EVALUATING THE MACRO-REPRESENTATIVENESS OF A FIRM-LEVEL DATABASE: AN APPLICATION FOR THE SPANISH ECONOMY

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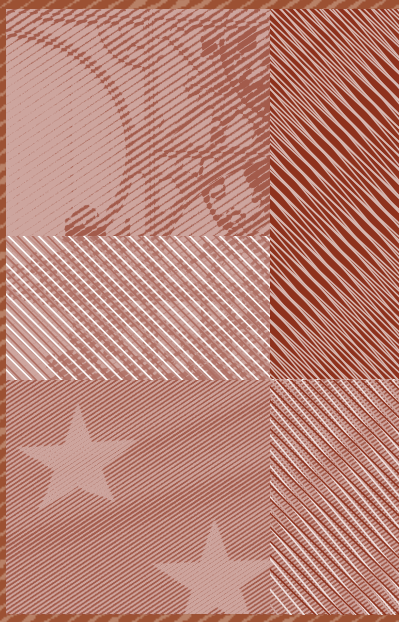

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Abstract

The availability of a firm-level database that represents the productive sector of an economy at the aggregate level is a necessary condition to undertake both reliable policy analysis and economic research in multiple areas. In this paper, we document the construction of a new representative firm-level dataset for Spain using detailed micro-level information provided by firms to the Spanish Commercial Registry and the Bank of Spain. A comparison with National Accounts figures serves to illustrate that the new micro-dataset is able to replicate the growth rates of output, employment and wage bill of the private sector. Using official statistics from the National Institute of Statistics (INE), we show that the resulting dataset covers more than 80% of firms registered in the census over the years 2000-2013 and, more importantly, the resulting dataset replicates the firm size distribution of the Spanish non-financial market economy. The same representativeness analysis is done for the manufacturing sector indicating that this sector is particularly well-represented in the dataset.

Keywords: firm data, firm size distributions, macroeconomic aggregates.

JEL classification: C81, E01, L11.

Resumen

La disponibilidad de una base de datos en el ámbito de empresa que sea representativa del sector productivo de una economía a escala agregada es una condición necesaria para realizar tanto análisis de política económica como investigación económica fiables en múltiples áreas. En este trabajo, se documenta la construcción de una nueva base de datos de empresas españolas utilizando información detallada a escala microeconómica proporcionada por las empresas al Registro Mercantil y al Banco de España. La comparación con los agregados que emergen de la Contabilidad Nacional sirve para ilustrar cómo la nueva base de datos de naturaleza microeconómica es capaz de replicar las tasas de crecimiento del producto, el empleo y la remuneración de asalariados del sector privado. Utilizando las estadísticas oficiales del Instituto Nacional de Estadística (INE), el análisis presentado muestra cómo la base de datos resultante cubre más del 80 % de las empresas registradas en el censo del DIRCE en el período 2000-2013 y, de manera más relevante, la base de datos es capaz de replicar la distribución de empresas por tamaño de la economía de mercado, excluyendo el sector financiero, de España. El mismo análisis de representatividad se realiza para el sector industrial, mostrando que este sector está particularmente bien representado en la nueva base de datos.

Palabras clave: datos empresariales, distribución de empresas por tamaño, agregados macroeconómicos.

Códigos JEL: C81, E01, L11.

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1 Introduction

It is a well-known fact that aggregate economic performance in the long-run strongly depends on firm-level decisions on labor and capital markets, as well as on firms' innovation and technological capacity. Economic analysis has long recognised that behind the observed aggregate behavior of the productive sector there is widespread heterogeneity in firms' behaviour that must be considered at both theoretical and empirical level (e.g., Bartelsman and Doms, 2000; Melitz, 2003).[1] This recognition highlights the limits of models based on representative agents pushing for research work that examines the causes and consequences of heterogeneity among firms on macro aggregates. Besides the required theoretical frameworks, the availability of high-quality microdata on firm's decisions and outcomes is crucial to be able to examine their impact on economic activity. At the same time, policy analysis has been recently enriched with the use of microdata on firms' decisions to examine the roots of the productivity differences among firms (e.g., Lopez-Garcia, di Mauro and CompNet, 2015). Indeed, the traditional use of macroeconomic data to make policy advice can be flawed in the presence of heterogeneity among agents. An aggregation problem can arise creating a misleading identification of macro channels that are rejected using rich microdata (e.g., Mian and Sufi, 2009, 2010). This paper aims to improve the quality and representativeness of the currently available micro-level datasets for the Spanish private productive sector for the period 2000-2013, building on the relative strengths of the existing datasets.

