) from 2006 to 2019 with a new project-level dataset, the Incentives Systems data. The latter includes information for projects submitted to the three SI backed by the ERDF within QREN and under the scope of the COMPETE programme, covering both successful and unsuccessful applications.

We take advantage of the longitudinal nature of CBHP to follow for several years firms applying for funding, both before and after the decision on whether to grant support or not. We perform event-study analyses focusing on key firm outcomes — employment, turnover, gross value added (GVA), the capital-to-assets ratio, labour productivity (GVA per worker) and export intensity (exports over turnover) — checking for an empirical relationship between successful applications and changes in these outcomes over time.

Results suggest that having at least one project financed by COMPETE has a positive and persistent impact on firms' performance. Though it is not possible to distinguish the effect of the funding *per se* from that arising from the selection of the best projects, it is clear that, after a successful application, employment, turnover and GVA are higher than in firms whose bids were unsuccessful. Positive effects of EU funds are also found for export intensity and the capital ratio. The impact on labour productivity, though positive, is relatively small. The effects are also found to be persistent, lasting in most cases for 5 to 7 years after the funding decision. Capital has the shortest lasting effect, as it begins to fade after three years. All in all, our results show that funding from COMPETE contributed to job creation, the internationalisation of firms and the expansion of their productive capacity.

The article is organised as follows. Section 2 discusses the related literature that frames this study. Section 3 describes the data sources and provides a description of the sample and relevant variables. Section 4 outlines our identification strategy and econometric framework. Section 5 presents the baseline results and a summary of robustness checks. Finally, Section 6 presents some concluding remarks.

2. Related literature

A number of papers have examined the causal impact of public subsidies on investment, employment, and economic activity over the years, especially in the context of the EU SCF. Assessing the effectiveness of these types of stimulus is an empirical question, but evaluating the impacts is a challenging task. The main problems are due to the difficulties faced in isolating the effects of the subsidies from the confounding effects induced by other factors and in controlling for the high selection bias (see Criscuolo

et al. (2022) for a discussion). There is no consensus on the empirical literature, but most micro-econometric evaluations find that economic development schemes – in particular EU programmes – have a growth-stimulating effect.

The EU provides grants to disadvantaged regions of Member States to help them to catch up. Hence, a stream of the literature exploits causal methods to assess the economic impact of EU funds at the regional level, investigating the effect of transfers on beneficiary regions with respect to untreated regions. The majority of these studies find evidence of a positive impact of EU funds on the growth of lagging areas (e.g., Becker *et al.* 2010, Pellegrini *et al.* 2013, Ferrara *et al.* 2017, Gagliardi and Percoco 2017). Another insight is that EU transfers tend to display immediate effects but they do not show much longevity beyond a programming period, failing to push treated regions into a higher growth path (Barone *et al.* 2016 and Becker *et al.* 2018). Taking into account the treatment intensity of EU regional transfers, Becker *et al.* (2012) and Cerqua and Pellegrini (2018) conclude that there is a maximum efficiency level of funds beyond which they do not generate stronger growth effects, implying that some reallocation of funds between regions would lead to higher aggregate growth in the EU. Moreover, regional heterogeneity also matters as a determinant of the policy effectiveness of EU funds, as a region's capacity to take advantage of the funds is found to be related to the local economic structure, human capital endowment and institutional quality (Becker *et al.* 2013, Percoco 2017).

As richer datasets become available, micro-level impact evaluation explicitly examining the firms' utilisation of EU funds represents a promising empirical approach. Mouqué (2012) summarises some of the early results on the firm-level impact of the 2007-2013 MFF using standard methods from the programme evaluation literature. The studies reviewed suggest that EU financial support is an effective way of increasing investment, production and employment in SMEs, but not in large firms. Bachtrögler and Hammer (2018) exploit a cross-country firm-level database on beneficiaries of EU funds during the 2007-2013 MFF. Using propensity score matching techniques, the authors find mixed effects on the performance of a sample of manufacturing firms in six European countries. On average, firms that receive financial assistance hire more workers and increase their capital stock to a larger extent, but there is little evidence of additional positive total factor productivity (TFP) effects. Bachtrögler *et al.* (2020) analyse the impact of the EU cohesion policy on firm growth in the programming period 2007–2013 in seven European countries. Results show that EU support promotes firm growth in size (value added and employment) more than in productivity. Dvouletý *et al.* (2021) provide a review of 30 recent studies on the effects of EU public grants on SMEs performance, covering 13 countries with various methodological approaches and databases. The summarised findings show mostly positive outcomes of the grants on firm survival, employment, fixed assets, and turnover, with mixed findings for labour productivity and TFP.

Since the late nineties, Italy has been one of the main subjects of counterfactual programme evaluation investigating EU policy measures undertaken to support the investment activities of private firms. Cerqua and Pellegrini (2020) and Bocci *et al.* (2021) provide recent overviews, showing that there is considerable heterogeneity in

the evaluation methods and in the results. However, in most cases, these policies have enhanced economic growth in Italy, especially for weaker firms and outcomes that are directly targeted by public programmes. Nevertheless, these policies are less likely to trigger changes in the long run. Some examples of recent studies on the impact of Law 488/1992 (L488), the largest EU subsidy program implemented in Italy, using regression discontinuity design (RDD) models are Cerqua and Pellegrini (2022) and Cingano *et al.* (2022). Both papers confirm the positive effect of L488 subsidies on the employment of funded firms. Also using RDD, Cerqua and Pellegrini (2014) find that the impact of L488 subsidies on employment, investment, and turnover is positive and statistically significant, while the effect on productivity is mostly negligible.

Several studies for other European countries investigate the causal impact of public support programmes, using longitudinal firm-level datasets that allow the estimation of the effects of grants after the end of the intervention. However, the literature is still limited considering the importance of the topic. Criscuolo *et al.* (2019) exploit exogenous changes in the area-specific eligibility criteria for an employment support program in the UK. Controlling for endogeneity with instrumental variables, the authors find positive effects on employment and investment but not on TFP. They also find that the program effects are confined to smaller firms.

Focusing on Latvia, Benkovskis *et al.* (2019) study the effect of EU regional support received in the context of the EU programming period 2007–2013, using a sample of around 500 beneficiaries. The authors find that participation in projects co-financed by the ERDF increases firms' employment, turnover and capital intensity immediately, while it raises productivity only two years after the launch of the projects. Selebaj and Bule (2021) analyse the impact of EU grants on firms' performance in Croatia. The results show that the use of EU funds has a strong and positive effect on employment, operating income, labour productivity, TFP and capital intensity.

Banai *et al.* (2020) and Muraközy and Telegdy (2022) use a combination of propensity score matching and difference-in-differences (DiD) regressions to evaluate the impact of SCF subsidies on Hungarian firms. Banai *et al.* (2020) focus on SMEs in the 2007–2013 programming period and find that EU funds had a significant positive effect on the number of employees, sales revenue, gross value added and, in some cases, operating profit, but not on labour productivity. Muraközy and Telegdy (2022) investigate the effects of EU grants between 2004 and 2014 and conclude that, compared to unsuccessful applicants, subsidised firms increase their employment, sales, total assets, capital-to-labour ratio and labour productivity, but not TFP.

There are some studies with micro-level data using impact evaluation methods to assess the effect of EU grants on Portuguese firms. The results of Bondonio *et al.* (2016) indicate that firm-level support co-financed by EU structural funds in Portugal in 2003-2006 contributed to improving job quality and increase average remuneration per hour in treated firms. Santos (2019) uses a small sample of around 300 subsidised and non-subsidised firms, finding a positive effect of an innovation subsidy during 2007-2011 on employment, sales, investment and TFP. More recently, Martins (2021) examines the effects on firm performance of a large training programme supported by the ESF from 2007 to 2011. Using DiD models and a large longitudinal dataset, the author finds

significant positive effects on training hours and expenditure; and that such additional training led to increased sales, value added, employment, productivity, and exports. These effects tend to be of at least 5% and, in some cases exceed 10%, and are robust in multiple dimensions.

Alexandre (2021) uses a database similar to the one utilised in this article and provides a thorough description of the characteristics of the Portuguese firms that applied for ERDF funds within QREN (2007-2013) and PT2020 (2014-2018).[2] His empirical results suggest a positive and statistically significant impact of ERDF funding on firms' investment, employment, value added, exports and productivity. Alexandre *et al.* (2022) implement a RDD to investigate the impact of a second investment grant for the same firm, showing that it has positive and significant additional effects on firms' productivity. Finally, Gabriel *et al.* (2022) examine the impact of widening the regional eligibility to EU funds on firm performance between 2003 and 2010. Their results uncover a positive causal effect on firms' sales, while employment and labour productivity do not seem significantly influenced by the reform.

We contribute to this literature by exploring a new detailed dataset, recently made available at Banco de Portugal, combined with rich longitudinal firm-level data. In particular, we provide new evidence on the effects of a specific EU-funded programme — COMPETE — leveraging on a long time span that allows contrasting successful and unsuccessful applicants both before and after the bid. By relying on a dynamic setup, we provide results not only as to the level of the impact on several firms' outcomes but also as regards its persistence over time.

3. Database and exploratory analysis

This article uses two micro-level databases available at the BPLIM - Banco de Portugal Microdata Research Laboratory.[3] The first database is the Central Balance Sheet - Harmonised Panel (CBHP), comprising firm-level balance sheet annual data from 2006 to 2019 (BPLIM, 2021). CBHP is based on the Central Balance Sheet database, which virtually covers the universe of non-financial corporations operating in Portugal. This dataset is mostly based on information reported through *Informação Empresarial Simplificada* (IES, Simplified Corporate Information), the system through which corporations report mandatory information to the tax administration and statistical authorities. Under IES, firms provide detailed annual balance sheet, profit and loss accounts. It further contains information on firms' characteristics such as number of employees, age and main sector of economic activity according to the Portuguese industrial classification Revision 3 – *Classificação Portuguesa das Actividades Económicas* (CAE).

2. PT2020 is the designation of the Partnership Agreement between the European Commission and Portugal for the period between 2014 and 2020.

3. `https://bplim.bportugal.pt/`

The second source is the Incentives Systems data (BPLIM, 2022). This is a project-level dataset made available by BPLIM that compiles information produced by the Development and Cohesion Agency (*Agência para o Desenvolvimento e Coesão*) and the Managing Authority for the COMPETE programme. These data comprise information for projects submitted to COMPETE to be financed by the ERDF under QREN, covering both successful and unsuccessful applications. It further covers applications under the PT2020 framework, in which case it also includes projects financed by the ESF. The reference date for information on QREN projects is September 2017 and it will no longer be updated, while for PT2020 the latest data freeze refers to May 2020 and it will be updated on an annual basis. The data cover a myriad of information on the projects, including details on the call for applications and the tender, an anonymised identifier for the submitting firm, the relevant OP and the specific measure within the SI under which the application was made. Importantly, the data include a set of variables allowing the identification of the different stages in the lifecycle of each project: application; first review by an intermediate body; evaluation by the selection committee; first and subsequent decisions on whether or not to grant support; signing of the incentives contract; and closure of the investment and the project. This makes it possible to clearly distinguish unsuccessful from successful applications and, among these, ongoing from closed projects.

This article focuses on QREN, which is the most recent closed framework, hence data on the PT2020 are discarded. Although applications for QREN are restricted to 2007-2013, dates of decisions and the signing of the incentives' contracts span a longer period. Originally, the Incentives Systems data covered around 28,000 applications. We dropped all which were de-committed or withdrawn.[4] Moreover, we only kept projects for which a decision is taken and that fall into one of three distinct statuses: not supported; approved; and closed (referring to either investment or project closure). This leaves us with 20,341 applications, out of which 9,524 projects were granted financial support. This covers most of the universe of projects backed by COMPETE.

The sample used in this article results from a merge between CBHP and the Incentives System data, thus comprising only firms present in both. As such, the final sample excludes most of the banking and insurance sector which is absent from CBHP.[5] In addition, all sole proprietors and independent workers and business associations are also dropped as they are not present in CBHP.

The project-level nature of the Incentives System data implies that firms are not uniquely identified as the same firm can submit multiple applications. The data were converted into firm-level by keeping only one project per firm. More precisely, if firms

4. The withdrawal occurs before the funding decision at the initiative of the beneficiary, while the de-commitment occurs after the communication of the funding decision at the initiative of the beneficiary or the OP.

5. Most corporations in section K - Financial and insurance activities (divisions 64 – 66), like banks and insurance companies, are excluded from CBHP, since they have specific accounting reporting requirements and a distinct balance-sheet structure. However, other financial and insurance intermediaries and auxiliaries are available in the dataset.

apply several times but are always unsuccessful, we keep only the first application. [6] If firms apply multiple times and are successful at least once, we only keep their first approved application. These options have implications in terms of the analysis herein presented, as it relies on a treatment effects setup based on the comparison between successful and unsuccessful applicants. On the one hand, this procedure may render an overestimation of the persistence of the effects we aim to capture if they also reflect subsequent successful applications. However, it also ensures that the control group clearly excludes firms that have received support for some project within COMPETE (see Martins 2021 for a similar reasoning). In order to mitigate the risk that results are affected by successful applications to PT2020 funding, we further exclude from the sample all firms with approved projects under this framework in the 2015-2019 period.[7]

The final sample is an unbalanced panel of 8,741 distinct firms with 95,081 observations from 2006 to 2019, with about half of the firms followed throughout the whole 14 years. All of these firms submitted at least one project between 2007 and 2013. Although we keep only one application for each firm, approximately 25% of the applicants in our sample submitted more than one project.

The first decisions on the relevant applications were issued between 2008 and 2014. Combining this with the 2006-2019 coverage of CBHP implies that we can observe firms ahead of the decision for a period between two and eight years: for firms with a decision in 2008, we observe 2006 and 2007; for those with a decision in 2014, we observe 2006-2013. Similarly, the post-decision period for a firm with a decision in 2008 corresponds to 2009-2019 (eleven years), whereas for one with a decision in 2014 it corresponds to 2015-2019 (five years).

Based solely on the relevant project submitted by each firm, the overall success rate across the period stands at 45%: 3,943 firms were granted EU funding and these represent our treatment group. This is about 40% of the total number of projects supported by COMPETE. The remaining 4,798 firms, which were unsuccessful in all their applications, represent our control group. The number of decisions covered in the data hovers around 1000 per year except in 2013, when it exceeds 3000, and 2014, when it falls below 700 (Figure 1). The treatment and control groups are fairly distributed across the treatment cohorts defined as the year in which the relevant decision was issued.

Compared to their counterparts with unsuccessful bids, the sub-sample of successful applicants features only a slightly higher share of small and medium firms (Figure 2). The distribution of firms across sectors and age cohorts is also fairly similar among the two groups in the year of the decision.

6. An alternative definition of the control group would be to keep all applications of always unsuccessful firms. That would mean that the same outcomes of a firm that applies (unsuccessfully) more than once would be used as a counterfactual in different periods for distinct treatment cohorts. Given that we have a large sample of firms, we decided to keep only one unsuccessful application per firm, thus mirroring the option taken for the treatment group.

7. Unfortunately, we lack data on whether a firm received EU funding during the previous MFF 2000–2006. We also do not know if a given firm has received funding under other EU financial instrument within the QREN 2007-2013 framework. Hence, we cannot rule out that some of the results presented in Section 5 reflect funding obtained previously or contemporaneously from a different EU fund.

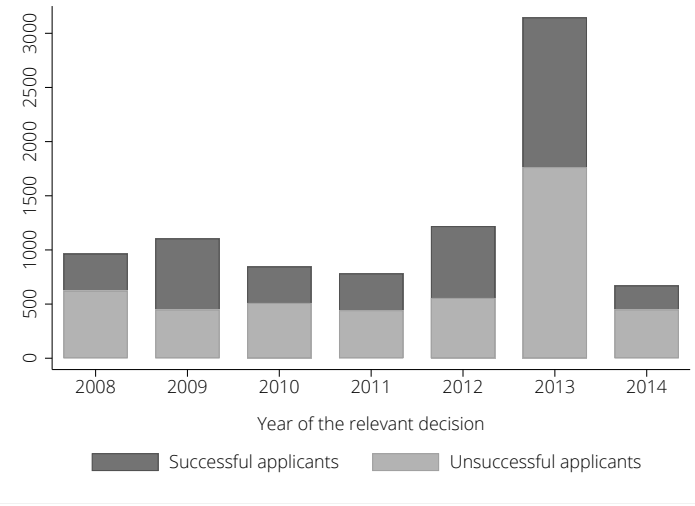

FIGURE 1: Number of applications by year of the relevant decision

Note: The chart depicts the number of applications for which a relevant decision was made between 2008 and 2014, split between successful and unsuccessful firms. For sucessful firms, it is the first favourable decision (though not necessarily corresponding to the first nor the last project submitted). For unsuccessful bidders, it is the first negative decision for a firm which never receives a favourable outcome.

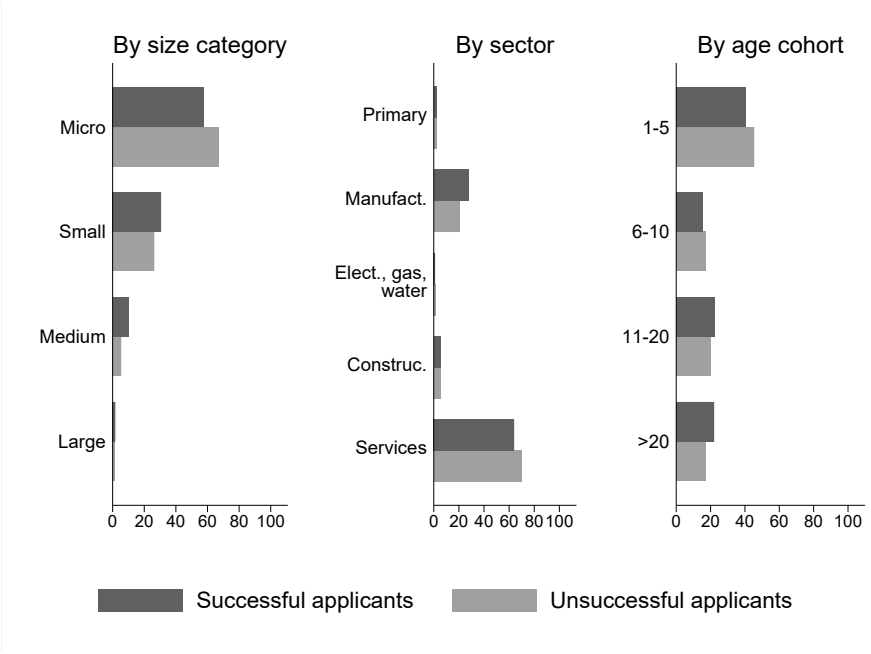

FIGURE 2: Distribution of successful and unsuccessful firms by size category, sector and age cohort

Note: The charts depict the distribution of applicant firms across size categories, sectors, and age cohorts in the year of the relevant decision. The size categorisation is in line with the definition adopted by the European Commission: micro-firms employ less than 10 persons with an annual turnover or annual balance sheet total not exceeding EUR 2 million; small firms employ less than 50 persons with an annual turnover or annual balance sheet total not exceeding EUR10 million; medium-sized firms employ less than 250 persons with an annual turnover not exceeding EUR 50 million or an annual balance sheet total not exceeding EUR 43 million. All other firms are considered as large. The sectors are defined as the broader sections of CAE rev.3.

Ahead of the treatment, successful firms are larger, both in terms of employment and turnover, and more productive than their unsuccessful counterparts. They also feature higher export intensity but lower capital over assets (Table 1). With the exception of the capital ratio, these differences are found to be statistically significant, which can be explained by several factors. For instance, smaller firms may have fewer resources invested in the application process making them less prone to put forward a successful bid. Stronger credit constraints may also limit incentives to put efforts into the application for co-financed projects, which, together with a learning curve as regards the procedural details, may give older firms an advantage when submitting applications.[8] In any case, an analysis focusing on 2006-2013 shows that, despite these *unconditional* differences in terms of levels, the evolution of firms' pre-treatment attributes was essentially parallel in the two groups. Moreover, as shown in Section 5 below, the inclusion of relevant controls in the regressions virtually eliminates the differences between the two groups in the pre-treatment period.

These pieces of evidence leave us confident that the control group corresponds to a reasonable proxy for the counterfactual dynamics of successful applicants had they not received EU funding. This supports our option for a DiD setup to frame the analysis. Still, this identification strategy has a limitation stemming from the fact that selection into treatment is not random. However, given that we are using a sample of applicants, assignment to treatment is essentially exogenous to the firm and results from the *ex-ante* project evaluations carried out by public bodies (see Santos *et al.* (2019) for a detailed analysis of the *ex-ante* selection process of applications submitted to one of the incentives system included in our sample). Besides the characteristics of the projects, their approval is also influenced by the circumstances of each call, including the availability of funds, the number of applicants, and the binding (or non-binding) character of the minimum scores. Nevertheless, our analysis cannot distinguish the effect of EU funding *per se* from the effect of an efficient *ex-ante* selection of the best projects. What we aim at evaluating is if, conditional on the selection process of each tender, firms that were previously comparable have distinct *ex-post* evolutions depending on their treatment status.

8. Indeed, a simple linear model regressing the probability of having a successful application on a set of firms' observables shows that age and multiple applications have a statistically significant positive impact, whereas the impact of leverage is negative. All other observables are not statistically significant determinants of success probability.