The micro-level firm dataset examined in this paper is built using the data from financial statements that all firms in Spain are required by law to submit annually to the Commercial Registry (*Registro Mercantil* in Spanish).[2] This information has an administrative nature and it is highly reliable, as firms are bound by law to provide accurate information on their financial situation. Failure to do so can result in fines and even criminal charges. Indeed, the tax administration routinely cross-checks the information provided in these financial statements with corporate income tax returns submitted by firms to ensure that they are consistent. The Commercial Registry regularly

[1] Early papers accounting for firm-heterogeneity in macroeconomic models date back to the late seventies and early eighties (see, for instance, Lucas, 1978; Jovanovic, 1982). However, over the last decade firm-heterogeneity has played a more prominent role in the theoretical and empirical literature given the availability of micro-datasets.

[2] Firms submit their statements to the commercial registry office located in the province where the firm's headquarters are located (i.e. *registros mercantiles provinciales*). These offices compile and process all the information that is publicly available at both the Central Commercial Registry (*Registro Mercantil Central*, `http://www.rmc.es/`) and the Association of Registrars (*Colegio de Registradores*, `https://www.registradores.org/registroonline/tramites/mercantil/estadisticas.seam`)

transfers to the Bank of Spain digitalized raw data on the financial statements submitted by firms. The Statistical Department of the Bank of Spain then processes and cleans this raw data according to exhaustive statistical and accounting criteria (Central de Balances, 2017*a*,*b*) that results in a dataset denominated *Central de Balances Integrada* (*CBI*). This database is only available for in-house economists and external researchers working in collaborations with the Bank's staff in selected investigation projects. In spite of the continuous efforts to improve and expand this dataset, the Bank of Spain dataset does not cover the universe of private-sector firms because it excludes firms that submit information late (after the regular submission deadline) or on paper.[3]

In order to expand the coverage of their micro-firm level dataset, the Bank of Spain acquired the SABI database (Iberian Balance-Sheet Analysis System), owned by the market-research company *Informa-Bureau van Dijk* (`http://www.informa.es/en`), which constitutes the Spanish input for the worldwide used Amadeus and Orbis datasets. This dataset is built using the same source of data, the financial statements submitted by firms to the Commercial Registry, and has the potential advantage of covering large and medium-sized firms that submit their statements either late or on paper. Given the careful treatment and compilation of the raw data done by *Informa*, this opens the possibility to combine this dataset with the one owned by the Bank of Spain in order to increase the sample size and the information reported by firms. The final goal of merging the available information in both datasets is to obtain a large micro dataset of Spanish firms that is representative of the aggregate behavior of both employment and production for the market economy from 2000 to 2013.

We evaluate the coverage and representativeness of the resulting dataset, henceforth called *BdE-extended dataset*, comparing it to official statistics from the National Institute of Statistics (INE) on the census of registered firms constituted as legal entities, and thus excluding businesses registered as self-employed entities. To examine the coverage and representativeness of the *BdE-extended dataset*, we undertake three main statistical analyses: i) examine the yearly and full-sample coverage in terms of registered firms, aggregate wage-earners full-time equivalent employment and their wage bill; ii) compare

[3] In order to address this issue, the Bank of Spain's Statistics Department has undertaken a reweighting process of the available firm-level observations to ensure that the dataset is representative of the full population of Spanish firms and consistent with official statistics. This reweighting procedure has been applied, when necessary, in analyses performed by Central de Balances Division while, in some cases, analysts have chosen to work with the original dataset without applying any reweighting to maximize the available sample size. Central de Balances Division has recently undertaken additional actions to include in future versions of the CBI database some of the missing companies to which this document refers.

the dynamics of employment, wage bill and production reported in National Accounts with the aggregate evolution that results from adding micro-data reported by firms in their financial statements; and iii) analyze the representativeness of the firm size distribution, defined in terms of employees, that emerges for the microdata. We undertake this analysis for the non-financial market economy and also for the manufacturing sector. We put special attention on manufacturing because of the relevance of this sector to examine productivity and misallocation of resources in the economy.