	Mean	Std. Deviation	25th perc.	75th perc.
Treatment group				
Age (years)	15	13	5	20
Capital/assets (%)	30.2	24.4	9.9	46.0
Export intensity (exports/turnover, %)	13.0	26.7	0.0	8.1
Gross value added (EUR, million)	0.8	2.0	0.1	0.6
Labour costs (EUR million per worker)	0.01	0.01	0.01	0.02
Labour productivity (EUR million per worker)	0.02	0.02	0.01	0.03
Leverage (financial debt/assets, %)	24.2	23.5	4.0	37.5
Return on assets (EBITDA/assets, %)	7.4	28.1	4.0	15.4
Total employment (#)	26	53	3	25
Total assets (EUR, million)	3.4	9.9	0.2	2.2
Turnover (EUR, million)	3.3	8.8	0.2	2.2
Control group				
Age (years)	13	12	4	18
Capital/assets (%)	30.7	25.9	8.4	47.6
Export intensity (exports/turnover, %)	9.3	22.9	0.0	2.3
Gross value added (EUR, million)	0.5	1.5	0.0	0.4
Labour costs (EUR million per worker)	0.01	0.01	0.01	0.02
Labour productivity (EUR million per worker)	0.02	0.02	0.01	0.03
Leverage (financial debt/assets, %)	25.9	26.4	2.7	40.1
Return on assets (EBITDA/assets, %)	4.9	32.3	2.4	14.6
Total employment (#)	18	41	2	16
Total assets (EUR, million)	2.3	8.3	0.1	1.4
Turnover (EUR, million)	2.0	6.5	0.1	1.3
Total sample				
Age (years)	13	13	4	19
Capital/assets (%)	30.4	25.3	9.0	46.9
Export intensity (exports/turnover, %)	11.0	24.8	0.0	4.3
Gross value added (EUR, million)	0.6	1.8	0.0	0.5
Labour costs (EUR million per worker)	0.01	0.01	0.01	0.02
Labour productivity (EUR million per worker)	0.02	0.02	0.01	0.03
Leverage (financial debt/assets, %)	25.2	25.1	3.4	38.8
Return on assets (EBITDA/assets, %)	6.1	30.5	3.2	15.0
Total employment (#)	22	47	3	20
Total assets (EUR, million)	2.8	9.1	0.1	1.7
Turnover (EUR, million)	2.6	7.6	0.1	1.7

TABLE 1. Summary statistics for selected firm characteristics in the pre-treatment years

Notes: To minimise the effects of outliers in terms of the variables, the top and bottom 1 percentiles in each calendar year were winsorised.

4. Econometric strategy

The DiD identification strategy used in this article relies on a setup based on binary, single treatment effects. However, the strategy differs from the conventional approach in several dimensions (see Martins (2021) and Muraközy and Telegdy (2022) for similar strategies). Treatment is staggered as it does not occur simultaneously for all firms. Instead, it depends on a specific decision on whether to grant EU funding for a certain project. We denote the year of this relevant decision by t_0^i for both winners and losers. The treatment group refers to firms which applied successfully at least once, and these are treated when their first favourable decision is issued; the control group corresponds to always unsuccessful applicants, and their treatment cohort is that of the first unfavourable decision.

The fact that we are using a detailed sample of applicants (rather than beneficiaries) bears two important advantages: first, it eliminates any potential problem of selection into applying while also implying a high degree of homogeneity across candidate firms, with an effect similar to matching on unobservable characteristics; second, since we observe the relevant dates for both successful and unsuccessful firms, we can control for common trends of the dependent variables between treated and untreated firms.

The treatment effect is estimated over time, on the basis of the following event-study equation at the firm-year level for the period 2006-2019:

$$Y_{ijt} = \sum_{\tau=-8}^{11} \beta_\tau D_{i\tau} + \gamma_\tau + \gamma_i + \gamma_{jt} + \varepsilon_{ijt}, \quad (1)$$

where Y_{ijt} is the dependent variable of interest for firm i in sector j in calendar year t, representing the firms' performance indicators on which we check for an impact of EU funding. More precisely, Y_{ijt} corresponds to total employment, turnover, gross value added (GVA), labour productivity (defined as GVA per employee), capital as a percentage of total assets, and export intensity (defined as exports as a percentage of turnover). To minimise the effects of outliers in terms of these variables, we winsorised the top and bottom 1 percentiles in each calendar year.

Subscript τ denotes the number of years relative to the relevant decision, i.e., $\tau = t - t_0^i$. Since t_0^i ranges from 2008 to 2014 and t covers 2006-2019, τ varies between -8 and $+11$: $\tau = -8$ denotes the 8$^{\text{th}}$ period prior to the decision, corresponding to year 2006 for firms that had a decision in 2014; similarly, $\tau = +11$ corresponds to the 11$^{\text{th}}$ year after the treatment, referring to 2019 for firms with a relevant decision in 2008. As such, γ_τ represents a set of dummies for each relative-time period centred around t_0^i. It is important to note that these dummies are defined for successful and unsuccessful applications since our data provide this information in both cases. These dummies account for potential common trends similarly affecting treated and untreated firms around the relevant decision year. This would eliminate, for instance, possible common anticipation behaviours in the period just prior to the decision that could affect the outcomes denoted by Y_{ijt} .

$D_{i\tau}$ is a set of dummy variables that identify the relative-time *only* for treated firms, i.e., they equal 1 for each relative-time period τ for treated firms and are constant on 0 for control firms. These dummies should therefore be interpreted as the standard treatment indicator in dynamic DiD analyses.

Category $\tau = 0$ is omitted in Equation (1), which means that all coefficients are evaluated with respect to the benchmark year of the decision t_0^i. Omitting this category is intuitively equivalent to expecting results to show up one year after the decision on whether to grant funding is taken. This would account for implementation lags, as an investment can only start after the signing of the incentives' contract, which typically occurs a few months after the actual decision but within the same calendar year.

The coefficients of interest are β_τ. At each relative-year τ, they provide a measure of the systematic differences in Y_{ijt} between firms that receive funding and those that do not (relative to period t_0^i). For $\tau < 0$, non-statistically significant coefficients imply the

absence of systematic differences between the two groups prior to the decision. This evidence indicates that the group of firms that did not receive funding can be used as a reasonable comparison group, thus providing information on what would have happened to the successful firms had they not been granted funding (the counterfactual scenario). For $\tau > 0$, significant β_τ imply systematic differences after the funding decision between previously similar groups of firms, the only difference being that the control group has not been supported. As such, β_τ can be interpreted as providing an estimate for the impact of funding on firms' outcomes.

In addition to the relative-time fixed effects, two other controls were added to the regression: γ_i, which are firm fixed effects controlling for firm-specific time-invariant characteristics; and γ_{jt}, which are sector-calendar year fixed effects that control for sector-specific shocks over time.[9] The error term is ε_{ijt}. Robust standard errors are clustered at the firm-level.

5. Empirical results

Figure 3 summarises our baseline results, depicting the point estimate of each β_τ parameter of Equation (1) and its confidence intervals, both before ($\tau < 0$) and after ($\tau > 0$) the decision year.

The identification strategy outlined above and the interpretation of the results hinge on a number of assumptions, most of which are not directly testable. Critically, the parallel trends assumption requires that, bar the effects of EU funding, the outcomes of successful firms would have evolved in the post-treatment period similarly to those of the control group. This counterfactual scenario is not observable. However, Figure 3 shows that, ahead of the decision, coefficients β_τ are generally not statistically different from zero.[10] This means that, by including in Equation (1) firm-fixed effects, controls for sector-specific shocks over time, and relative-time dummies for each treatment cohort, we eliminated any systematic differences between successful and unsuccessful firms in the pre-treatment period. Though this is not proof of the parallel trends assumption, it supports the similitude of the pre-treatment trends in the two groups, which is reassuring as regards its plausibility.

We are also confident as regards other conditions. Visual inspection of the relevant distributions confirms the common support requirement, which is facilitated by using a sample exclusively made of applicant firms. In order to minimise endogeneity problems, we use an agnostic specification exclusively relying on fixed effects as defined in Equation (1).

9. Sector is herein defined on the basis of CAE - rev.3 classification, at the two-digit level, comprising 78 distinct sectors of activity.

10. Significance tests further show that, in the pre-treatment period, the β_τ coefficients are also jointly not different from zero for most variables under analysis. The only exceptions refer to GVA and turnover, which is consistent with insight provided by the visual inspection of Figure 3. Moreover, similar significance tests of the parameters β_τ in the post-treatment period reveal that they are jointly significant for all variables.

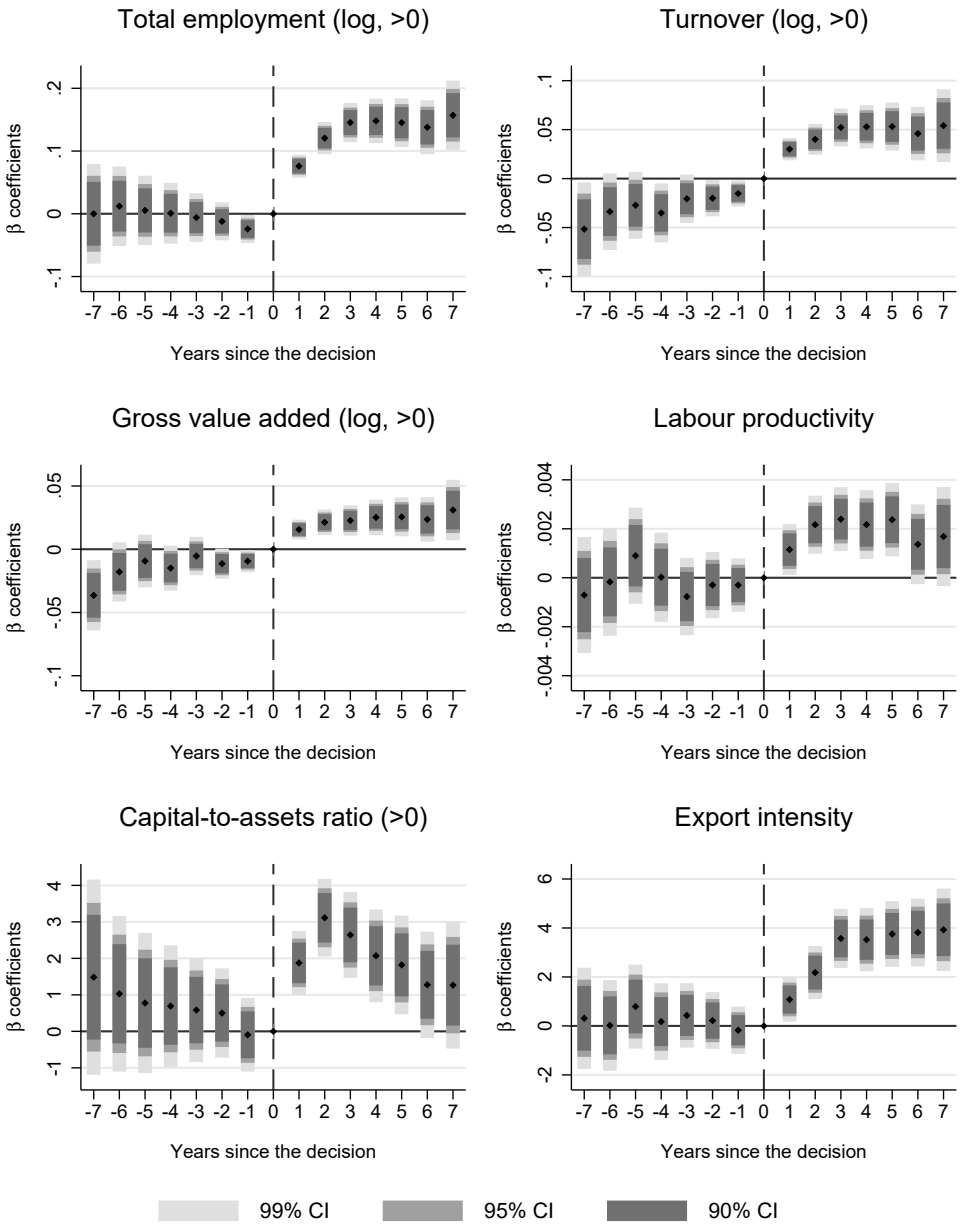

FIGURE 3: Baseline results: event-study analysis for selected firm outcomes

Notes: All regressions include relative-year dummy variables (γ_τ), firm and sector-calendar year fixed effects as specified in Equation (1). Sectors are defined at the two-digit level of CAE rev. 3 classification. The point estimates take as benchmark the year in which the relevant decision regarding the funding was taken. The confidence intervals are derived from robust standard-errors clustered at the firm-level. Significance tests show that, in the pre-treatment period, the coefficients are jointly not different from zero for all variables, except for GVA and turnover. Similar significance tests of the parameters β_τ in the post-treatment period reveal that they are jointly significant for all variables. For total employment, turnover and GVA, the natural logarithm is considered. For these dependent variables, as well as for the capital-to-assets ratio, zeroes and negative observations are discarded. Although included in the regressions, coefficients for relative-time periods before -7 and after 7 are not depicted as the large confidence intervals would hamper the legibility of the charts.

The results of Figure 3 point to a statistically significant positive and persistent effect of having at least one project supported under COMPETE on firms' performance. The estimated impacts on employment are especially large and long-lasting. Three years after the decision, total employment is, on average, 15.7% higher in successful firms compared to their counterparts which got a negative decision. As highlighted in Section 2, the positive effect on employment is a common result in most previous studies on the firm-level effects of EU funding. This favourable impact on employment is also consistent with QREN's emphasis on job creation.

The effects on exports are substantial and persistent over time. As a ratio to turnover, they stand, on average, 3.6 percentage points (pp) higher than in unsuccessful firms by the third year after the decision. This impact on exports is not immediate, building up within the first years after treatment. This is consistent with the progressive nature of firms' internationalisation, which involves a learning curve in terms of destination markets, global marketing and promotion, and the access to distribution networks abroad. The positive effect on exports is also compatible with QREN's focus on external competitiveness and internationalisation, particularly in the case of SMEs.

The capital-to-assets ratio of beneficiary firms is higher, thus reinforcing the link between receiving EU funding and the widening of the productive capacity of companies. However, the effects on capital appear to be particularly short-lived: marginal effects start decaying as of the third year after the decision. This could be explained by planned projects that were not granted EU support still being implemented later on, at least to some extent. In addition, for one-off projects, the depreciation of fixed assets would imply an over time decline in their value.

Positive effects are estimated for GVA and turnover as well. However, for these variables, there seems to be an upward trend in the estimated parameters even in the pre-treatment period. Also, for more stringent levels of significance, the plausibility of similar pre-treatment trends is weaker even controlling for firm fixed effects, relative-time periods and sector-specific shocks over time. While this hampers the causality claim on the impact of EU funding on these variables, the charts do still show an increase in GVA and turnover compared to unsuccessful firms in the years following the decision.

The treatment effect on labour productivity is statistically significant but small. This can be explained by GVA and employment being both affected by EU funding: first, as discussed, the programme achieved its job creation goal; second, the effects on GVA are found to be small and do not cumulate over time. Impacts on firms' productivity could anyway be expected later on, as a more efficient use of new capacity should build up over time. Still, even focusing on a longer horizon, productivity gains compared to non-beneficiary firms remain low and quickly converge to zero. The milder effects estimated for productivity than for other variables is a recurring finding in this literature. We further checked for the effects of funding on other firms' outcomes, including different measures of profitability and leverage, but found no evidence of a significant impact.

For most variables, the effect of EU funding seems to prevail for at least 5 to 7 years. The impacts are particularly persistent in the cases of employment and exports, and short-lived in the case of capital. However, it should be mentioned that, because we only kept the first favourable decision for each firm and several have submitted further

successful projects, the persistence insights from the charts may be reflecting the impact of the latter. In the outer years following the decision, the point estimates somewhat decline and the smaller number of observations contribute to larger confidence intervals, yielding statistically nil treatment effects.

The analysis was replicated on a number of differently defined sub-samples based on sector, firm size and age cohorts, allowing us to examine the heterogeneity of the baseline results across firms' characteristics. The results are qualitatively unchanged for all dependent variables considered, except for labour productivity. Overall, the effects of having at least one supported project appear to be stronger in the case of firms in the manufacturing sector and of those with less than 5 years of activity. In the case of productivity, we find no evidence of significant effects once we focus on sub-samples of manufacturing firms, non-micro corporations, or firms older than 5 years. By contrast, effects on this variable are larger in the case of micro firms, those in the younger age cohorts or in services.

We have also replicated the analysis on an alternative sample of applicant firms considering only those which are present across all the 14 years covered by CBHP. By focusing on this balanced panel, results are unchanged only in the cases of turnover and GVA. The effects on total employment and export intensity remain significant but are milder, while they become virtually nil as regards the capital ratio and labour productivity.

Another robustness check concerns the role of firms that also successfully applied to funds under the PT2020 framework. Recall that, in the definition of our sample, we excluded all firms that had also approved PT2020 projects in the 2015-2019 period. We reproduced the analysis keeping all these beneficiaries in the sample and the results are very similar to those presented in Figure 3. The estimated coefficients for all variables are slightly higher, except for the capital intensity ratio for which the parameters are a bit smaller.

Finally, it should be acknowledged that the results in Figure 3 can be affected by the way we define the treatment and control groups. By focusing only on the first favourable decision for a successful firm, we are disregarding the possibility of subsequent supported projects, which would imply an upward bias both in the level and the persistence of the effects. Similarly, by selecting for the control group firms which are always unsuccessful in their bids (regardless of the number of applications), we may be inducing negative selection effects. In order to improve the comparability of the two groups and check whether different definitions would yield differences in the estimates, we replicated the baseline analysis: 1) restricting the treatment group to firms with only one approved project; 2) further restricting the control group to firms with only one application (unsuccessful); and 3) restricting both groups to firms with a single application. The results in Figure 3 are quantitative and qualitatively robust to these alternative definitions. In the Appendix, we illustrate this fact by showing the estimation results considering the sub-sample of single applicants, the most restrictive

robustness check as it excludes all firms (successful and unsuccessful) that applied more than once.[11]

6. Concluding remarks

NGEU, the large scale EU-wide response to the pandemic shock and to the long term challenges of the European economy, renewed interest in the effective impacts of EU funding. Portugal has been a net beneficiary of structural funds since EU accession. The most recent closed programming period under which EU funds were distributed spanned 2007-2013 and, in the case of Portugal, it was framed by QREN — the National Strategic Reference Framework. QREN had a strong focus on Portuguese firms, notably through COMPETE, a specific programme supporting business R&D, innovation and the internationalisation of SMEs.

This article provides a first take on the assessment of the effects of receiving funding under COMPETE on a set of firms' performance indicators in 2006-2019. In particular, we focus on employment, turnover, GVA, the capital ratio, labour productivity and export intensity of firms which submitted a successful bid and contrast them with firms that also applied but did not obtain the funding. We draw on a rich longitudinal firm-level dataset and combine it with new project-level data on all projects submitted in 2007-2013. We implement a DiD strategy considering a binary treatment that is determined by the relevant decision on whether to grant EU support for some project. Firms that succeed are our treatment group; the unsuccessful applicants, which never receive funding, are the control group.

We provide evidence of statistically significant positive effects on firms' performance of having a supported project. It is not possible to disentangle the contribution of the funding *per se* from that of a selection effect stemming from the *ex-ante* approval of the best projects. Still, before the funding decision was made, and controlling for relevant fixed effects, the two groups were broadly indistinguishable. In the years after the decision, successful firms feature higher employment, turnover, GVA, productivity, capital-to-assets ratio and export intensity than their counterparts in the control group. Although statistically significant, the effects on labour productivity are smaller than on the other variables. We also show that the effects are persistent, as the analysed outcomes remain higher in successful firms for several years after the bid. The impact on capital is the least persistent, starting to decay after three years. The results are robust to alternative definitions of the treatment and control groups and also broadly hold in different sub-samples of firms.

As firms' support via EU funding becomes increasingly prominent, it is essential to properly evaluate the effectiveness of such policies. The analysis herein represents a first step in exploring the potentialities of the project-level Incentives Systems data, recently made available at BPLIM, for counterfactual impact evaluation. In particular, it could be interesting to explore how the impacts change depending on the number of supported

11. All detailed results are available from the authors upon request.

projects, or on the magnitude of the incentives provided. Other possible sources of variability in the effects include different kinds of financial support (repayable vs non-repayable), the different nature of each system of incentives, or the regional distribution of the supported projects. These are avenues to be explored in future research.