The results show the remarkably high coverage of the merged database, cleaned of outliers and inconsistent observations, with rates above 80% of registered firms for the market economy and above 85% for the manufacturing sector, being these ratios fairly constant over the time period. In terms of macro aggregates, the firm-level dataset also reaches high and stable coverage ratios for both wage-earners employment and remuneration of workers (see Tables 1 and 2) with average ratios of, respectively, 77% and 80% for the non-financial market economy and 78% and 85% for the manufacturing sector. Besides the good aggregate coverage, the analysis shows that the *BdE-extended dataset* results over time in a representative firm size distribution of the economy and the manufacturing sector according to the employment size categories reported in the official statistics (see Tables 3 and 4).

The good cross-sectional behavior of the BdE dataset is complemented with its high predictive power of the dynamics of the main macro aggregates (see Figures 1 to 3). In fact, the correlation between micro-aggregated employment, wage-bill and output growth that emerge from the firm-level dataset and their counterparts in National Accounts is 0.91, 0.96 and 0.96 respectively for the non-financial market economy; and 0.94, 0.94 and 0.97 respectively for the manufacturing sector. It is important to note that all these results hold once we discard unreliable observations and outliers detected in the robustness analysis. The exhaustive cleaning undertaken, that is sounded in robustness exercises, reduces in 5 percentage points the aggregate coverage of registered firms, although it remains high at 80%, but improves the representativeness of the dataset and its predictive power of the macro dynamics. Taken together, the statistical analyses indicate that combining the Bank of Spain and the SABI databases we obtain a dataset with a very high coverage of Spanish firms that is representative for a set of relevant economic indicators for the Spanish non-financial market economy and the manufacturing sector over the period 2000-2013.

The main contribution of this paper consists of documenting both the construction and the representativeness exercises of the micro-dataset used by the Bank of Spain to

undertake policy and research analysis using firm-level data. As recently stressed by the influential analysis done by Kalemli-Ozcan et al. (2015), in order to validate the reliability of the analysis with micro-level firm data it is crucial to assess the representativeness and coverage of the microdatasets used in those studies. The improvement in the representativeness of this micro-level dataset of Spanish firms will allow researchers to tackle relevant research and policy questions for the Spanish economy that have been recently analyzed for other advanced economies where datasets covering the universe of firms are available. Indeed, the literature investigating the micro-foundations of aggregate fluctuations has already shown that firm-level data delivers crucial information for understanding the drivers of aggregate productivity for the US economy (Fernald, 2015; Jones, 2016). A non-exhaustive list of topics for further research covered by this micro-founded investigation includes testing the main theoretical and empirical hypothesis raised in international trade (Melitz, 2003), the novel literature on misallocation of resources (Hsieh and Klenow, 2009) or new research on the aggregate impact of size-dependent regulations (Guner, Ventura and Xu, 2008; Gourio and Roys, 2014; Garicano, Lelarge and VanReenen, 2016). Turning to the case of Spain, some work has been already done exploiting the heterogeneity in firms' behavior. As an example, recent research illustrates the importance of firm-level heterogeneity for explaining the dismal performance of aggregate productivity growth (Gopinath et al., 2017; Garcia-Santana et al., 2016) and the welfare effects of tax enforcement policies (Almunia and Lopez-Rodriguez, 2018). However, there is ample space for new research and relevant policy analysis on the Spanish economy using micro-analysis.

The rest of the paper is organized as follows. Section 2 explains the process of cleaning and merging of available micro datasets. Section 3 discusses the representativeness of the dataset in terms of its coverage of the macro-aggregates as well as its predictive power on the dynamics of output, employment and wage-bill. Section 4 examines the ability of the Bank of Spain dataset to replicate over time the firm-size distribution in terms of employment. Section 5 presents the representativeness analysis for the manufacturing sector. Section 6 concludes.

2 Datasets: Cleaning and Merging Process

Spanish firms must submit by law their financial statements to the Commercial Registry. The Bank of Spain reached an agreement with the Association of Registrars of Spain to obtain the available information on firms' statements submited on time and digitalized

since 1991.[4] However, the full information on the universe of firms is not covered because some firms submit the financial statements only in paper and are thus not digitalized, and also because some firms submit their statements after the submission deadeline, in which case the Bank of Spain may not receive them.