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Appendix: Robustness test

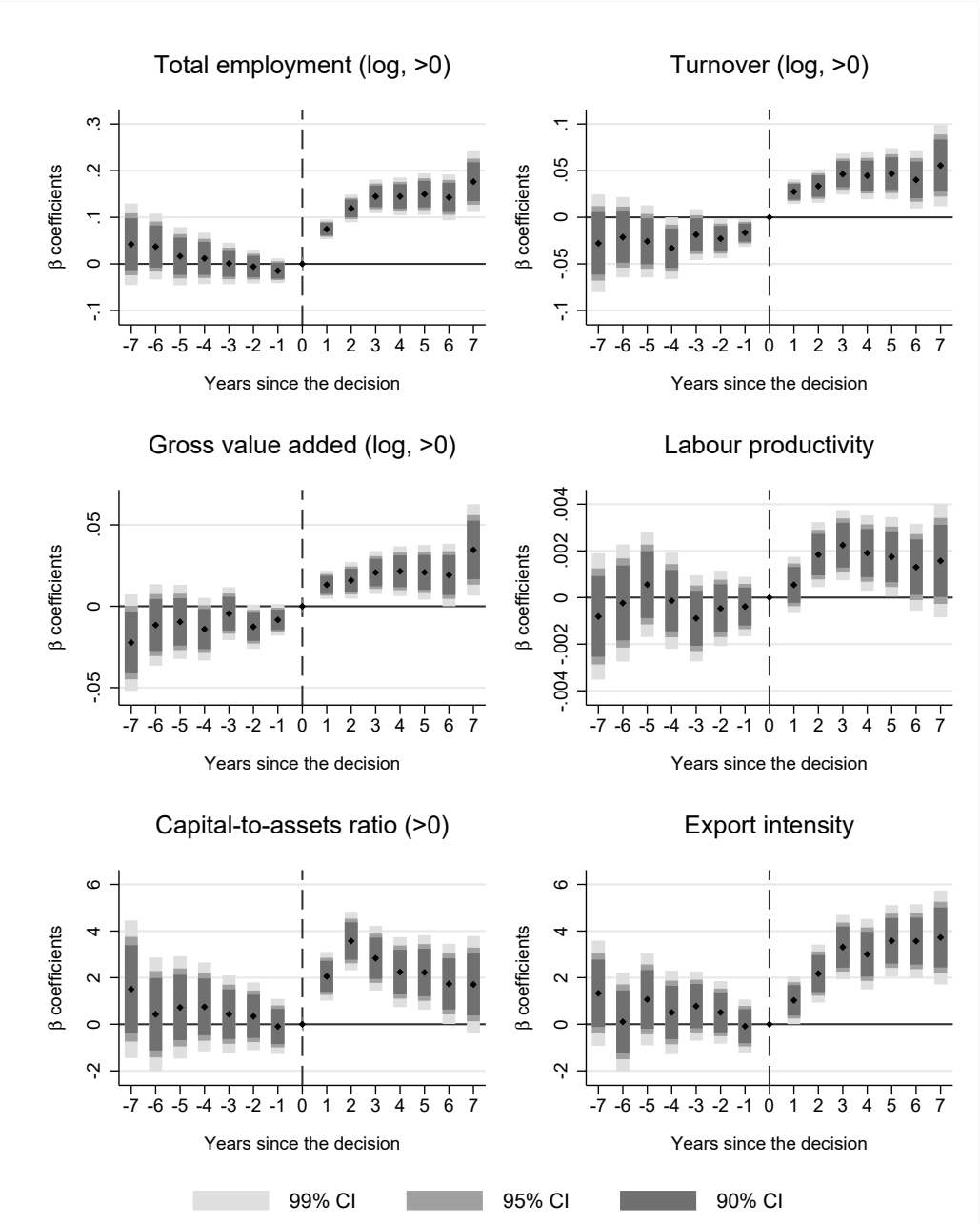

FIGURE A.1: Sub-sample of firms that apply only once: event-study analysis

Notes: All regressions include relative-year dummy variables (γ_τ), firm and sector-calendar year fixed effects as specified in Equation (1). Sectors are defined at the two-digit level of CAE rev. 3 classification. The point estimates take as a benchmark the year in which the relevant decision regarding the funding was taken. The confidence intervals are derived from robust standard-errors clustered at the firm-level. Significance tests show that, in the pre-treatment period, the coefficients are jointly not different from zero for all variables, except for GVA and turnover. Similar significance tests of the parameters β_τ in the post-treatment period reveal that they are jointly significant for all variables. For total employment, turnover and GVA, the natural logarithm is considered. For these dependent variables, as well as for the capital-to-assets ratio, zeroes and negative observations are discarded. Although included in the regressions, coefficients for relative-time periods before -7 and after 7 are not depicted as the large confidence intervals would hamper the legibility of the charts.

Banco de Portugal
Banco de Portugal Economic Studies, Vol. IX, No. 1

Non-technical summary

January 2023

Markup premium of Portuguese exporters

Ana Cristina Soares and Rita Sousa

Standard models of international trade suggest that firms that export tend to be different from the ones that sell only to domestic markets. A key ingredient of such theoretical settings is that exporting firms - labeled in this strand of the literature as "*the happy few*" - have higher productivity and average wages compared to the firms that only sell in the domestic market.

This article empirically tests, for Portugal, if the markup - defined as the ratio of output prices to the corresponding marginal costs - of exporting firms is statistically higher, on average, compared to firms that only sell in the domestic market.

Using firm-level data over the period 2010-2019, this article finds gains obtained using the preferred empirical specifications are, on average, 1.2%-1.3% and 2.6%-2.7% higher markups in the Manufacturing and Non-Manufacturing sectors, respectively. These gains are often known in this strand of literature as the export markup premium.

In addition, this article shows that this premium is heterogeneous across different industries, particularly in the Non-Manufacturing sector (Figure 1).

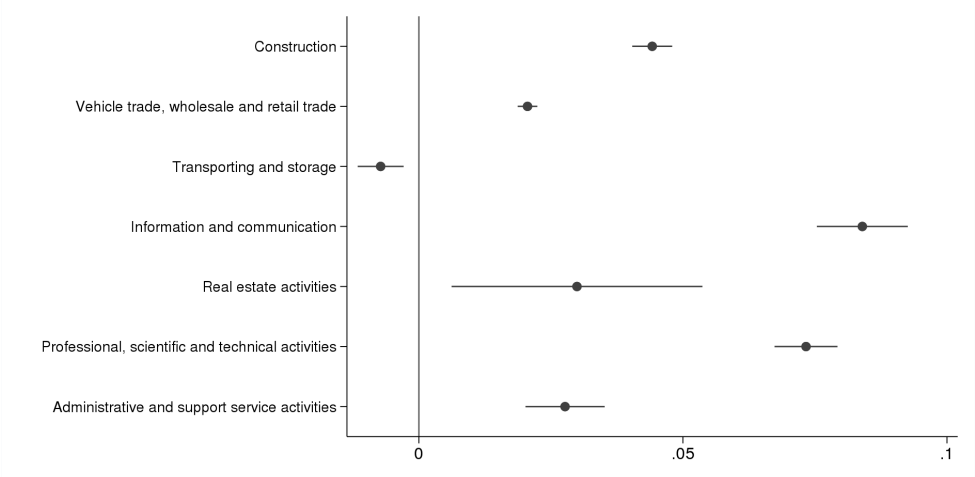

FIGURE 1: Export markup premium and corresponding confidence intervals by industry in the Non-Manufacturing sector

Notes: The confidence interval uses a 10 percent significance level.

Another finding of this study is that the estimated gains of exporting firms are not substantially changed if a firm decides also to import, that is, the markup gain for exporting firms is generally invariant to its decision to import.

In addition, this article shows that when firms enter export markets their markups increase, on average, in both the Manufacturing and Non-Manufacturing sectors. Similarly, markup gains for exporting firms tend to be unchanged when the firm decides also to import.

Banco de Portugal
Banco de Portugal Economic Studies, Vol. IX, No. 1

Markup premium of Portuguese exporters

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January 2023

Abstract
In this article, we estimate the markup premium of exporting firms for Portugal over the period 2010-2019. We include evidence not only for the Manufacturing sector but also for the Non-Manufacturing sector that is generally not available. We find that exporting firms have a positive, sizeable, and statistically significant markup premium compared to their non-exporting counterparts, both in the Manufacturing and Non-Manufacturing sectors. We also show that upon entry into export markets, markups also depict a positive and statistically significant increase in both of these sectors. (JEL: L22, D22, F14)

Keywords: Lerner index, Firm-level data, exports, imports.

1. Introduction

How firms set markups has been a question of interest among economists for many decades. One dimension of study of this question, both theoretically and empirically, is the extent to which participation in international trade, and in particular, the export status of the firm, is associated with changes in firm-level markups. This question is particularly relevant from a policy perspective since there are firms and sectors increasingly engaged in international trade, particularly in export markets.

In this article, we contribute to this line of research by providing empirical evidence on the markup premium of exporting firms using representative data for Portugal (excluding the financial sector) over the period 2010-2019, including evidence for the Manufacturing and Non-Manufacturing sectors. Evidence for this last sector is generally unavailable due to lack of data. However, this sector is increasingly relevant to aggregate value-added and employment, thus its exclusion yields a potential partial view of the aggregate economy. To include the Non-Manufacturing sector and rely on the universe of firms, we use information from accounting data to obtain a proxy for the markup at the firm level.

Acknowledgements: We would like to thank Sónia Cabral, Cláudia Duarte, Cláudia Braz, Nuno Alves, Pedro Duarte Neves, Nicholas Kozeniauskas, António Antunes, José Maria and Paulo Guimarães for their comments and suggestions. The paper represents the authors' personal opinions and does not necessarily reflect the views of the Banco de Portugal or the Eurosystem.

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The degree of price-setting power of a firm can in some settings be captured by the markup, which corresponds by definition to the ratio of the output price charged by the firm to the corresponding marginal cost. Despite the significant and known challenges measuring this ratio, there is ample empirical evidence suggesting that firms operate in imperfectly competitive markets so that prices rise above marginal costs and markups exceed one. This result appears consistently in this strand of the literature using data for several countries, time periods, and alternative estimation methods, either from a supply (e.g., Hall (1988), Roeger (1995), De Loecker and Warzynski (2012)) or demand side approaches (Bresnahan (1989), Berry *et al.* (1995)). In a standard benchmark case of a static perspective, the presence of imperfect competition reduces welfare since prices are higher and output is lower compared to the perfectly competitive case. However, the link between imperfect competition and welfare tends to be, in general, more complex in richer models. At the same time, international trade can also shape firm markups.

It is well documented that exporting firms tend to be different from non-exporting firms in several dimensions, such as size, wages, and productivity (Wagner (2007)). In fact, exporting firms are often labeled in the literature as "the happy few" given the favorable comparison in terms of these dimensions to non-exporting firms (Mayer and Ottaviano (2008)). The same seems to hold with respect to markups.

Several theoretical international trade models predict a positive markup premium for exporting firms which is defined in general as the difference in log markups between exporting and non-exporting firms. Standard models of international trade such as Bernard *et al.* (2003) and Melitz (2003) incorporate heterogeneous agents in terms of their productivity. In their models, productivity plays a crucial role in the decision to export, predicting that only the most productive firms export. This is known as the self-selection hypothesis according to which only the most productive firms are able to pay the fixed cost of exporting, which can be rationalized, for instance, by the fact that firms need to learn about foreign laws and establish foreign trade links. The presence of such a fixed cost induces a positive correlation between exports and productivity corroborated by a large set of empirical studies (e.g. Bernard and Jensen (1999), Clerides *et al.* (1998), Aw *et al.* (2000)).[1] Later richer models, such as Melitz and Ottaviano (2008), that allow for endogenous markups, also emphasize the self-selection of firms into export markets, delivering a consistent prediction in terms of the positive relation between productivity and export status.[2] Such a framework also yields a theoretical prediction in terms of markups. In particular, given productivity differences exporting firms are expected to charge higher markups.

Aiming to test this prediction, De Loecker and Warzynski (2012) point to a markup premium of exporters of around 7.8 percent for the Slovenian manufacturing sector. They find also a positive and sizeable markup increase associated with export market

1. Evidence on the reverse link where firms become more productive after starting to export is more muted (see for instance Bernard *et al.* (2012), Syverson (2011)).

2. They develop a model of monopolist competition with firm heterogeneity with respect to productivity differences and allow for endogenous markups by resorting to a linear demand system with horizontal product differentiation. Markups react to market size and its integration through trade.

entry. These results provide empirical evidence that is consistent with these model predictions. Additional work relying on more granular data, in particular, at the product level shows that the export destination characteristics can matter as well. In particular, Kilinç (2019) and Bellone *et al.* (2016) find that markups of products exported to larger destination markets tend to be lower. More recently, some authors gathered evidence for specific industries such as, for instance, Jafari *et al.* (2022), that look at this relation for the French food processing industry. They show that higher markups tend to increase the probability that a firm enters export markets or increase its export intensity. Upon entry into export markets, markups increase in that period and the next two subsequent years. Overall, their findings are consistent with the self-selection effect of exporting firms.

Recent work shows also that the export markup premium tends to be compressed or even disappear by adding a control for the import status of the firm. For instance, Hornok and Muraközy (2019) reach this conclusion using data for Hungary from 1995-2003 for the Manufacturing sector. Similarly, other authors do not find a positive markup premium of exporting firms. For example, Garcia-Marin and Voigtländer (2019) report that marginal costs tend to fall with entry into export markets, but markups tend to remain stable by looking at data from the Chilean, Colombian, and Mexican manufacturing sectors. They argue that exporting firms face an increase in their efficiency in production. However, these gains are reflected in a reduction of output prices so that markups remain unchanged.

Evidence directly related to the link between export market participation and markups in the Manufacturing and Non-Manufacturing sectors is virtually undocumented for Portugal. There are few studies on markups for Portugal which focus on different dimensions such as: tradable and non-tradable sector differences (Amador and Soares (2017)), provide evidence on the incompleteness of the Single Market integration (Soares (2020)), discuss its cyclical properties (Santos *et al.* (2022)) or document a negative trend in the aggregate markup (De Loecker and Eeckhout (2018)).

Our findings point to a positive markup premium for exporting firms. We find that over the 2010-2019 period, exporting firms in Portugal have, on average, a higher markup compared to non-exporting firms both in the Manufacturing and Non-Manufacturing sectors. The coefficient for the export status dummy variable is positive, sizeable, and statistically significant. In terms of magnitude and depending on the specification, exporting firms have a 1.2-1.3 percent higher markup in the Manufacturing sector and 2.6-2.7 percent higher in the Non-Manufacturing sector in the most saturated specifications. Once we further include the import status of the firm, the markup export premium is still positive, economically relevant, and statistically significant. The magnitude of the effect is also not substantially changed, particularly in more saturated specifications. In addition, we further estimate how this effect varies across narrowly defined industries. We find that the export status tends to correlate positively with markups across firms, but the size of this effect is heterogeneous across industries and sectors. The markup premium can be sizeable and reach figures above 8 percent, for instance, in industries such as "Information and communication". In addition, we find a statistically significant increase in markups associated with entry into export markets in both Manufacturing and Non-Manufacturing sectors.

This article is organized as follows. Section 2 describes the data and section 3 provides some descriptive statistics. Section 4 describes the empirical framework to investigate the relation of interest, and the next section presents our main findings. At last, section 6 presents some concluding remarks.

2. Data and variable definition

We use balance sheet and profit and loss account data for Portugal collected jointly by the Ministry of Finance, Ministry of Justice, Statistics Portugal, and Banco de Portugal under the database named *Informação Empresarial Simplificada* (IES). The introduction of this survey aimed to implement a unified reporting system to several authorities to comply with legal, fiscal, and statistical requirements.

In this article, we use annual data for the period 2010 to 2019 [3] for the Portuguese non-financial sector gathered in the latter survey.[4] One interesting feature of this dataset is that it covers the universe of non-financial firms operating in Portugal, which includes around 350,000 firms per year. This feature arises from the fact that the survey is mandatory by nature. Another interesting feature of this survey is that it also includes additional information that is not generally collected. Besides information on the number of workers of each firm, it includes also detailed information on exporting and importing activities. In particular, for each firm and year, we observe nominal exports and imports grouped into goods and services. At odds with most product trade datasets, export/import values in this survey are not subject to reporting thresholds. Hence, we can include firms that export/import lower figures, which allows us to avoid potential selection concerns associated with the exclusion of these firms.

One of the challenges of this estimation is that the markup at the firm level is, in general, not observed since output prices tend not to be available and marginal costs are not registered in the data. The markup for firm i and year t (μ_{it}) is the ratio of the output price charged by the firm to the corresponding marginal cost. This ratio captures the gap between the output price and the corresponding marginal cost. As this gap increases, a firm may in some settings gain higher price-setting power in output markets. In contrast, when prices match exactly marginal costs, the markup translates into a perfectly competitive setting and becomes equal to one in such a case.

3. We use the panel data of Central Balance Sheet Database available at Banco de Portugal Microdata Research Laboratory (BPLIM) from the June 2021 extraction (Central Balance Sheet Harmonized Panel. Extraction: June 2021. Version: V1. BANCO DE PORTUGAL. Dataset. https://doi.org/10.17900/CB.CBHP.Jun2021.V1).

4. The year 2020 is available, but it is affected by the Covid-19 pandemic, which could potentially affect our findings given the magnitude of the shock. It is beyond the scope of this article to study Covid-19-related effects, hence this year was not taken into account. Note also that data for the earlier period between 2006 and 2009 is available. However, the accounting system is not fully comparable with the one started in 2010, as a result of the implementation of the International Accounting Standards. In addition, this earlier sample includes also the period of the international and financial crisis which occurred mainly during 2008 and 2009, and was characterized by a collapse in international trade. For these reasons, we focus the analysis on the 2010-2019 period.

We compute the markup as $(1/(1-pcm_{it}))$ where pcm_{it} is the Lerner index, defined as the firm's revenues from goods and services deducted from the corresponding labour costs (including social security contributions) and intermediate expenses, expressed as a ratio to their revenues. Intermediate expenses correspond to the sum of external supplies and the cost of goods sold.

We define an export dummy variable that assumes the value of one when a firm exports more than 40.000 Euro in year t and, zero otherwise. In addition, we also adopt a consistent criterium in terms of the import threshold to define the import dummy variable. The threshold imposed at 40.000 Euro aims at dismissing the effect of either exports or imports that are extremely low.

We perform a standard data cleaning exercise to ensure that our results are robust to the presence of potential outliers, reporting errors, or unreasonable observations.

First, we exclude all firms that report missing, negative or null information for key variables such as labour costs, revenues, intermediate input expenses, employment, gross value added, firm location and its age. In addition, we exclude observations outside the 0.5^{th} and 99.5^{th} percentiles for the Manufacturing and Non-Manufacturing sectors in the distribution of key variables such as the markup, labour productivity, mean wages, and capital intensity, all considered in log terms. We also exclude observations outside the same percentiles for intermediate input expenses, labour costs, and stock of capital measured as a share on total revenues.

Second, we exclude firms that were subject to significant events that substantially changed the structure and/or activity of the firm, associated for instance to mergers and acquisitions, and keep firms that were considered active according to the information available in the survey which includes firms that for instance are not facing a liquidation process. In addition, we drop sectors based on the NACE Rev. 2 classification at 2 digit level, for which there are less than 50 observations per year. We keep firms that have at least two observations over the sample period.

Finally, we remove some sectors given the reduced number of observations, specific nature, and/or low gross value-added contribution to aggregate GDP. In particular, we exclude "Agriculture, forestry, and fishing"; "Mining and quarrying"; "Public administration and defence; compulsory social security"; "Education"; "Human health and social work activities"; "Arts, entertainment and recreation"; "Other service activities"; "Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use" and "Activities of extraterritorial organizations and bodies"; "Manufacture of tobacco products"; "Manufacture of coke and refined petroleum products" and "Electricity, gas, steam and air conditioning supply". We aim to focus on the non-financial sector and hence exclude firms in the "Financial and Insurance activities" sector. To ensure consistency with National Accounts, we also exclude firms registered in Madeira free trade zone that have a beneficial tax treatment. We exclude firms in "Accommodation and food service activities" since measurement issues associated, particularly with export and import records, can be potentially exacerbated.

3. Descriptive evidence

After the cleaning procedure detailed above, the final dataset includes more than 140,000 firms per year over the period 2010-2019. It covers a total number of observations above 1,480,000 comprising more than 240,000 distinct firms. Table 1 shows some descriptive evidence for key variables.

	Non-Manufacturing Mean/SD	Manufacturing Mean/SD
Revenues (ln)	12.210	12.731
	(1.510)	(1.589)
Fixed capital stock (ln)	9.788	10.864
	(2.124)	(2.269)
Number of workers (ln)	1.283	2.084
	(1.048)	(1.236)
Labour productivity (ln)	9.660	9.610
	(0.817)	(0.677)
Mean wages (ln)	9.411	9.413
	(0.507)	(0.403)
Export to revenues ratio	0.484	0.485
	(0.362)	(0.328)
Import to revenues ratio	0.343	0.218
	(0.245)	(0.182)
Observations	1,214,547	266,916

TABLE 1. Descriptive statistics of key variables
Notes: SD stands for standard deviation.

We report some additional descriptive statistics concerning export and import market participation in Portugal from 2010 to 2019. In particular, we are interested in understanding what share of firms engage in international trade through exports or imports. We also provide evidence concerning the intensity of the export participation for exporting firms, which we measure as the ratio of nominal exports of a firm to its total revenues. While Non-Manufacturing industries tend to be assumed as mainly domestic, recent technological progress could have potentially shifted their nature in this dimension. For this reason, we report separate figures for the Manufacturing and Non-Manufacturing sectors.

Figure 1 reports the evolution of the share of firms participating in international trade through exports and also imports in these two sectors. We find that, over this period, more than 25 percent of the firms export in the Manufacturing sector, while in the Non-Manufacturing sector, this proportion is below 10 percent. In terms of imports, around 20 percent of the firms import in the Manufacturing sector but, in the Non-Manufacturing sector around 10 percent of the firms import. These results suggest that participation in international trade, through either exports or imports, is not a frequent activity, and more so in the Non-Manufacturing sector which is in line with findings for other countries and time periods.

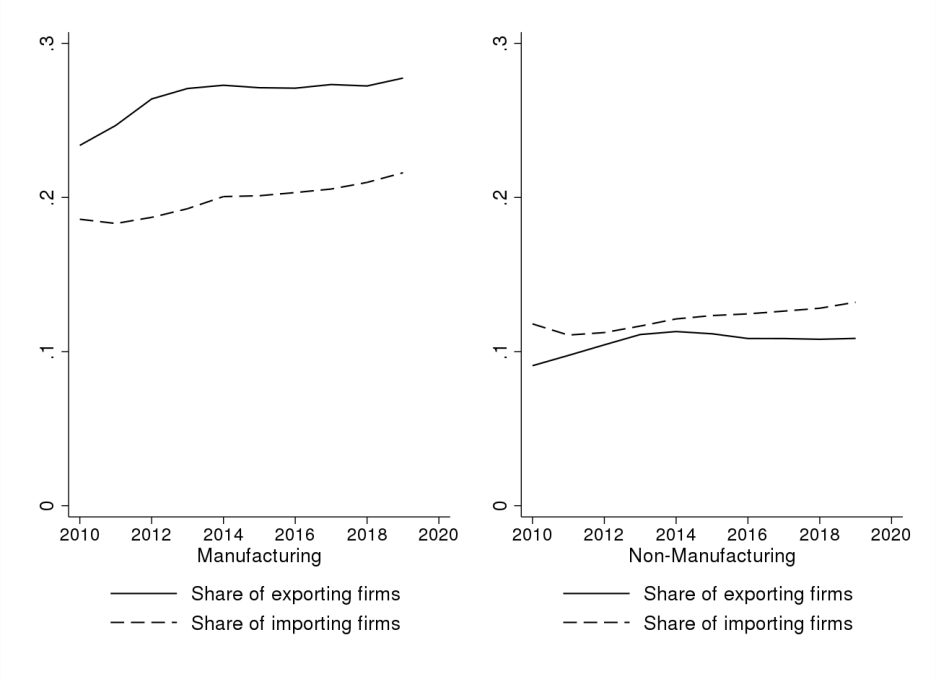

FIGURE 1: Share of firms participating in international trade

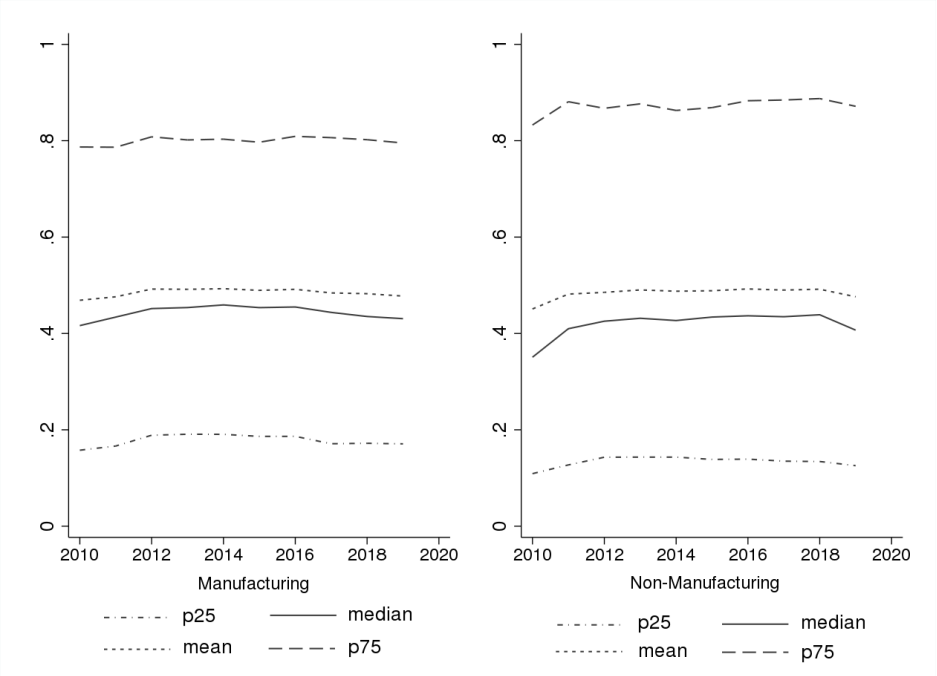

FIGURE 2: Export intensity

Notes: The export intensity of a firm corresponds to the ratio of nominal exports to its total revenues.

Figure 2 depicts the evolution of export intensity percentiles for exporting firms. The export intensity of a firm is the ratio of nominal exports to its turnover. We find that participation in international trade is not only a rare activity but also that firms are heterogeneous in their intensity of participation in export markets, which holds also

in both Manufacturing and Non-Manufacturing sectors. The 25th percentile is below 20 percent, suggesting that one out of four firms has a very low intensity of participation in export markets in both of these sectors. At the same time, firms in the 75th percentile depict export intensity figures around 80 percent of their revenues in the Manufacturing sector and above 80 percent in the Non-Manufacturing sector.

We report also some descriptive statistics for more narrowly defined industries within the Manufacturing and Non-Manufacturing to uncover potential heterogeneity within each of these sectors. Figures 3 and 4 show the share of exporting firms across more narrowly defined industries in the Manufacturing and Non-Manufacturing sectors, respectively. We report this share for the first and last year of our sample which are 2010 and 2019, respectively.

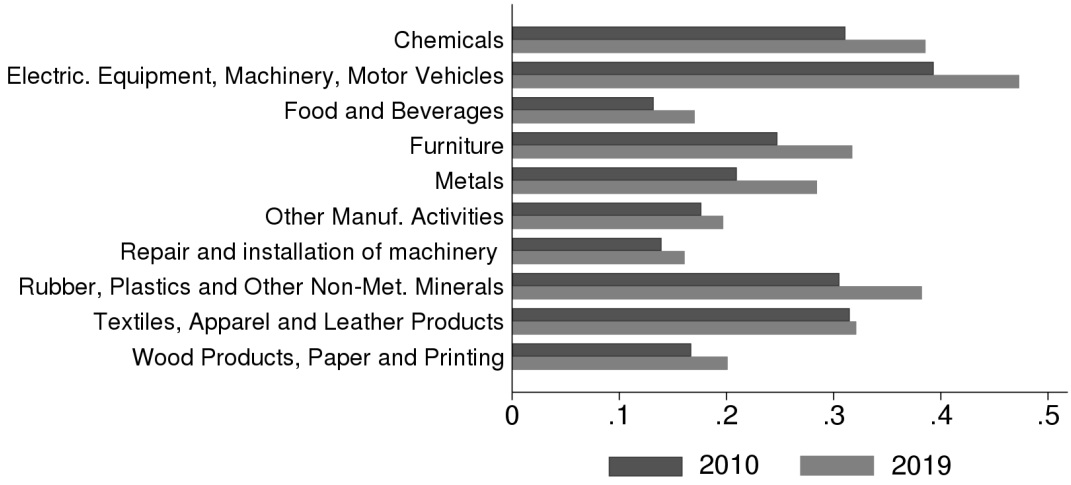

FIGURE 3: Share of exporters at the industry-level in the Manufacturing sector

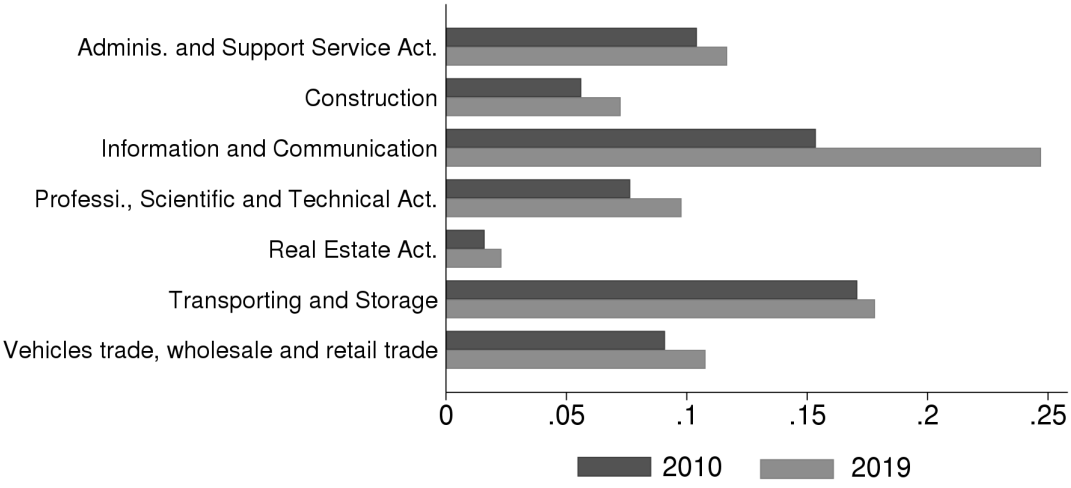

FIGURE 4: Share of exporters at the industry-level in the Non-Manufacturing sector

We find that the share of exporting firms has increased in most of the industries in the Manufacturing sector even though there is substantial heterogeneity across these industries.

In "Electric. Equipment, Machinery, Motor Vehicles", "Chemicals" "Furniture", and "Textiles, Apparel and Leather Products" more than 30 percent of firms participate in export markets. In contrast, "Food and Beverages" and also "Repair and installation of machinery" less than 20 percent of firms are exporters. In the Non-Manufacturing sector, a lower proportion of firms tends to participate in export markets. Nevertheless, this share increased in these industries, particularly in "Information and communication". In most industries, less than 1 out of 10 firms are exporters but in "Information and communication" and "Transporting and storage" more than 15 percent of firms are exporters.

In addition, we also show in Figures 5 and 6 the distribution of export intensities for the same two years across this narrower sectoral definition for the Manufacturing and Non-Manufacturing sectors.

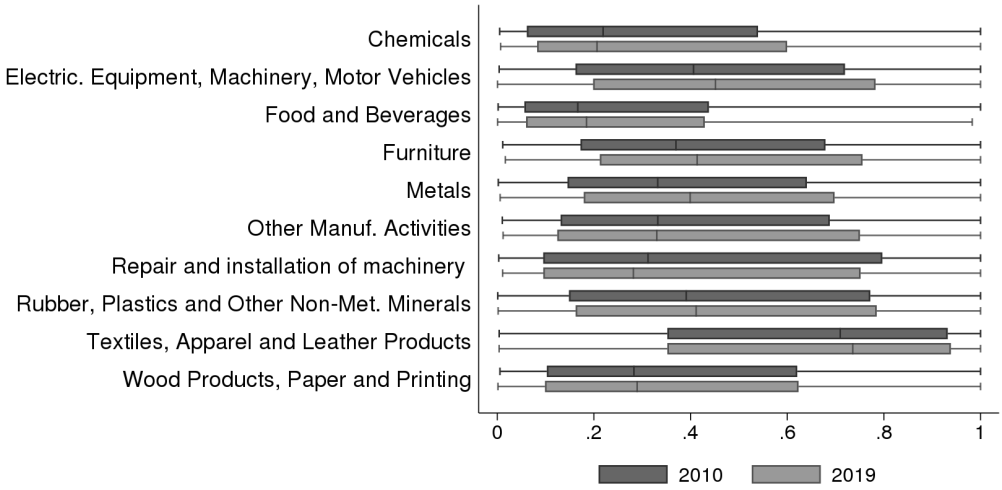

FIGURE 5: Distribution of export intensity at the industry level - Manufacturing sector

Notes: The export intensity of a firm corresponds to the ratio of nominal exports to its total revenues.

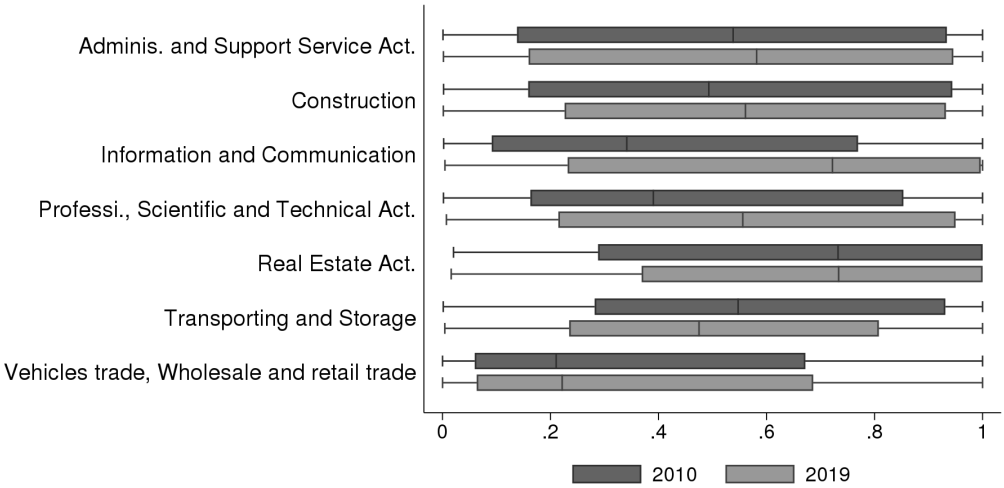

FIGURE 6: Distribution of export intensity at the industry level - Non-Manufacturing sector
Notes:The export intensity of a firm corresponds to the ratio of nominal exports to its total revenues.

As above, we consider a conditional distribution of export intensities by including exporting firms as defined above. These figures illustrate that even within narrowly defined industries export intensities vary markedly across firms in the Manufacturing and Non-Manufacturing sectors. The median export intensity in "Food and Beverages" is below 20 percent, while in "Textiles, Apparel and Leather Products" it reaches more than 70 percent of firm revenues. In the Non-Manufacturing sector, the median export intensity is around 20 percent in "Vehicle trade, wholesale and retail trade". In contrast, the median intensity is particularly high in "Real estate activities" where it reaches 70 percent. In "Information and communication" we find a sharp increase in the median export intensity, which was below 40 percent in 2010 and reached figures around 70 percent in 2019.

A well-known stylized fact is that exporters tend to be, on average, larger and more productive than non-exporting firms. In addition, they seem to pay higher average wages and also charge higher markups which is the main focus of this article. Figures 7 and 8 show the distribution for the year 2019 of each of these variables for both exporting and non-exporting firms, while distinguishing between Manufacturing and Non-manufacturing sectors. We use the number of workers and labour productivity as proxy variables for firm size and productivity, respectively. The distribution of firm markups, size, mean wages, and also labour productivity tends to present higher density in higher values for each of these variables compared to non-exporting firms which are in line with the model predictions highlighted above.

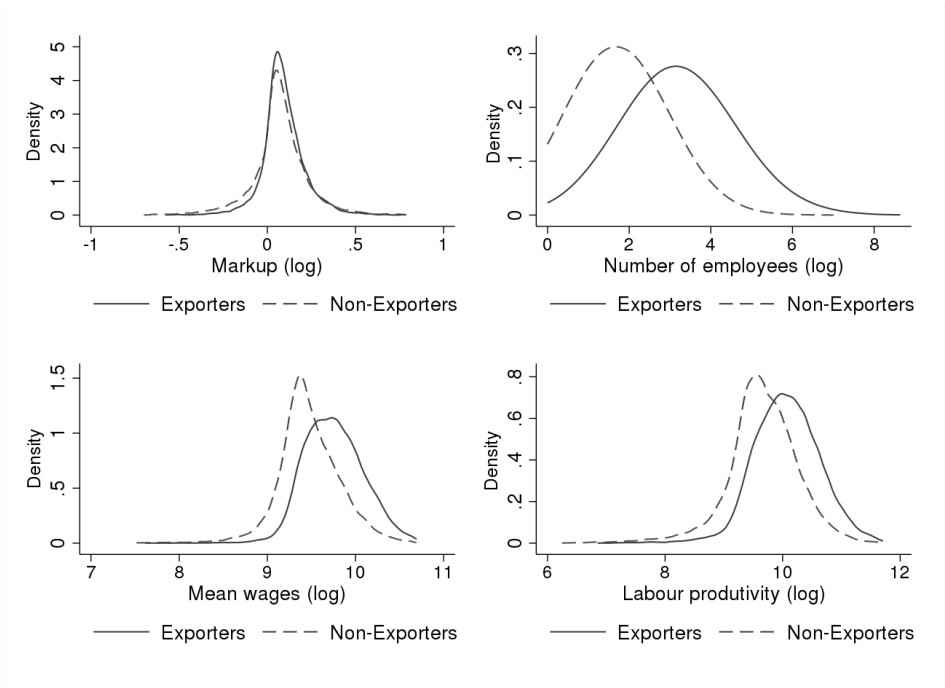

FIGURE 7: Manufacturing sector: Distribution of key variables in 2019

Notes: The bandwidth is greater in the variable number of employees in order to obtain a smoother density curve.

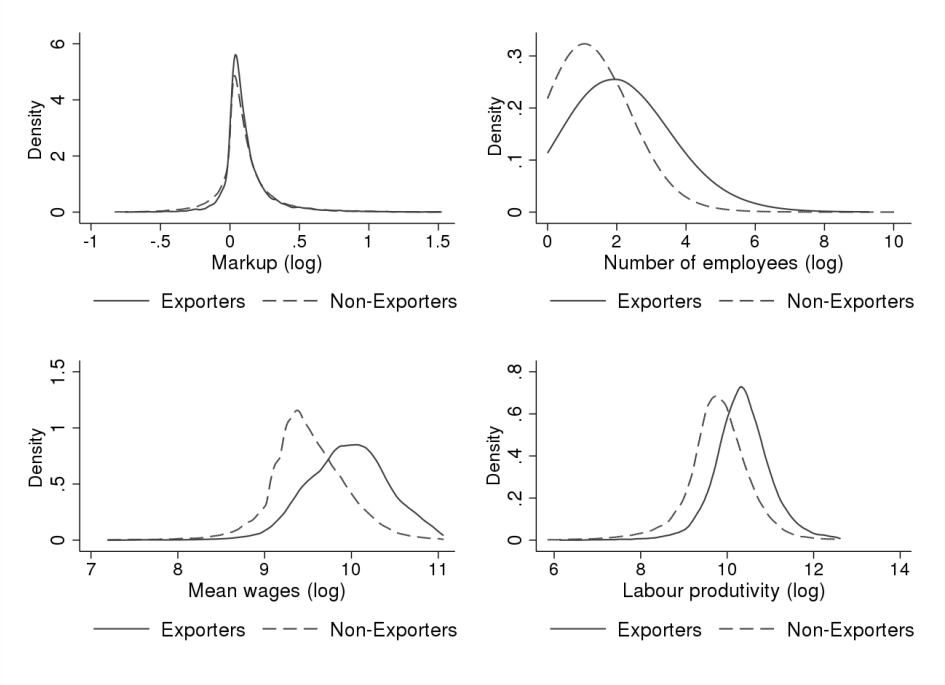

FIGURE 8: Non-Manufacturing sector: Distribution of key variables in 2019

Notes: The bandwidth is greater in the variable number of employees in order to obtain a smoother density curve.

4. Empirical framework: Markups and exporters

Our aim is to estimate the markup premium of exporters by comparing the markup of exporting and non-exporting firms. In addition, we also investigate if markups increase when firms start to export. Below, we lay out our empirical estimation strategy.

4.1. Markup premia of exporting firms

In order to estimate the markup premium of exporting firms, we adopt the following empirical specification as suggested by De Loecker and Warzynski (2012):

$$ln(\mu_{it}) = \alpha_0 + \alpha_1 dexp_{it} + \alpha_2 X_{it} + \gamma_s * \gamma_t + \varepsilon_{it} \quad (1)$$

where $ln(\mu_{it})$ is the markup of firm i in year t in log terms, γ_t and γ_s are year and sector fixed effects. $dexp_{it}$ is a dummy variable that takes the value 1 if the firm is an exporter and 0 otherwise. ε_{it} is an error term. We include an interaction between sector and time-fixed effects which absorbs aggregate shocks, business cycle fluctuations, and sectoral shocks, including specific trends that could be present. We define sectors at 3 digit level in NACE Rev.2. Furthermore, we include a set of control variables summarized in X_{it} that aim at capturing potential remaining confounding variables in the relation of interest. In particular, we include labour and stock of capital in logs in order to capture both size effects and capital intensity. We also extend this set of covariates to include the import status of the firm, to understand the extent to which the results change when taking into account the import decision of the firm. The dependent variable is considered in log terms given the substantial variation of this variable across firms in the economy as consistently adopted in this literature. Standard errors are clustered at the firm level.

This specification includes a rich fixed effect structure, along with a set of covariates that aims at capturing confounding effects in the relation of interest. However, this specification does not allow a causal interpretation of this relation.

The coefficient of interest is α_1, which quantifies to what extent exporters have a higher markup compared to their non-exporting peers. Note that we are not interested in the level of the markup but rather its variation associated with the export status of a firm. In particular, α_1 captures the percentage markup premium of exporters. We can obtain the level markup difference of exporting firms compared to non-exporting firms by computing α_1*exp(α_0) following De Loecker and Warzynski (2012).

We estimate this regression separately for the Manufacturing and Non-manufacturing sectors. In addition, we investigate the presence of potential heterogeneity across different industries that could be underlying these estimates. Hence, we also estimate this relation across narrowly defined industries to identify whether this effect varies in this dimension in these two sectors.

4.2. Markups and export market entry

We adopt the following specification to estimate the percentage change of the markup for firms that start exporting while identifying the effect of the remaining types of exporters in line with the suggestion by De Loecker and Warzynski (2012):

$$\begin{aligned} ln(\mu_{it}) = \alpha_0 + \alpha_{11} dexp\_entry_{it} + \alpha_{12} dexp\_exit_{it} + \\ \alpha_{13} dexp\_stay_{it} + \alpha_2 X_{it} + \gamma_s * \gamma_t + \varepsilon_{it} \end{aligned} \tag{2}$$

where γ_t and γ_s are year and sector fixed effects. $ln(\mu_{it})$ is the markup of firm i, in year t in log terms. ε_{it} is an error term. Standard errors are clustered at the firm level. In this equation, we identify three types of exporters. Export entry dummy variable ($dexp\_entry_{it}$) assumes the value one if a firm that was not considered an exporter in the previous period but is considered an exporter in the current period and, zero otherwise. Exiters ($dexp\_exit_{it}$) is a dummy variable that assumes the value one if a firm classified as an exporter in the current period but does not in the following period and, zero otherwise. Finally, stay exporters ($dexp\_stay_{it}$) is a dummy variable that takes the value one if the firm is classified as an exporter in at least two periods and zero otherwise. As above, we consider the markup in log terms and include the same covariates summarized in X_{it}. In addition, we keep the same fixed effect structure as mentioned above. Our main variable of interest is the coefficient of the variable $dexp\_entry_{it}$.

5. Results

In this section, we report the results obtained using the empirical specifications in equations (1) and (2) to identify, respectively, the markup premia of exporting firms and the markup change upon entry into export markets for the Manufacturing and Non-manufacturing sectors. In addition, we estimate the export markup premium across narrowly defined industries to uncover potential heterogeneity in this relation across them.

5.1. Export markup premia

Table 2 reports the coefficient associated with the export dummy, which captures the percentage markup premium between exporting and non-exporting firms according to the equation (1) for the Manufacturing sector. To ensure that our results are robust to the set of fixed effects and control variables, we experiment with different specifications. In all the specifications, we maintain the controls for the number of workers and stock of capital, both in log terms. In the first column, we report the results from a specification that further includes year-fixed effects. In the second, we add sectoral fixed effects and in the third we introduce an interaction variable between sectoral and year fixed effects. In the fourth column, we further include the import status of the firm as an

additional control variable. In the last column, we further extend the set of control variables to include also firms' age, in log terms, and also firm location fixed effects. This extended set of control variables aims at ensuring that our results still hold, even when considering other potential confounding variables.

	(1)	(2)	(3)	(4)	(5)
d_exp	0.0186***	0.0133***	0.0130***	0.0134***	0.0117***
	(0.00117)	(0.00120)	(0.00120)	(0.00123)	(0.00120)
Obs.	266,916	266,916	266,916	266,916	266,916
Year FE	YES	YES	NO	NO	NO
Sector FE	NO	YES	NO	NO	NO
Year*Sector FE	NO	NO	YES	YES	YES
Import Dummy	NO	NO	NO	YES	YES
Other controls	YES	YES	YES	YES	YES
Extended controls	NO	NO	NO	NO	YES

TABLE 2. Exporting premia - Manufacturing sector

Notes: *** p<0.01, ** p<0.05, * p<0.1. Firm cluster robust standard errors in parentheses. d_exp is a dummy variable that is one if a firm is an exporter and zero otherwise. Other controls are size measured by the number of workers and stock of capital both in log terms. The extended set of control variables are firms' age, in log terms, and also firm location fixed effects.

Table 3 shows the results obtained from the same exercise but now focused on the Non-Manufacturing sector. We find that the markup premium of exporters is positive and statistically significant for the Manufacturing and Non-Manufacturing sectors.[5]

	(1)	(2)	(3)	(4)	(5)
d_exp	0.0323***	0.0262***	0.0263***	0.0267***	0.0273***
	(0.000959)	(0.000935)	(0.000936)	(0.000979)	(0.000982)
Obs.	1,214,547	1,214,547	1,214,547	1,214,547	1,214,547
Year FE	YES	YES	NO	NO	NO
Sector FE	NO	YES	NO	NO	NO
Year*Sector FE	NO	NO	YES	YES	YES
Import Dummy	NO	NO	NO	YES	YES
Other controls	YES	YES	YES	YES	YES
Extended controls	NO	NO	NO	NO	YES

TABLE 3. Exporting premia - Non-Manufacturing sector

Notes:*** p<0.01, ** p<0.05, * p<0.1. Firm cluster robust standard errors in parentheses. d_exp is a dummy variable that is one if a firm is an exporter and zero otherwise. Other controls are size measured by the number of workers and stock of capital both in log terms. The extended set of control variables are firms' age, in log terms, and also firm location dummy variables.

Once we control for the import status of the firm, the coefficient on the export dummy is still positive and statistically significant. This result holds both in the Manufacturing and Non-Manufacturing sectors. In terms of the magnitude of the effect and depending on the specification, the percentage increase in markups associated with exporting is around 1.2-1.3 percent for the Manufacturing sector and 2.6-2.7 percent for the Non-Manufacturing sector in the more saturated specifications.[6]

5. Our findings remain qualitatively unchanged when experimenting with some more and less restrictive definitions of exporting and importing firms.

6. In terms of the corresponding level markup premium of exporting firms compared to their non-exporting counterparts, the results are around 0.01 and 0.03 for Manufacturing and Non-Manufacturing, in

These findings corroborate the prediction of models of international trade as discussed above, which emphasize the self-selection effect of exporters and predict a positive markup premium as discussed above not only for the Manufacturing sector but also the Non-Manufacturing.[7]

This strand of the literature finds in several cases a positive markup premium for exporting firms. However, the magnitude of this effect varies substantially across countries, depending on the sample period and data collection features. In addition, in contrast with our dataset, most datasets have a size threshold above which firms are required to report information based, for instance, on size and/or exporting/importing values. Hence, the magnitudes reported in this article are not directly comparable. For instance, De Loecker and Warzynski (2012) use data for the Slovenian Manufacturing sector between 1994 and 2000 and find an export markup premium of around 7.8 percent. Using data for France for the period 1995 to 2007, Guillou and Nesta (2015) estimate a higher premium of around 11.8 percent. Closer to the results reported in this article, Jafari *et al.* (2022) shows a markup premium of exporters of around 2.0 to 2.2 percent for the French food processing industry and Hornok and Muraközy (2019) find that exporting firms charge 3.7 percent higher markup, without a control for the import status of the firm. In their case, the markup premium of exporting firms disappears once they add a control variable for the import status of the firm. They use detailed trade data for Hungary over the period 1995-2003.

One should also note that the coefficients shown above relate to averages across industries within the Manufacturing and Non-Manufacturing sectors. To uncover the potential presence of heterogeneous effects within these two sectors, we also run a consistent specification at the industry level for the Manufacturing and Non-Manufacturing sectors using the specification associated with column 5, which is the most saturated.

Figures 9 and 10 report the estimates of this exercise conducted at the industry level, within both the Manufacturing and Non-Manufacturing sectors with corresponding confidence levels. We find that in the Manufacturing sector, the markup premium of exporters is highest in industries classified in "Furniture" (NACE Rev. 2 - 31) which reaches a markup premium of exporting firms of around 5 percent and also "Chemicals" (NACE Rev. 2-20) and "Rubber, Plastics, and Other Non-Met. Minerals" (NACE Rev. 2- 22-23) which depict values around 3 percent. In the Non-Manufacturing sector, the industries with the highest markup premium are: "Information and communication" (NACE Rev. 2- 58-63), "Professional, scientific and technical activities" (NACE Rev. 2-69-75); "Construction" (NACE Rev. 2- 41-43). Exporting firms have, in this case, a

the most saturated specification. As a robustness exercise, we adopt also a specification that uses revenue weights where firms have different weights according to their revenues. The results obtained under such a specification are qualitatively unchanged compared to the ones reported in this article.

7. Besides the efficiency channel suggested by theoretical models, there are other possible alternative effects that could be at play related, for instance, to different demand elasticities and consumer valuation in export markets (De Loecker and Warzynski (2012)).

markup that is higher than their non-exporting firms above 8, 7 and close to 5 percent, respectively.

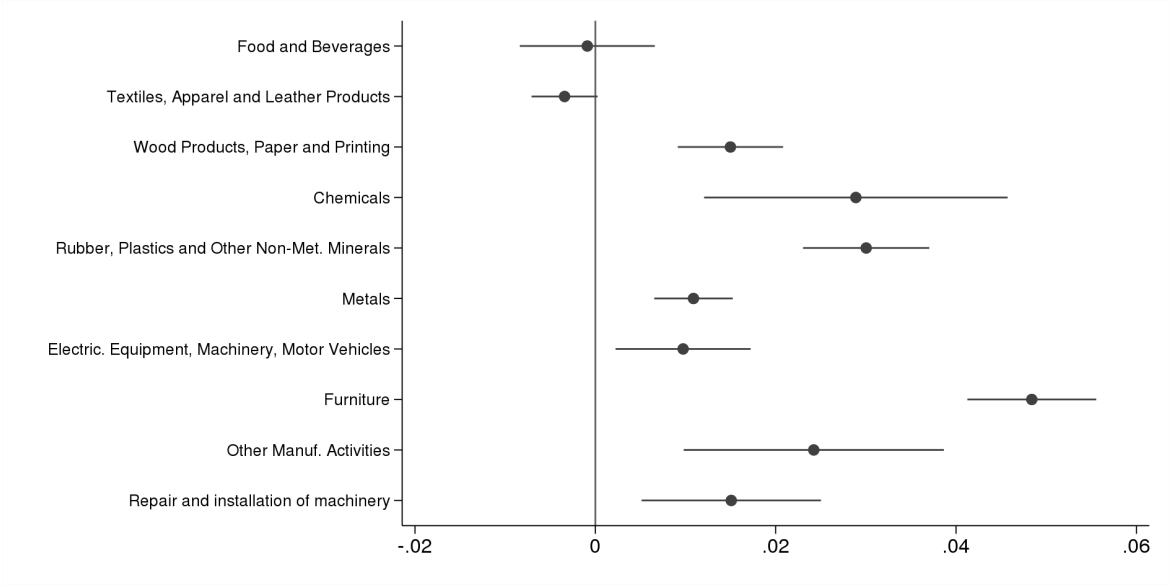

FIGURE 9: Industry export markup premia and confidence intervals in the Manufacturing sector

Notes: The confidence interval uses a 10 per cent significance level.

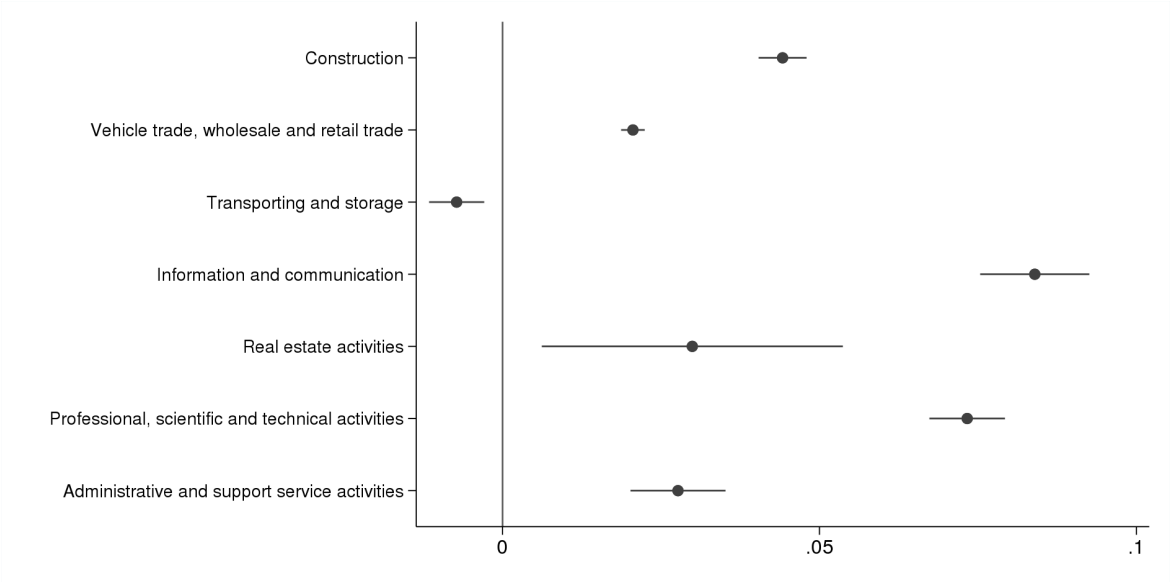

FIGURE 10: Industry export markup premia and confidence intervals in the Non-Manufacturing sector

Notes: The confidence interval uses a 10 per cent significance level.

5.2. *Entry in export markets*

Table 4 reports the coefficient for the export dummy entry variable for the Manufacturing sector according to equation (2), which captures the average percent difference in markups between firms who are not exporting, and firms in their first year of exporting.

	(1)	(2)	(3)	(4)	(5)
d_entry	0.0226***	0.0200***	0.0204***	0.0206***	0.0178***
	(0.00169)	(0.00168)	(0.00169)	(0.00169)	(0.00169)
Obs.	188,360	188,360	188,360	188,360	188,360
Year FE	YES	YES	NO	NO	NO
Sector FE	NO	YES	NO	NO	NO
Year*Sector FE	NO	NO	YES	YES	YES
Import Dummy	NO	NO	NO	YES	YES
Other controls	YES	YES	YES	YES	YES
Extended controls	NO	NO	NO	NO	YES

TABLE 4. Export entry and markups - Manufacturing sector

Notes: *** p<0.01, ** p<0.05, * p<0.1. Firm cluster robust standard errors in parentheses. Other controls are size measured by the number of workers and stock of capital both in log terms. The extended control variables are firms' age, in log terms, and also firm location fixed effects.

As above, we experiment with different empirical specifications regarding the fixed effect structure and control variables to ensure that our findings are robust to this choice. In all the specifications, we keep the stock of capital and the number of workers both in log terms as control variables. We consider a specification that further adds year fixed effects in column 1 of this table, we further add sectoral fixed effects in column 2, and last, we consider a full interaction between year and sectoral fixed effects reported in column 3. In the next column, we report the results from a specification that also includes a control for the import status of the firm. In the last column of the table, we further expand the set of control variables by including also firm's age, in log terms, and firm location fixed effects. Table 5 shows a similar exercise but we focus instead on the Non-Manufacturing sector.[8]

	(1)	(2)	(3)	(4)	(5)
d_entry	0.0316***	0.0272***	0.0272***	0.0275***	0.0269***
	(0.00138)	(0.00133)	(0.00134)	(0.00134)	(0.00134)
Obs.	809,161	809,161	809,161	809,161	809,161
Year FE	YES	YES	NO	NO	NO
Sector FE	NO	YES	NO	NO	NO
Year*Sector FE	NO	NO	YES	YES	YES
Import Dummy	NO	NO	NO	YES	YES
Other controls	YES	YES	YES	YES	YES
Extended controls	NO	NO	NO	NO	YES

TABLE 5. Export entry and markups- Non-Manufacturing sector

Notes:*** p<0.01, ** p<0.05, * p<0.1. Firm cluster robust standard errors in parentheses. Other controls are size measured by the number of workers and stock of capital both in log terms. The extended control variables are firms' age, in log terms, and also firm location fixed effects.

8. The number of observations differs from Tables 2 and 3, respectively since the panel of firms is not fully balanced. For instance, the export entry dummy variable can only be computed for firms that are observed both in years t-1 and t.

We find that the coefficient for the entry dummy variable in export markets is positive and highly statistically significant in both Manufacturing and Non-Manufacturing sectors. These results are in line with findings reported by De Loecker and Warzynski (2012) but they contrast with the ones reported by Garcia-Marin and Voigtländer (2019) for the Manufacturing sector. Entry in export markets is associated with higher markups and this effect is around 1.8-2.3 percent in the Manufacturing sector and around 2.7-3.2 percent in the Non-Manufacturing, depending on the empirical specification.[9] When we add the import status of the firm as an additional control variable, the markup premium upon entry into export markets remains positive, highly significant and the magnitude of this coefficient is not substantially changed in both of these sectors. These figures are in line with De Loecker and Warzynski (2012) which point to markup gains of 4-5 percent upon entry into export markets.

6. Conclusion

In this article, we gather empirical evidence on the markup premium of exporting firms for the Portuguese economy over the period 2010-2019. According to standard models of international trade, only the most efficient producers are able to export and charge also higher markups. Consistent with this model prediction, we find a positive, sizeable, and statistically significant markup premium for exporting firms. We include evidence for Manufacturing and Non-Manufacturing sectors by using a rich panel data on the universe of non-financial firms. Empirical evidence for this last sector is generally not available. Using this data, we show that exporting firms have a markup that is around 1.2%-1.3% and 2.6%-2.7% higher than non-exporting firms in the Manufacturing and Non-manufacturing sectors, respectively, in the most saturated specifications. However, there is substantial heterogeneity across sectors and industries in the size of this effect, which can reach magnitudes above 8 percent in industries such as "Information and communication". In addition, we show that markups increase upon entry into export markets. The coefficient on the export dummy entry variable is positive, sizeable, and statistically significant for the Manufacturing and Non-Manufacturing sectors.

Future research would be relevant, for instance, in establishing causal evidence between participation in export markets and markups and also provide robustness of these results using a structural framework to estimate the markup.

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Banco de Portugal
Banco de Portugal Economic Studies, Vol. IX, No. 1

Non-technical summary

January 2023

A novel decomposition of national central banks' profits in the euro area: application to the case of Banco de Portugal

José Miguel Cardoso da Costa and Nuno Silva

Central banks' balance sheets and risk exposures increased significantly over the past decade. As such, the discussion of the implications of central banks' potential income losses on the conduct of monetary policy has regained relevance. While central banks' financial credibility is supported by the ability to issue legal tender, which typically provides a significant and stable stream of revenue, the possible materialisation of certain financial risks still has fiscal and political implications that deserve attention. It is thus important to understand the drivers of central banks' income.

This article discusses the main sources of central banks' profits, focusing on the case of national central banks within the Eurosystem, where the generation of income follows certain specificities that make the analysis more complex. A novel decomposition of national central banks' profits is proposed, allowing to clearly distinguish the income generated from monetary policy decisions taken at the aggregate level, from that determined by national activities not directly related with monetary policy. The first is further split between the component shared among all national central banks and that driven from assets with non-shared income. Finally, we decompose the income generated by the different assets and liabilities taking into account the difference vis-à-vis the Eurosystem's marginal funding cost.

When applied to the case of Banco de Portugal over the past 20 years, this decomposition shows that on average earnings were mainly determined by monetary income, while income from assets not related with monetary policy was of the same order of magnitude of administrative costs. Income related with monetary policy decisions has been less volatile than income not related with monetary policy. Since the onset of large-scale asset purchases, we show that (i) Banco de Portugal's profits have increased mostly from non-shared monetary income resulting from the risk premium embedded in Portuguese sovereign debt yields; (ii) shared monetary income has remained only slightly below the historical average level, as the income associated with significant asset purchases largely compensated the decrease in income associated with banknotes resulting from the low interest rate environment; and (iii) income from activities not related with monetary policy remained similar to the historical average despite a gradual reduction in the most recent years (Figure 1).

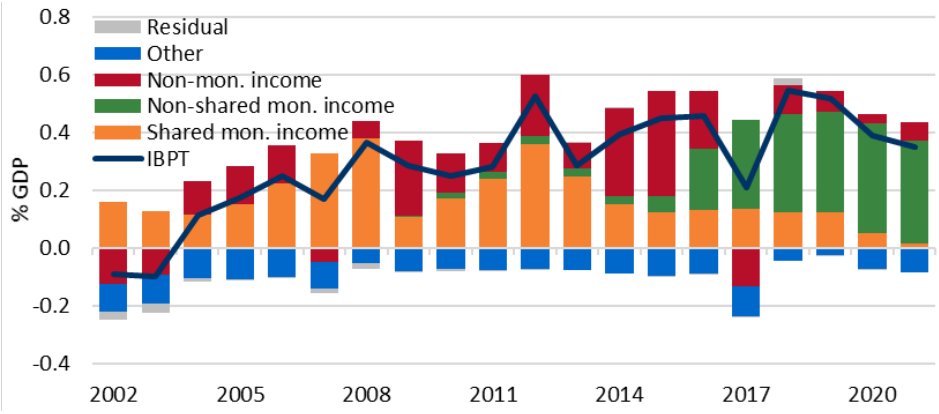

FIGURE 1: Central banks' total assets in selected advanced economies

Notes: Other corresponds mainly to administrative costs. Residual results from the difference between total IBPT and the sum of the four estimated contributions, which for some components is proxied using annual average figures of interest rates and balance sheet items. | Latest observation: 2021.
Sources: Banco de Portugal and Statistics Portugal (authors' calculations).

Assessing the drivers of central banks' profits is important, especially at a time when these may come under pressure, given the detrimental impact that higher interest rates will have on the net return of the large portfolios of long-term fixed-rate securities held in the balance sheets. In the usual income statement this will imply a reduction in the interest margin of the central bank without further information on its drivers. Our alternative decomposition makes clear that this decline will be determined by non-shared monetary income, which recently turned negative as a result of policy rates rising above the return of sovereign debt securities purchased for monetary policy purposes, and by a lower net return of assets with shared income. This will be only partly compensated by a higher income associated with banknotes that benefits from a higher policy rate.

In the Eurosystem, the primary objective of monetary policy is price stability. A consistent risk management framework is important to safeguard the credibility of the central bank in the long run, and avoid that other considerations, including concerns over potential short-term income losses, unduly affect monetary policy decisions. Clearly distinguishing the different sources of income, in particular those stemming from monetary policy decisions, may simplify modelling efforts that allow us to better project future income and assess risks going forward.

Banco de Portugal
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A novel decomposition of national central banks' profits in the euro area: application to the case of Banco de Portugal

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Banco de Portugal

January 2023

Abstract
We propose a new methodology to decompose the profits of a national central bank within the Eurosystem. Our methodology compares the income generated by the different assets and liabilities with the Eurosystem's marginal funding cost and distinguishes the income driven by monetary policy decisions taken at the aggregate level (with shared or non-shared income) from that determined by national activities not related with monetary policy. We apply this decomposition to the case of Banco de Portugal for the last two decades and show that the bulk of the central bank's profits was driven by monetary policy decisions, while income from other assets was on average close to administrative costs. (JEL: E58, E52, M41)
Keywords: central bank finances; seigniorage; monetary policy credibility; profitability analysis.

1. Introduction

Until the burst of the great financial crisis in 2008, central banks' balance sheets were relatively small and their assets mainly comprised short-term financing operations with financial institutions and short- and medium-term sovereign debt securities. On the liability side, operations were mainly financed by currency issuance, with interest-bearing reserves playing a minor role. The last decade saw however an unprecedented increase in central banks' balance sheets around the world (Figure 1). At the end of 2021, the total assets of the Eurosystem, the US Federal Reserve, the Bank of England and the Bank of Japan ranged between 38% and 134% of GDP, which compares with an interval between 6% and 21% of GDP before the great financial

Acknowledgements: The analysis presented in this article has benefitted from the careful explanations and help in gathering data from colleagues of the Accounting Department, in particular José Pedro Ferreira, Sara Martinho Rebelo and Nuno Seara Rodrigues, to whom the authors are highly indebted. The authors are also grateful for comments and suggestions from the editor, Pedro Duarte Neves, and from an anonymous referee, as well as from Nuno Alves, João Amador, António Antunes and participants in a Banco de Portugal internal seminar. The analyses, opinions and conclusions expressed herein are the sole responsibility of the authors and do not necessarily reflect the opinions of Banco de Portugal or the Eurosystem.

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crisis.[1] Within the Eurosystem, a similar trend was observed across all NCBs despite substantial heterogeneity, especially in the first years after the great financial crisis and again after the pandemic crisis. In 2021, NCBs' total assets ranged between 44% and 137% of GDP. The increase in balance sheets resulted mostly from large purchases of sovereign debt securities, mainly with medium to long-term maturities and fixed interest rates, implying a significant increase of central banks' exposure to interest rate risk and, in some cases, to sovereign credit risk.

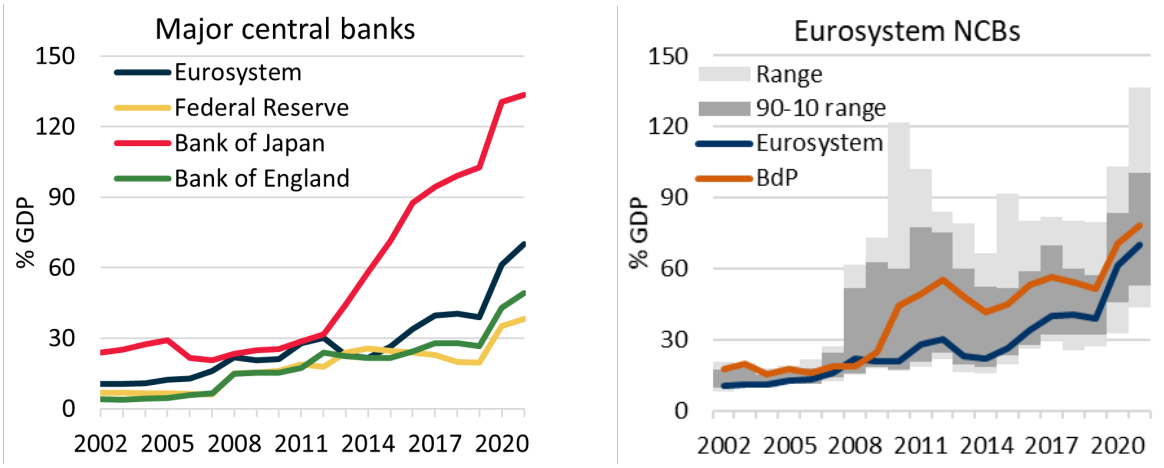

FIGURE 1: Central banks' total assets in selected advanced economies and within the Eurosystem

Notes: Eurosystem total assets do not include intra-Eurosystem claims as they net out. For NCBs, total assets include only the net position between intra-Eurosystem claims and liabilities. | Latest observation: 2021.
Sources: European Central Bank, Eurosystem, Federal Reserve, Bank of Japan and Bank of England.

The increase in central banks' balance sheets and the risks involved with outright asset purchase programmes have reignited the discussion on monetary and fiscal policies interactions. In particular, a recent strand of the literature discusses the role of central bank's solvency in supporting monetary policy credibility. Bassetto and Messer (2013), Del Negro and Sims (2015), Hall and Reis (2015) and Benigno and Nisticò (2020) discuss the case of a single monetary authority issuing liabilities in domestic currency, while Bassetto and Caracciolo (2021) study the case of a NCB within a monetary union.[2] These studies show that a central bank is capable of achieving a price stability objective if (i) fiscal policy guarantees public debt sustainability for any given price level and (ii) the fiscal authority ensures fiscal support of the central bank in case of need. In the absence of these conditions, the central bank could in principle become 'policy insolvent' (i.e. not be able to achieve its policy objectives). Although the quantitative estimates suggest that such situation is very unlikely to occur in advanced economies, it is important to monitor central banks' financial strength and design mechanisms to ensure that their financial situation does not undermine the price stability objective.

1. The Eurosystem comprises the European Central Bank (ECB) and the national central banks (NCBs) of European Union member states that have adopted the euro as their domestic currency.

2. See Cardoso da Costa (2022) for a literature review.

Some empirical studies have tried to assess the risks of central banks' balance sheets. In the case of the Federal Reserve, Anderson *et al.* (2022) have recently simulated the evolution of net income under different paths for interest rates and other financial variables, based on policy assumptions consistent with the plans defined by the Federal Open Market Committee (FOMC) in May 2022. These simulations suggest that the Federal Reserve's remittances to the US Treasury will likely be suspended for three years, but show that under more extreme scenarios the suspension could endure until the end of the decade. In the case of the Eurosystem, Debrun *et al.* (2021) presented projections for the net income between 2021 and 2030 under three alternative scenarios. In all of them, the net income remains positive over this period, despite falling gradually after 2024. The decline is more pronounced in a scenario where interest rates rise more quickly, with several NCBs temporarily facing negative net income. After the strong increase of inflation in 2022 and the tightening of the monetary policy stance with successive interest rate hikes, several central banks have already alerted that their profits may turn negative for some time.[3]

This article discusses the income generation process of a NCB in the Eurosystem. For most central banks, it is relatively easy to understand and quantify their seigniorage revenues, which generally derive from the right to issue legal tender. Profit accounting in the Eurosystem has however certain specificities that turn the analysis more complex. First, each NCB implements commonly agreed monetary policy measures within its jurisdiction and has its own balance sheet. Generally, the remuneration of assets related with monetary policy (the monetary income) is shared across all NCBs based on the Eurosystem capital key,[4] independently of the income generated by the assets and liabilities specifically held in each NCB's balance sheet. However, this general rule does not apply to all monetary policy operations. In particular, the income generated by sovereign debt securities held by NCBs for monetary policy purposes under some asset purchase programmes is not shared in any return exceeding the ECB rate for Main Refinancing Operations (MRO),[5] which leads to a first source of income heterogeneity across NCBs. Moreover, NCBs balance sheets may also comprise a significant fraction of assets not related with monetary policy, adding a second important layer of heterogeneity across NCBs. Hence, the specificity of central bank accounting in the Eurosystem implies that it is necessary to understand the drivers of central banks' aggregates both at the Eurosystem and national levels in order to fully uncover the evolution of NCBs' income.

3. In a letter recently sent to the Ministry of Finance, De Nederlandsche Bank highlights that it will likely register losses in the coming years (De Nederlandsche Bank 2022). Similarly, the National Bank of Belgium communicated to the market the expectation of recording losses in 2022, a situation that could continue until 2027 (National Bank of Belgium 2022). Kjellberg and Ahl (2022) show the negative impact of an interest rate hike scenario for the case of the Sveriges Riksbank.

4. The Eurosystem capital key is reviewed periodically to reflect each country's share in the total population and in the GDP of the euro area.

5. This is the case of the Public Sector Purchase Programme (PSPP) and the Pandemic Emergency Purchase Programme (PEPP) in its components of sovereign debt: PSPP-GOV and PEPP-GOV.

Additionally, the set of rules guiding the distribution of monetary income across NCBs were defined under the framework of a corridor system to steer short-term interest rates, where the marginal cost of funding of the Eurosystem corresponds largely to the MRO rate. Under an excess liquidity environment, as the one observed in the last decade, the monetary policy works under a *de facto* floor system, where the short-term market interest rates are closer to the deposit facility rate (DFR). This implies a difference between the remuneration of certain monetary policy operations (at the MRO rate) and the marginal cost of funding of the Eurosystem (the DFR).[6] As discussed below, this difference may further distort the generation of NCBs' income.

In this article, we address these concerns by proposing a novel decomposition of NCBs' profits that clearly distinguishes the income generated from monetary policy decisions taken at the aggregate level, from that determined by national activities not directly related with monetary policy. In addition, monetary income is split between the component shared among all NCBs and that driven from assets with non-shared income. We further decompose the income generated by the different assets and liabilities taking into account the difference vis-à-vis the Eurosystem's marginal funding cost, an approach that could also be applied to other central banks. The proposed view over the income generating process is typically not presented in the financial statements, but may prove useful to understand the main drivers of central banks' income and to develop risk assessment exercises. We illustrate the decomposition for the case of Banco de Portugal over the past two decades.

2. The national central banks' balance sheet

The common Eurosystem accounting and reporting rules are set out in a published ECB guideline that is tailored to the needs of Eurosystem's central banks and differs in specific aspects from the International Financial Reporting Standards (IFRS).[7] The objective of this article is to give a high-level picture of how NCBs in the Eurosystem generate income rather than to give a detailed description over accounting rules within the Eurosystem.

We build on a stylised version of the balance sheet of a NCB as that presented in Table 1. On the asset side, NCBs mainly hold assets related with monetary policy, namely credits to financial institutions and securities purchased for monetary policy purposes. We distinguish between the portfolios with shared and non-shared income. As part of their monetary policy assets, NCBs may also hold intra-Eurosystem claims, mainly reflecting positive TARGET balances and the difference between actual banknotes in circulation and the allocation of banknotes according to the Eurosystem capital key.

6. In our quantitative application, we assume that the ECB policy rate equals the MRO rate until September 2008 and the DFR from October 2008 onwards, when the fixed-rate full allotment procedure was implemented and excess liquidity surpassed € 250 billion for the first time.

7. See European Central Bank (2012).

Additionally, central banks also hold other assets not related with monetary policy as part of their investment strategies.

On the liability side, the balance sheet mainly comprises responsibilities related with monetary policy, namely banknotes in circulation, banks' reserves (required and excess) and intra-Eurosystem liabilities. NCBs also hold other liabilities, including deposits from the government or from non-residents, as well as own funds, namely revaluation accounts, general risk provisions, capital and reserves and profit for the year. In the Eurosystem, these four items constitute the central bank's financial buffers and serve as different lines of defence against possible losses.

The difference between liabilities and assets related with monetary policy is usually denoted as the *gap* and plays a critical role in the sharing mechanism of monetary income across NCBs, as will become clear below. Whenever liabilities related with monetary policy are higher than assets related with monetary policy, implying a positive *gap*, the NCB is at least partly using such liabilities to finance assets not related with monetary policy. In contrast, when the *gap* is negative the NCB is implicitly using liabilities not related with monetary policy to invest in intra-Eurosystem claims. In practice, the *gap* can also be obtained by the difference between assets and liabilities not related with monetary policy, including NCB's financial buffers, which is known in the Eurosystem jargon as net financial assets (NFA). The maximum amount of NFA is regulated by the Agreement on Net Financial Assets (ANFA), which in practice sets a ceiling for the *gap*.[8]

Assets	**Liabilities**
Assets related with monetary policy	Liabilities related with monetary policy
Credit to financial institutions	Banknotes in circulation
Securities (shared income)	Minimum reserve requirements
Securities (non-shared income)	Excess reserves
Intra-Eurosystem claims (e.g. TARGET+)	Intra-Eurosystem liabilities (e.g. TARGET-)
Assets not related with monetary policy	Liabilities not related with monetary policy
	Own funds (financial buffers)

TABLE 1. Stylised balance sheet of a NCB in the Eurosystem

Notes: Securities purchased for monetary policy purposes with non-shared income include the purchases of covered bonds under the first two Covered Bond Purchase Programmes (CBPP1 and CBPP2) and of PSPP-GOV and PEPP-GOV. Securities with shared income include all other securities purchased for monetary policy purposes.

Figure 2 shows how the main balance sheet items have evolved since 2002 in the case of the Eurosystem and Banco de Portugal. At the end of 2021, assets related with monetary policy (including both credit to financial institutions and securities purchased for monetary policy purposes) were by far the main category, representing around 80% of total assets (close to 60% of GDP) in the case of the Eurosystem. This contrasts with

8. This agreement has been set up "to ensure that the Governing Council of the ECB is in full control of the size of the Eurosystem's balance sheet" and may be seen as a way to insulate the Eurosystem's balance sheet from any losses incurred by NCBs in their non-monetary policy activities. See `https://www.ecb.europa.eu/ecb/educational/explainers/tell-me-more/html/anfa_qa.en.html` for further details.

the pre-2008 period, when assets related with monetary policy represented on average only 37% of total assets (and 5% of GDP).

The composition of monetary policy assets also changed significantly in the last twenty years. Up to 2008, monetary policy assets corresponded only to credit to financial institutions, which in Portugal was often below the euro area average (in percentage of GDP). The great financial crisis and the sovereign debt crisis had a particularly strong impact in the Portuguese financial system, ultimately increasing credit to financial institutions by more than what was observed on average in the Eurosystem. This was mainly financed by higher intra-Eurosystem liabilities (negative TARGET balances).[9] In the aftermath of the sovereign debt crisis, credit to financial institutions started decreasing both in the Eurosystem and Banco de Portugal, but this effect was more than compensated by the implementation of large-scale asset purchases since early 2015, which led to a significant increase of monetary policy assets across most NCBs. In 2020, both credit to financial institutions and securities' holdings increased significantly with the response to the pandemic.[10]

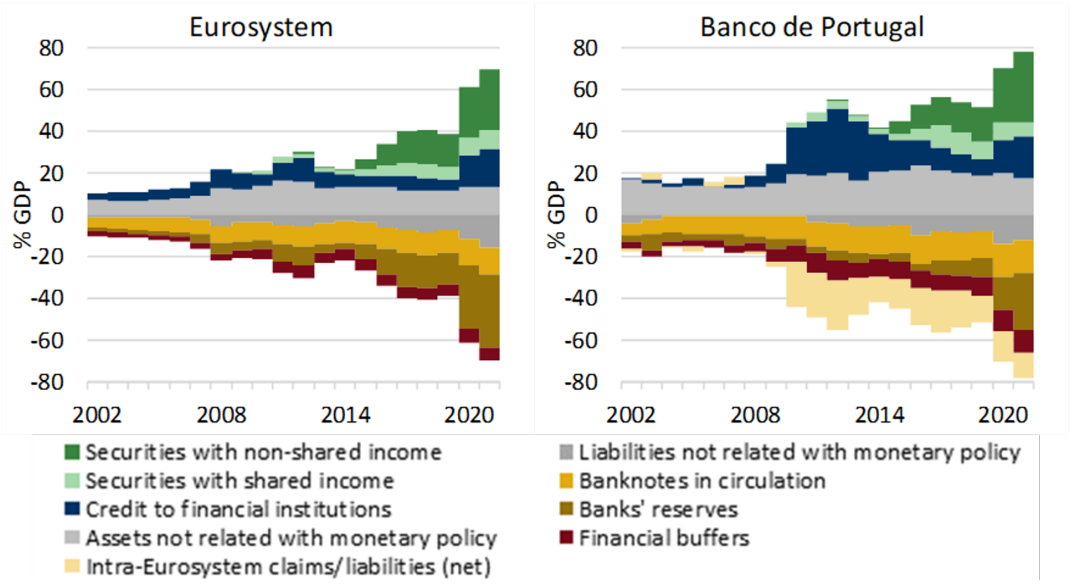

FIGURE 2: Balance sheet composition of the Eurosystem and Banco de Portugal

Notes: Eurosystem's total assets do not include intra-Eurosystem claims as they net out. Banco de Portugal's total assets include only the net position between intra-Eurosystem claims and liabilities. | Latest observation: 2021.
Sources: European Central Bank, Banco de Portugal and Eurostat (authors' calculations).

On the liability side, up to 2008 the Eurosystem balance sheet was mainly financed by banknotes in circulation, which represented more than 50% of total assets (6% of GDP). The remaining was mostly financed by banks' reserves (mostly to comply with minimum requirements) and financial buffers, each representing close to 20% of total

9. See Soares *et al.* (2020) for an explanation of the main drivers behind the evolution of TARGET balances in the case of Banco de Portugal until 2018.

10. See Sousa-Leite *et al.* (2022) for a thorough description of the evolution of Banco de Portugal's balance sheet over the past 20 years.

assets, while liabilities not related with monetary policy represented on average only 11% of total assets. This changed with the implementation of non-standard monetary policy measures since the great financial crisis. In particular, the introduction in October 2008 of a fixed-rate full allotment tender procedure in all Eurosystem's refinancing operations allowed banks a continued access to liquidity leading to a significant increase of banks' reserves with the Eurosystem.

The implementation of large-scale asset purchase programmes from 2015 onwards further contributed to exacerbate the increase of banks' reserves. Between 2007 and 2021, these increased from around 2% to 35% of GDP, financing most of the expansion in the Eurosystem balance sheet. Liabilities not related with monetary policy, such as government deposits and liabilities against non-residents, also became more relevant, increasing from 1% of GDP in 2002 to 16% in 2021. On the other hand, banknotes in circulation and financial buffers, while increasing as a share of GDP, reduced their weight on the balance sheet, representing respectively 18% and 9% of total assets in 2021. The increase of financial buffers was mainly supported by higher revaluation accounts related with gold reserves and retained earnings in the form of general reserves and general risk provisions.

The liability structure of Banco de Portugal up to 2008 was similar to the one observed in the Eurosystem. Since 2008, the TARGET balances of Banco de Portugal became more negative to finance the additional credit to financial institutions and, at a later stage, the large-scale asset purchases. This movement was only partly compensated by an expansion in intra-Eurosystem claims related with banknotes. While this negative intra-Eurosystem position declined in the most recent years, compensated by a substantial increase in banks' reserves, it remains a relevant source of funding for Banco de Portugal.

3. The national central banks' income statement

Similarly to the previous section, we build on a stylised version of the income statement of a NCB as that presented in Table 2. The revenue of Eurosystem's NCBs can be split in three types: (i) interest income from financial assets (both related and not related with monetary policy);[11] (ii) realised gains from financial assets; and (iii) other income, which includes income from equity holdings (e.g. ECB) and commissions (e.g. fees raised from supervised institutions). Similarly, central banks' costs can be divided in (i) interest expenses from financial liabilities; (ii) realised losses from financial assets; and (iii) other costs, which include mainly administrative costs (e.g. staff costs and depreciation of fixed assets). On top of this, NCBs income includes the net result of pooling monetary income among NCBs, which can be positive or negative, as discussed below. Finally, the net profit of the year is affected by taxes, as well as by transfers to/from risk provisions that reflect the provisioning and dividend policies of each NCB. Notwithstanding, in this article we focus the analysis on income before provisions and taxes (IBPT).

11. This includes the income on intra-Eurosystem claims and liabilities, which by convention are remunerated at the MRO rate.

Figure 3 presents the evolution of the main components of IBPT for the Eurosystem and Banco de Portugal. The income shows an upward trend over the last two decades in both cases. In the Eurosystem, IBPT has increased on average from about 0.16% of GDP before the great financial crisis to close to 0.29% of GDP in the last decade. Despite a peak of 0.42% in 2012, justified by a significant increase in credit to financial institutions and the return on Securities Market Programme (SMP) purchases, the evolution has been rather stable and almost exclusively driven by interest margin.

Income	**Expenses**
Interest income from financial assets	Interest expenses from financial liabilities
Realised gains from financial assets	Realised losses from financial assets
Other income	Other costs
Net result of pooling monetary income (+)	Net result of pooling monetary income (-)

TABLE 2. Stylised income statement of a NCB in the Eurosystem

The overall trend was similar in the case of Banco de Portugal, as IBPT moved from an average of 0.20% of GDP between 2005 and 2007 to close to 0.41% of GDP over the last decade. IBPT was nevertheless more volatile in the case of Banco de Portugal, mainly reflecting fluctuations in the net result (realised gains or losses) of financial operations, which at the Eurosystem level benefit from a diversification effect. In the case of Banco de Portugal, the net result of pooling monetary income typically had a positive contribution, as Banco de Portugal's share on the Eurosystem monetary income was higher than its contribution to the pooling mechanism. This was particularly relevant in 2012, reflecting the higher cost of Banco de Portugal's liabilities in the TARGET system vis-à-vis that of Eurosystem reserves, and again in the most recent years, reflecting in addition the lower stock of assets purchased by Banco de Portugal under PSPP-GOV relative to its share in the Eurosystem capital key.

The pooling of monetary income is a distinctive feature of the Eurosystem. According to Article 32 of the Statute of the European System of Central Banks, the monetary income of all Eurosystem NCBs should be pooled and then reallocated to the NCBs in proportion to their share in the Eurosystem capital key. As a result, whenever the contribution of a NCB to the monetary income is higher (lower) than its respective share on the total, a negative (positive) net result of pooling of monetary income ought to be registered leading to a lower (higher) intra-Eurosystem net position of this NCB. The more heterogeneous is the balance sheet composition across NCBs, the larger may be the net pooling in absolute terms, something that reinforces the need to distinguish monetary and non-monetary income when analyzing NCBs income. In the case of Banco de Portugal, the net pooling of monetary income represented on average (in absolute terms) 0.03% of GDP between 2002 and 2021.

Since 2003 the pooling mechanism follows the so-called semi-direct method.[12] According to this method, each country contribution is given by the sum of the income generated by all monetary policy assets in its balance sheet less the costs associated

12. See Handig and Holzfeind (2007) for further details.

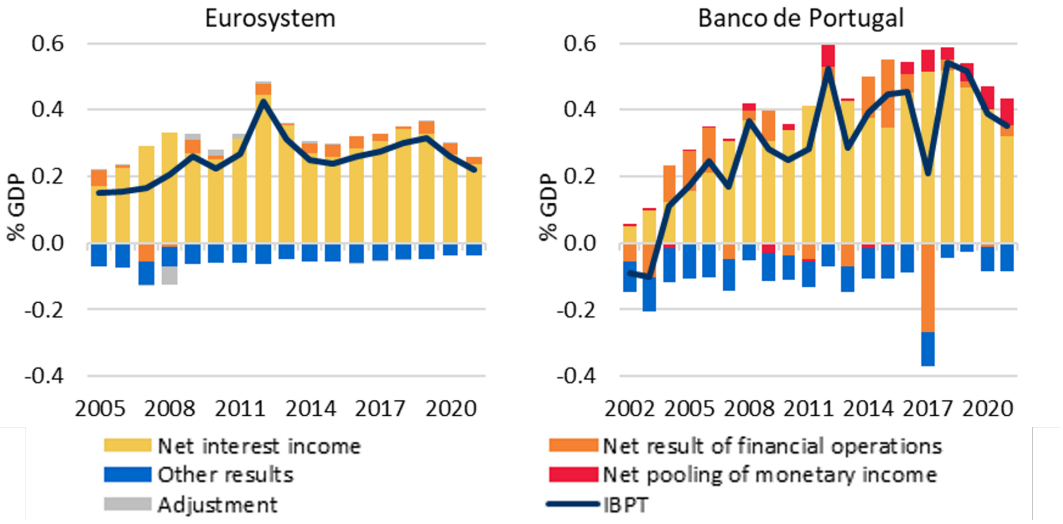

FIGURE 3: Composition of the Eurosystem's and Banco de Portugal's income before provisions and taxes (accounting view)

Notes: Adjustments in the Eurosystem decomposition mainly represent provisions related with assets related with monetary policy that were recorded in certain periods under a loss sharing mechanism, but that in most cases were eliminated in subsequent periods. | Latest observation: 2021.
Sources: European Central Bank, Banco de Portugal and Eurostat (authors' calculations).

with liabilities related with monetary policy in its balance sheet plus the revenue/costs associated with the *gap*, which is assumed to be remunerated at the MRO rate.

There is however an important exception regarding assets with non-shared income. In this case, the income is decomposed between the MRO rate times the book value associated with these assets, which enters each NCB contribution to the shared monetary income, and the excess income. The latter impacts only each NCB income statement. In practice, monetary policy assets with non-shared income contribute to the pooling mechanism in a similar manner as assets not related with monetary policy. At the margin, NCBs asset purchases, either monetary or not, are financed through an intra-Eurosystem liability. As this is remunerated at the MRO rate, the purchased assets must contribute in equal terms in order to guarantee that these operations lead to an equal increase in NCBs contribution to the Eurosystem's pooled monetary income. In the case of assets not related with monetary policy this is achieved through the remuneration of the *gap*.

Since NCBs monetary income corresponds to the sum of the income generated by assets and liabilities related with monetary policy held in its own balance sheets, plus the net result of pooling monetary income, one cannot fully uncover the economic drivers behind monetary income by looking only to NCBs income statements. In particular, it is not possible to evaluate the contribution to monetary income from money creation and non-standard monetary policy operations (e.g. TLTRO – Targeted Long-Term Refinancing Operations – and asset purchases with shared and non-shared income). The financial statements of NCBs usually report the total contribution of all NCBs to shared monetary income, but this is insufficient to understand the drivers behind this figure and does not provide information on the contribution of non-shared monetary income.

The decomposition proposed below tries to overcome these caveats by separating the income generated by monetary policy assets and liabilities from the components not related. Also, within the monetary income, it separates the shared part that only depends on balance sheet items at the aggregate level of all NCBs, from the non-shared component.

4. A novel decomposition of national central banks' net income

We propose a novel decomposition of a NCB net income compatible with the stylised balance sheet presented in section 2. Under this decomposition, the NCB's income before provisions and taxes can be seen as the sum of four components: (i) NCB's share on total Eurosystem shared monetary income;[13] (ii) the return associated with non-shared monetary policy assets in excess of the MRO rate; (iii) the return associated with assets and liabilities not related with monetary policy; and (iv) other income and expenses:[14]

$$
\begin{aligned}
IBPT = \quad & k.MI_{EUR}^{Shared} && \text{Shared monetary income} \\
& + \left(r^{MA^{NonShared}} - MRO\right).MA^{NonShared} && \text{Non-shared monetary income} \\
& + \left(r^{NMA}.NMA - r^{NML}.NML - MRO.Gap\right) && \text{Non-monetary income} \\
& + Other && \text{Other results}
\end{aligned}
$$

where k is the NCB's share in the Eurosystem capital key, MI_{EUR}^{Shared} is the shared monetary income generated by all NCBs, $r^{MA^{NonShared}}$ is the actual average return of NCB's assets related with monetary policy with non-shared return and $MA^{NonShared}$ its respective stock (mainly comprising NCB's holdings of sovereign debt securities purchased under PSPP and PEPP), r^{NMA} and r^{NML} are the actual average returns of assets and liabilities not related with monetary policy and NMA and NML the respective stocks.

In contrast with the traditional presentation of net income, this decomposition allows us to identify the profit contribution of assets and liabilities related with monetary policy, as well as the income contribution of other investments net of the related funding costs, which includes the remuneration of the *gap*.[15] The contribution of each of these components is analysed for the case of Banco de Portugal in section 5.

13. Throughout the following exposition, variables aggregated for all NCBs (Eurosystem excluding the ECB) are denoted with the subscript EUR, while national variables have no subscript.

14. See Appendix A.1 for a derivation of the decomposition of income before provisions and taxes.

15. As noticed above, when the *gap* is positive, liabilities related with monetary policy are financing part of the non-monetary policy portfolios, so we consider the cost of funding associated with the *gap* in the non-monetary income component. Notice that assets that do not generate income except through realised gains or losses, as is the case of gold, impose a cost associated with its funding.

In order to uncover the economic drivers of shared monetary income, we further decompose it by comparing the rate of return of all assets and liabilities with a rate representative of the marginal cost of funding of the Eurosystem, which we define as the policy rate, PR. While in a liquidity shortage environment the MRO rate may be a good proxy for this rate, in an excess liquidity environment, the DFR would be a more reasonable benchmark. Considering the policy rate, we thus allow for both regimes.

We decompose shared monetary income, which is exclusively driven by Eurosystem's aggregates (excluding the ECB) and is independent of each NCB's individual positions, into four components:[16]

$$MI_{Eur}^{Shared} = PR.M_{EUR} + \quad \text{Net return from banknotes}$$

$$-(MRO - PR).MRR_{EUR} \quad \text{Net cost of minimum reserve requirements}$$

$$+(r^{MA_{EUR}^{OtherShared}} - PR).MA_{EUR}^{OtherShared} \quad \text{Net return from other assets with shared income}$$

$$+(MRO - PR).\left(Gap_{EUR} + IC_{EUR} - IL_{EUR} + MA_{EUR}^{NonShared}\right) \quad \text{Net return associated with monetary income agreement conventions}$$

where M_{EUR} corresponds to the stock of banknotes in circulation, MRR_{EUR} is the stock of minimum reserve requirements, $MA_{EUR}^{OtherShared}$ is the stock of assets related with monetary policy with shared income other than intra-Eurosystem claims, with $r^{MA_{EUR}^{OtherShared}}$ being its respective return, and $IC_{EUR} - IL_{EUR}$ is the stock of intra-Eurosystem claims and liabilities (for the aggregate of all NCBs corresponds to the symmetric position of the ECB in these operations).

The first component stems from the right given to central banks to issue banknotes. Using the policy rate as a reference and assuming that the cost of issuing banknotes is zero, this contribution is positive as long as the policy rate is positive.[17] In the case of the Eurosystem, the policy rate was negative between June 2014 and July 2022, and hence this component actually represented a cost to central banks in this period.

The second component represents the cost of remunerating part of the reserves at the MRO rate, which in an excess liquidity environment as the one prevailing in the euro area since 2008 is higher than the policy rate.[18] When the policy rate is equal to the MRO rate (i.e. if there is no excess liquidity), the contribution from this term is zero.

16. See Appendix A.2 for a derivation of the decomposition of shared monetary income.

17. The cost of printing new banknotes is not zero, but it is negligible as a fraction of the amount issued. We abstract from these costs here for simplicity, but they are included in the other costs component.

18. Banks' reserves held at the Eurosystem in compliance with the minimum reserve requirement were remunerated at the MRO rate until December 2022. Since then, they are remunerated at the DFR and thus this component will no longer represent a cost. Additionally, with the introduction of the two-tier system in October 2019, excess reserves up to a multiple of the MRR were exempted from remuneration of a negative DFR whenever the DFR was negative and thus also implied a financial cost to the Eurosystem. Under our decomposition framework the cost associated with the two-tier system in 2019-2021 is included in this second component of the shared monetary income.

The third component takes into account the contribution to NCBs income from asset holdings related with monetary policy with shared income other than intra-Eurosystem claims. In our framework, this is positive (negative) whenever these are remunerated at a rate above (below) the policy rate. This may be the case for securities with shared income held under the different purchase programmes, whose return depends on the coupon rate and the price at which each security was purchased in the secondary market. Moreover, credit to financial institutions may also be remunerated at a rate different than the policy rate. This contributes positively to monetary income whenever loans are granted at the marginal lending facility rate or in the case of the traditional refinancing operations under an excess liquidity environment. Loans granted to financial institutions may also contribute negatively, namely in the case of TLTRO III, whose rate of return was on average lower than the policy rate.

Finally, our fourth component captures the fact that the policy rate may be different from the rate defined in the monetary income distribution agreement for the purpose of computing the contribution to shared monetary income from the *gap*, the intra-Eurosystem claims and the assets related with monetary policy with non-shared income. As explained above, the convention so far has been to use the MRO rate for this purpose.

Similarly to shared monetary income, it is possible to decompose non-shared monetary income, $MI^{NonShared}$, taking as reference the policy rate, in the following two components:

$$MI^{NonShared} = \underbrace{\left(r^{MA^{NonShared}} - PR\right).MA^{NonShared}}_{\text{Net return on assets related with monetary policy with non-shared income}} \underbrace{-(MRO - PR).MA^{NonShared}}_{\text{Net cost associated with monetary income agreement conventions}}$$

The first term corresponds to the income associated with non-shared monetary policy assets net of the Eurosystem marginal funding cost. Taking the latter as a proxy for the risk-free rate in the Eurosystem, one can interpret the first term as the fair market compensation for holding those assets. The second term follows from the rules defined in the monetary income distribution agreement and represents the national contribution to the fourth component of our shared monetary income decomposition, in what concerns non-shared assets.

Lastly, it is also possible to decompose non-monetary income taking as reference the policy rate.[19] In this case, we split non-monetary income in four components:

The first two components capture the contributions from assets and liabilities not related with monetary policy, which in our approach correspond to the remuneration of these positions above the policy rate. The third component is the contribution from the *gap*, which is zero when the policy rate is equal to the MRO rate. When the policy

19. See Appendix A.3 for a derivation of the decomposition of non-monetary income.

$$
\begin{aligned}
NMI = \quad & \left(r^{NMA} - PR\right).NMA && \text{Net return from assets not related with monetary policy} \\
& -\left(r^{NML} - PR\right).NML && \text{Net cost from liabilities not related with monetary policy} \\
& -\left(MRO - PR\right).Gap && \text{Net cost from the gap} \\
& +PR.Buffers && \text{Net return from financial buffers}
\end{aligned}
$$

rate is lower than the MRO rate, the *gap* contributes negatively (positively) to non-monetary income if it takes a positive (negative) value, meaning that the NCB is being financed by (investing in) intra-Eurosystem liabilities (claims). The last component is the contribution from financial buffers. Similarly to banknotes, financial buffers have no funding costs and, as a result, they contribute positively (negatively) to non-monetary income whenever the policy rate is positive (negative).

The fact that the Eurosystem agreement assumes that some monetary claims are remunerated at the MRO rate, independently of market conditions, may potentially distort NCBs investment decisions not related with monetary policy. In practice, any investment decision of an individual NCB not related with monetary policy has a marginal financing cost given by the MRO rate. As a result, at the margin if the rate of return of this investment is below the MRO rate but above the policy rate, the NCB suffers a net loss, even though this contributes positively to the Eurosystem aggregate monetary income (see the fourth component of the decomposition of shared monetary income). In addition, applying the same rationale, the current mechanism may also distort the distribution of monetary income whenever non-shared assets held by each NCB are not proportional to their share in the Eurosystem capital key.[20]

In the following section, we apply these decompositions to the case of Banco de Portugal over the past 20 years.

5. Application to the case of Banco de Portugal

Figure 4 decomposes Banco de Portugal's IBPT between 2002 and 2021 as a percentage of GDP.[21] Table 3 presents some descriptive statistics on the decomposition of IBPT in the same period. During these years, Banco de Portugal's IBPT amounted on average to 0.29% of GDP with monetary income, non-monetary income and other income/cost sources contributing with 0.28, 0.10 and -0.08 percentage points, respectively. Monetary income represents thus the main source of income for Banco de Portugal, with the

20. Notice, however, that in the limiting case where all NCBs purchase the same financial asset in an amount proportional to their share in the Eurosystem capital key, all NCBs end up obtaining the same positive net return, and thus there is no such distortion. In the case of financial investments not related with monetary policy, this is merely an academic scenario. In the case of asset purchases conducted for monetary policy purposes, on the contrary, this is the rule to the extent that purchases are done according to the capital key, as is broadly the experience with APP.

21. Whenever possible the income decomposition is computed on a daily basis using the contemporaneous monetary policy rates.

income generated by investment activities not related with monetary policy being on average similar to its operating cost. Banco de Portugal IBPT fluctuated between -0.10% and 0.54% of GDP, leading to a standard deviation of 0.18 and a coefficient of variation of 0.61.

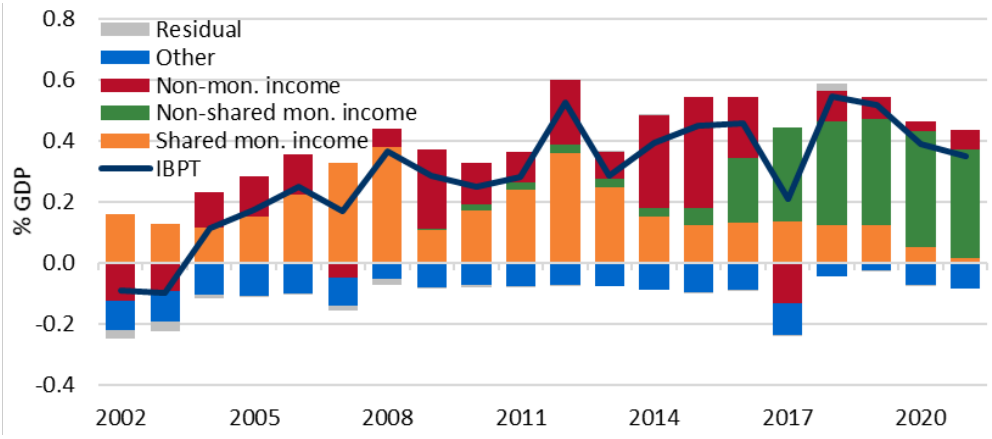

FIGURE 4: Decomposition of Banco de Portugal's IBPT

Notes: The residual results from the difference between total IBPT and the sum of the four estimated contributions, which for some components is proxied using annual average figures of interest rates and balance sheet items. | Latest observation: 2021.
Sources: Banco de Portugal and Statistics Portugal (authors' calculations).

Monetary income oscillated between 0.11% of GDP in 2009 and 0.47% in 2019. These values reflect very different contributions from shared and non-shared components. While the shared component has been responsible for almost all monetary income up to 2009, non-shared income became the main source after 2016, representing 96% of Banco de Portugal's monetary income in 2021. On average, shared and non-shared monetary income contributed with 0.17 and 0.11 percentage points per year, respectively. These numbers reflect the fact that all monetary income was shared until the introduction of the Covered Bond Purchase Programme (CBPP) in 2009. This became quantitatively more relevant in 2015 with the introduction of PSPP-GOV. Over this period, shared and non-shared monetary income have shown to be negatively correlated, reflecting the fact that quantitative easing programmes were initiated when the policy rate got close to its effective lower bound, which translated into a reduction of income associated with banknotes.

	Mean	Median	Min	P25	P75	Max	Standard deviation	Coefficient of variation
Income before taxes and provisions	0.29	0.28	-0.10	0.20	0.41	0.54	0.18	0.61
Monetary income	0.28	0.27	0.11	0.17	0.38	0.47	0.12	0.44
of which, shared	0.17	0.14	0.01	0.12	0.23	0.38	0.09	0.54
of which, non-shared	0.11	0.02	0.00	0.00	0.24	0.38	0.15	1.38
Non-monetary income	0.10	0.10	-0.13	0.05	0.37	0.37	0.13	1.31
Other	-0.08	-0.09	-0.11	-0.10	-0.03	-0.03	0.02	-0.25

TABLE 3. Descriptive statistics on Banco de Portugal's IBPT

Note: All figures presented as a percentage of GDP.
Sources: Banco de Portugal and Statistics Portugal (authors' calculations).

The income generated by investment activities not related with monetary policy oscillated between -0.13% of GDP in 2002 and 0.37% in 2015. Non-monetary income has been more volatile than monetary income, which mostly reflects the variability of the euro-dollar exchange rate and changes in sovereign debt risk premia. Monetary income and non-monetary income have shown a strong positive correlation during these years, something not surprising given that assets not related with monetary policy have corresponded mostly to short-term euro area sovereign debt securities.

5.1. Decomposition of shared monetary income

Figure 5 shows the evolution of the shared monetary income received by Banco de Portugal as a percentage of GDP and identifies the contributions from banknotes, minimum reserve requirements, shared monetary policy assets other than intra-Eurosystem claims and differences accruing from the conventions established in the monetary income distribution agreement.[22] Figure 6 presents the evolution of the main determinants of shared monetary income. As this depends on the income generated by all NCBs, we present balance sheet items for all NCBs (Eurosystem excluding ECB) expressed as a share of euro area GDP.

Shared monetary income oscillated between a maximum of 0.38% of GDP in 2008 and a minimum of 0.01% in 2021. In the period between 2002 and 2008 there was a significant increase in shared monetary income motivated almost exclusively by the income associated with banknotes. In this period, shared monetary income increased from 0.16% to 0.38% of GDP, reflecting both an increase of the policy rate (at the time, the MRO rate) from 3.2% in 2002 to 3.9% in 2008 (annual average values) and an increase of banknotes in circulation, which grew 81% in only 5 years.

Shared monetary income fell significantly in the midst of the great financial crisis, to only 0.11% of GDP in 2009. This decrease resulted mostly from the decrease in the policy rate to an annual average of 0.4%, which implied a substantial decrease of the income associated with banknotes. The decrease in the policy rate reflected the ECB Governing

22. As Banco de Portugal's share in the Eurosystem capital key is higher than Portugal's share on euro area's GDP, the shared monetary income received by Banco de Portugal as a share of GDP is slightly higher than the total shared monetary income as a share of euro area GDP.

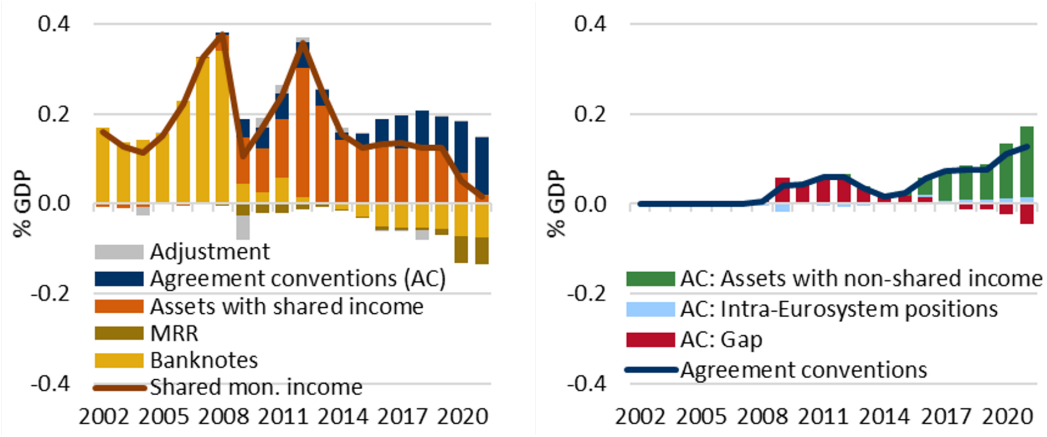

FIGURE 5: Decomposition of shared monetary income

Notes: The adjustment results mainly from annual corrections in the application of the semi-direct method. The cost with the MRR also includes the cost with excess reserves exempted from remuneration of a negative DFR since the introduction of the two-tier system in October 2019, assuming that all credit institutions have sufficient reserves to maximise this exemption. The right panel further decomposes the contribution from monetary income agreement conventions in three components. | Latest observation: 2021.
Sources: Banco de Portugal, European Central Bank and Statistics Portugal (authors' calculations).

council decisions regarding all key interest rates, but also the fact that the euro area started operating in an excess liquidity environment, where we assume that the policy rate is given by the DFR instead of the MRO rate. As a result of this change, all credit to financial institutions at the MRO rate became a net contributor to shared monetary income under our decomposition framework. The fact that some monetary claims are by convention remunerated at the MRO rate independently of market conditions also contributed positively to avoid a deeper reduction in shared monetary income. This is the case of the *gap*, which by 2009 accounted for roughly 5% of euro area GDP (Figure 6).

Amidst the sovereign debt crisis, the increase of credit to financial institutions and the asset purchases conducted under the SMP to address market fragmentation led to an increase in shared monetary income in 2011 and, especially, in 2012. Since this credit was granted at a rate above the policy rate, we identify it as a contribution from shared assets.

With the normalisation of interbank money markets in subsequent years, the contribution of assets with shared income gradually declined, stabilising at a level slightly above 0.10% of GDP between 2014 and 2019. In this period, monetary policy was characterised by the implementation of additional non-standard measures, namely the adoption of negative policy rates that justifies the negative contribution from banknotes in circulation and the implementation of large-scale asset purchases, mostly with non-shared income, which also implies an increase of some shared income under the pooling agreement that largely compensated the negative contribution of banknotes.

In the most recent years, shared monetary income has benefitted from an even more substantial contribution of the pooled component associated with sovereign debt securities purchased under PSPP and PEPP. This was more than offset by a significant

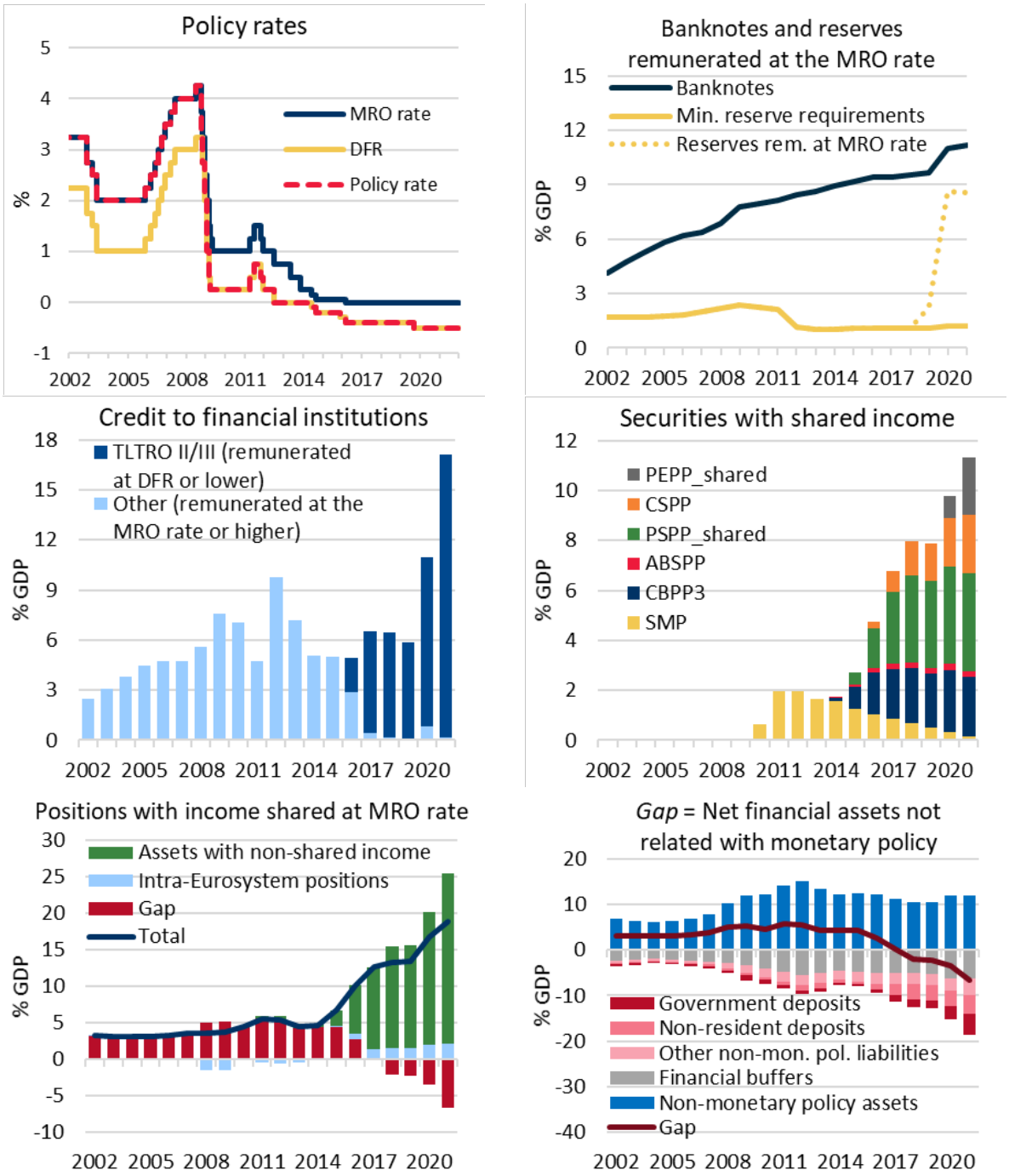

FIGURE 6: Main drivers of shared monetary income in the Eurosystem

Notes: Aggregates for all NCBs (Eurosystem excluding the ECB) expressed as a share of euro area GDP. Reserves remunerated at the MRO rate include MRR and excess reserves exempted from negative DFR since the introduction of the two-tier system in October 2019, assuming that all credit institutions are able to maximise this exemption. SMP – Securities Market Programme. CBPP3 – Covered Bond Purchase Programme 3. ABSPP – Asset-Backed Securities Purchase Programme. PSPP – Public Sector Purchase Programme. CSPP – Corporate Sector Purchase Programme. PEPP – Pandemic Emergency Purchase Programme. PSPP (PEPP) with shared income corresponds to 20% of total PSPP (PEPP) holdings (of public debt securities). Intra-Eurosystem positions correspond to the symmetric position of the ECB. | Latest observation: 2021.
Sources: European Central Bank and Eurostat (authors' calculations).

decline of the average return on shared assets, which was negatively affected by the specific conditions of TLTRO III, and the increasing cost of central banks' reserves with the implementation of the two-tier system.

Going forward, these negative effects on shared monetary income will likely be dissipated, mainly as a result of the higher policy rate, which directly benefits the income associated with banknotes. In addition, the ECB's decision to change the remuneration of TLTRO III operations from November 2022 onwards will reduce the negative contribution of these operation and will likely accelerate their redemption. However, this will be largely offset by a substantial decline of non-shared monetary income, which will likely turn negative for most NCBs, as the increase in the policy rate will in most cases surpass the average yield on sovereign securities purchased under the PSPP-GOV and PEPP-GOV.

5.2. *Decomposition of non-shared monetary income*

Figure 7 shows the evolution of Banco de Portugal's non-shared monetary income and identifies the contributions from the market return of non-shared assets and the net cost of holding these assets associated with monetary income agreement conventions.

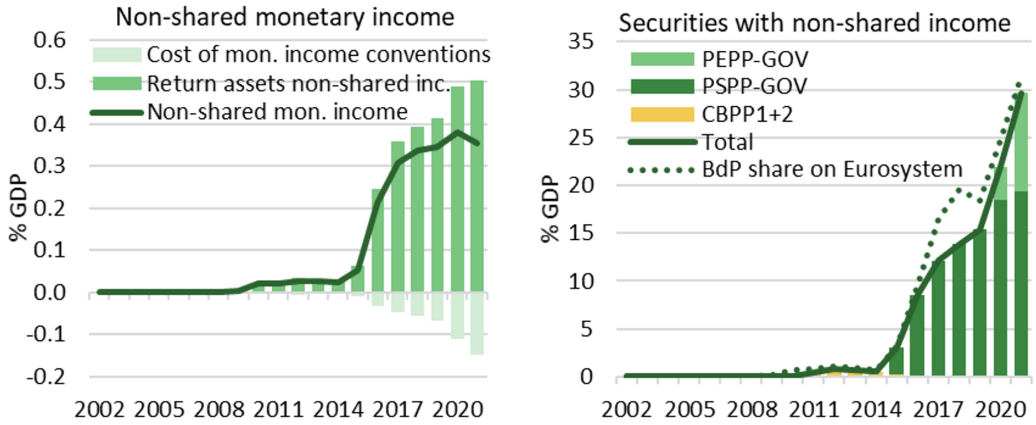

FIGURE 7: Decomposition and main drivers of Banco de Portugal's non-shared monetary income

Note: Latest observation: 2021.
Sources: Banco de Portugal and Statistics Portugal (authors' calculations).

The significant increase observed between 2015 and 2017 was driven by the implementation of large-scale purchases of sovereign debt securities under the PSPP-GOV at a rate substantially higher than the policy rate. Since then, the income generated from these assets remained relatively constant as a share of GDP, despite additional purchases under the PEPP-GOV, as the yield of new purchases was lower and not significantly higher than the MRO rate.

Interestingly, the cost of holding assets with non-shared income resulting from the monetary income agreement conventions (light green bars in Figure 7, left panel) was slightly lower than the contribution obtained from the share of Eurosystem's monetary income associated with these assets (green bars in Figure 5, right panel), which results

from the fact that Banco de Portugal's holdings under PSPP-GOV were lower than what would be given by the Eurosystem capital key (dotted line in Figure 7, right panel).

5.3. *Decomposition of non-monetary income*

Figure 8 shows the evolution of Banco de Portugal's non-monetary income and identifies the contributions from assets and liabilities not related with monetary policy, the *gap* and the financial buffers. Financial assets not related with monetary policy have contributed positively in most years, especially in the aftermath of the global financial crisis, which is likely related with the higher risk premia and higher stock of these assets observed at the time. More recently, this contribution has remained more contained given that the margin between the return on sovereign debt securities and the policy rate has been compressed. Nonetheless, the contribution remained above its historical average.

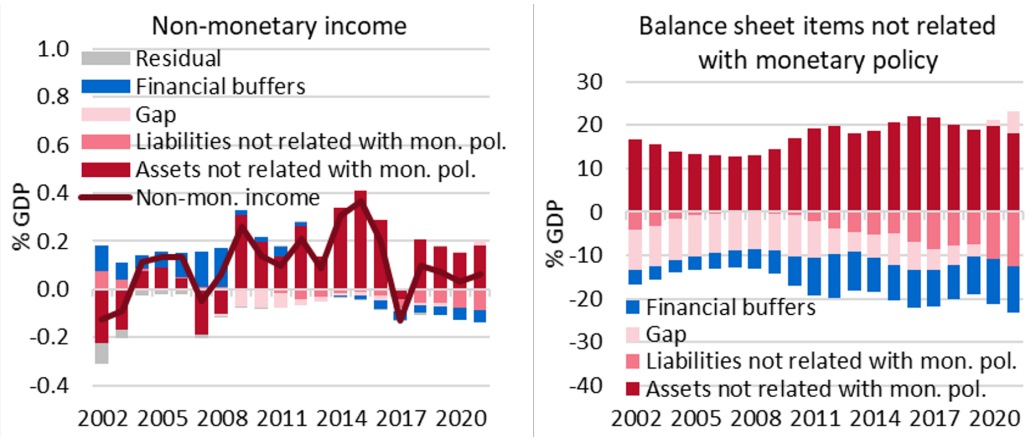

FIGURE 8: Decomposition and main drivers of Banco de Portugal's non-monetary income

Note: The residual results from the difference between total non-monetary income and the sum of the four estimated contributions, which for some components is proxied using annual average figures of interest rates and balance sheet items. | Latest observation: 2021.
Sources: Banco de Portugal and Statistics Portugal (authors' calculations).

The contribution from liabilities not related with monetary policy was relatively small up to 2011. This changed with the financial assistance program, mainly as a result of the significant increase of government deposits at Banco de Portugal. As these were largely remunerated above the policy rate, they imply a cost for the central bank that is highlighted under our decomposition framework. This was further intensified with the pandemic crisis.

As noted above, the contribution of the *gap* is only relevant in an excess liquidity environment, when the policy rate is different from the MRO rate, which we assume to have occurred only from late 2008 onwards. In this period, the contribution of the *gap* was almost always negative, especially between 2009 and 2011, when intra-Eurosystem liabilities were financing a substantial share of assets not related with monetary policy. This declined significantly thereafter, as other liabilities, namely government deposits, started playing a larger role. In particular, they turned positive in 2020-21, when the *gap* turned negative.

Finally, financial buffers typically contributed positively when the policy rate was positive but, similarly to banknotes in circulation, started having a negative contribution as the policy rate turned negative from 2014 onwards.

6. Concluding remarks

This article provides a novel decomposition of the profits of a NCB in the Eurosystem that clearly distinguishes the income generated from monetary policy decisions taken at the aggregate level, from that determined by national activities not directly related with monetary policy. Monetary income is also split between the component shared among all NCB's according to the Eurosystem capital key and that driven from assets with non-shared income. Finally, we decompose shared monetary income, non-shared monetary income and non-monetary income by comparing the return/cost of their components with the contemporaneous policy rate. These insights are useful to complement the usual income statement where the reported interest margin aggregates income related and not related with monetary policy.

When applied to the case of Banco de Portugal over the past 20 years, this decomposition clarifies that on average earnings were mainly determined by monetary income, while income from assets not related with monetary policy was of the same order of magnitude of other expenses, mainly administrative costs. Since the onset of large-scale asset purchases, we show that (i) the above-average Banco de Portugal profits have been mostly due to non-shared monetary income; (ii) shared monetary income has remained only slightly below historical average level despite the low interest rate environment; and (iii) income from activities not related with monetary policy remained similar to the historical average despite a gradual reduction.

Assessing the drivers of central banks' profits is important, especially at a time when these may come under pressure given the detrimental impact of higher interest rates. In our decomposition this will imply a significant decline of non-shared monetary income, which recently turned negative as a result of policy rates rising above the average return of sovereign debt securities in the balance sheet, and also of the net return of assets with shared income. This will be only partly compensated by higher income associated with banknotes that benefits from a higher policy rate.

In the Eurosystem, the primary objective of monetary policy is price stability. A consistent risk management framework is important to safeguard the credibility of the central bank in the long run, and avoid that other considerations, including concerns over short-term income losses, unduly affect monetary policy decisions. Clearly distinguishing the different sources of income, in particular those stemming from monetary policy decisions, may simplify modelling efforts that allow us to better project future income and assess risks going forward.

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Appendix: Derivation of a novel decomposition of national central banks' profits

A.1. Decomposition of income before provisions and taxes

Starting from the stylised versions of the balance sheet and the income statement presented in sections 2 and 3, the income before provisions and taxes of a NCB can be written as:

$$\begin{aligned} IBPT = & r^{MA^{Total}}.MA^{Total} - r^{ML^{Total}}.ML^{Total} + MI^{NetPooling} \\ & + r^{NMA}.NMA - r^{NML}.NML + Other \end{aligned}, \tag{A.1}$$

where MA^{Total} and ML^{Total} denote the book value of assets and liabilities related with monetary policy in the NCB balance sheet, NMA and NML denote the book value of assets and liabilities not related with monetary policy, $r^{MA^{Total}}$, $r^{ML^{Total}}$, r^{NMA} and r^{NML} represent, the rate of return of each of these aggregates, $MI^{NetPooling}$ represents the net result of the pooling of monetary income and, finally, $Other$ aggregates all other results.

The net result of the pooling of monetary income corresponds to the difference between the NCB rightful share on the Eurosystem shared monetary income, corresponding to its share in the Eurosystem capital key, k, multiplied by the Eurosystem shared monetary income, MI_{EUR}^{Shared}, less the national contribution to this income, which we denote by C. The latter is already registered in the NCB income statement before the net pooling income is computed. Substituting $MI^{NetPooling}$ by $k.MI_{EUR}^{Shared} - C$, one obtains,

$$\begin{aligned} IBPT = & r^{MA^{Total}}.MA^{Total} - r^{ML^{Total}}.ML^{Total} + k.MI_{EUR}^{Shared} - C \\ & + r^{NMA}.NMA - r^{NML}.NML + Other \end{aligned}. \tag{A.2}$$

Following the semi-direct method presented in section 3, each national central bank contribution to the Eurosystem shared monetary income is given by

$$C = r^{MA^{Shared}}.MA^{Shared} + MRO.MA^{NonShared} - r^{ML^{Total}}.ML^{Total} + MRO.Gap, \tag{A.3}$$

where $r^{MA^{Shared}}$ represents the rate of return on assets with shared income held by the NCB and MA^{Shared} denotes its book value.

Adding and substracting $r^{MA^{NonShared}}.MA^{NonShared}$, in order to aggregate the total income from assets related with monetary policy, and factoring out the assets with non-shared income, this can be written as

$$\begin{aligned} C = & r^{MA^{Total}}.MA^{Total} - \left(r^{MA^{NonShared}} - MRO\right).MA^{NonShared} - r^{ML^{Total}}.ML^{Total} \\ & + MRO.Gap \end{aligned}. \tag{A.4}$$

Substituting equation A.4 in equation A.2, and cancelling out the income from all assets related with monetary policy and costs with all liabilities related with monetary policy one obtains:

$$\begin{aligned} IBPT = k.MI_{EUR}^{Shared} + \left(r^{MA^{NonShared}} - MRO\right).MA^{NonShared} \\ + \left(r^{NMA}.NMA - r^{NML}.NML - MRO.Gap\right) + Other \end{aligned} . \quad (A.5)$$

A.2. Decomposition of shared monetary income

We start by noting that the contribution of each NCB for the pooling of monetary income (equation A.3) can be broken between the income generated by intra-Eurosystem claims, remunerated at the MRO rate, and the income generated by all other assets related with monetary policy, which may have different returns. In particular, the return on securities depends on the coupon and price at which they are purchased in the secondary market, while TLTRO may be remunerated below the MRO rate. We denote intra-Eurosystem claims by IC, other shared assets by $MA^{OtherShared}$ and the average remuneration of other shared assets as $r^{MA^{OtherShared}}$.

Regarding monetary policy liabilities, these can be broken between banknotes, intra-Eurosystem liabilities, minimum required reserves and excess reserves. These are denoted by M, IL, MRR and EL. Banknotes are not remunerated. Intra-Eurosystem liabilities and required reserves are remunerated at the MRO rate. Excess reserves are remunerated at the DFR rate.[23] Substituting these terms in equation A.3 one obtains,

$$\begin{aligned} C = MRO.IC + r^{MA^{OtherShared}}.MA^{OtherShared} + MRO.MA^{NonShared} \\ - [0.M + MRO.IL + MRO.MRR + DFR.EL] + MRO.Gap \end{aligned} . \quad (A.6)$$

Collecting most terms pooled at the MRO rate, we have:

$$\begin{aligned} C = MRO.\left(Gap + (IC - IL) + MA^{NonShared}\right) + r^{MA^{OtherShared}}.MA^{OtherShared} \\ - [0.M + MRO.MRR + DFR.EL] \end{aligned} . \quad (A.7)$$

Noting that the gap is the difference between liabilities and assets related with monetary policy, and thus $ML^{Total} - MA^{Total} - Gap = 0$, one may write:

$$\begin{aligned} C = MRO.\left(Gap + (IC - IL) + MA^{NonShared}\right) + r^{MA^{OtherShared}}.MA^{OtherShared} \\ - [0.M + MRO.MRR + DFR.EL] + PR.\left(ML^{Total} - MA^{Total} - Gap\right) \end{aligned} . \quad (A.8)$$

23. Since 2019, with the introduction of the two-tier system, a significant fraction of excess reserves were exempted from a negative DFR and thus effectively remunerated at 0. As the MRO rate was equal to 0 in this period, we lump this fraction of excess reserves with the minimum reserve requirements.

Then, collecting terms we obtain:

$$\begin{aligned} C = & PR.M + (PR - MRO).MRR + (PR - DFR).EL \\ & + \left(r^{MA^{OtherShared}} - PR\right).MA^{OtherShared} \\ & + (MRO - PR).\left(Gap + (IC - IL) + MA^{NonShared}\right) \end{aligned} . \quad \text{(A.9)}$$

Summing all NCBs contributions, we can define the aggregate Eurosystem shared monetary income as:

$$\begin{aligned} MI_{EUR}^{Shared} = & PR.M_{EUR} + (PR - MRO).MRR_{EUR} + (PR - DFR).EL_{EUR} \\ & + (r^{MA_{EUR}^{OtherShared}} - PR).MA_{EUR}^{OtherShared} \\ & + (MRO - PR).\left(Gap_{EUR} + (IC_{EUR} - IL_{EUR}) + MA_{EUR}^{NonShared}\right) \end{aligned} . \quad \text{(A.10)}$$

In the main text, the term on excess liquidity disappears because we assumed that in case of excess liquidity the policy rate is equal to the DFR. Excess liquidity represents an additional source of monetary income when it is positive and the policy rate is above the DFR, which may occur in the transition between the corridor and floor systems.

A.3. Decomposition of non-monetary income

Non-monetary income can also be further decomposed to highlight the contributions of portfolio investments, liabilities not related with monetary policy, the gap and financial buffers. We start with the split of non-monetary income included in equation A.5 above, simply noting that the cost of financial buffers is 0:

$$NMI = r^{NMA}.NMA - r^{NML}.NML - MRO.Gap - 0.Buffers. \quad \text{(A.11)}$$

Just as we did for the decomposition on shared monetary income, in order to understand the economic contribution of each component, we compare its remuneration with the policy rate. In order to do that, simply notice that $NMA - NML - Gap - Buffers = 0$, so we can subtract this expression, multiplied by the policy rate, to the previous equation, to obtain:

$$\begin{aligned} NMI = & \left(r^{NMA} - PR\right).NMA - \left(r^{NML} - PR\right).NML - (MRO - PR).Gap \\ & + PR.Buffers \end{aligned} . \quad \text{(A.12)}$$

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