The *Central de Balances* Division from the Statistical Department of the Bank of Spain has made a big effort to process the raw data, homogenize accounting concepts across time and clean the data received from the Commercial Registry. In particular, the most relevant and highly valuable analysis done by the Statistical Department of the Bank of Spain is the assessment of each individual firm statement's reliability in terms of its internal consistency. Indeed, firms with more than 5% discrepancies in the balance sheets items or inconsistencies between total assets, liabilities and net wealth are labelled as "unsuitable" for statistical analysis. Besides this, systematic analysis at firm level of the consistency between number of employees and wage payments is routinely done, as well as a cross-check of the monetary units in which each of the statements is reported.[5] Finally, the voluntary cooperation of a subset of economically relevant firms with the *Central de Balances* Division allows Bank of Spain's analysts to clarify and expand the information submitted by these firms in their financial statements, and also allows to deal with complex operations such as mergers and divisions among different companies.[6] To sum up, the *Central de Balances* Division undertakes an exhaustive data digitalization process and multiple cross-checks to ensure that the information reported by firms is complete and accurately recorded in its files. The resulting micro database is called *Central de Balances Integrada* (CBI).[7]

In spite of that effort, CBI coverage of firms' data is constrained by the data reception limitations previously exposed. In order to improve their dataset coverage, the Bank of Spain acquired the SABI database, which comprises the full set of information on Spanish

[4]The Commercial Registry has made a significant effort to facilitate the digital submission of financial statements by firms since the year 2000. According to the Statistical Process Centre of the Association of Registrars, the rate of digital submissions of financial statements rose from less than 20% in 2002 to 80% in 2013 (Meléndez, 2017).

[5]When discrepancies between reported items are detected, e.g. expenditures in thousands and assets in millions or in levels, firms are labelled as observations with "unreliable" units. These firms represent around 1% of the BdE sample and we drop them from the dataset.

[6]The information for this subset of firms is compiled in the database called *Central de Balances Anual* (CBA) that is integrated in the CBI database. The subset of firms included in CBA is small in number (around 10,000 in 2016 over a census of more than 1 million of firms) but they represent on average more than 30% of total gross value-added. See Central de Balances (2017*a*) for further details on the information contained in this database.

[7]An exhaustive description of the data sources, construction database criteria and also the statistical procedures and accounting treatment of information can be found at Central de Balances (2017*a*,*b*).

firms for which *Informa* has data as of April 2016. *Informa* is owned by *Bureau van Dijk* and it is the official data provider for Spain and Portugal to the extensively worldwide used Amadeus and Orbis datasets. In particular, the acquired sample contains all the information included in CD vintages and internet plus other information that is not uploaded in the online version of the database. This exhaustive dataset does not require performing the long merging process of available subsamples for Orbis and Amadeus datasets as analysts must do to construct the full database as explained in Kalemli-Ozcan et al. (2015). The SABI database is well-suited to complement the Bank of Spain dataset because *Informa* puts special emphasis on reaching the maximum coverage of large and medium-sized firms, given the potential market appeal of having these firms to undertake financial and market analysis. Indeed, *Informa* periodically buys packages of financial statements to cover missing firms in its database, digitalizes financial statements and carefully treats and analyzes all the information received. The main limitation of using the SABI dataset to examine the aggregate behavior of the market economy is the lower coverage of small firms, which are better represented in the CBI dataset.

Against this background, we combine the CBI and SABI datasets to take advantage of their complementarities in order to maximize the coverage of the resulting database. In the merging process, we sequentially follow two strategies to deal with the micro-data without manipulating the original data reported by firms. First, we undertake a simple and generic cleaning procedure aiming to eliminate outliers and remaining reporting mistakes that are common in large-scale microdatasets. Second, given the quality filters and cleaning undertaken in CBI and also the careful individual digitalization done by SABI, we do not make additional individual analysis of firm-level data but combine all available data reported by firms in both datasets to maximize coverage. This self-contained cleaning strategy is rationalized to preserve a broad dataset that allows, for instance, studies which are focused on a small subset of variables to have the largest possible sample size, without missing companies due to outliers in variables that they do not use. In any case, the resulting dataset of the merging process is not a faultless database. Indeed, each analysts will have to make her own decisions on how to combine and statistically treat the available firm-level information in order to address the policy or research question she is intended to answer.[8]

[8] As an example, analysts should take into account several changes in accounting regulations that may have affected the definition of certain variables in order to work with an homogeneous definition of economic concepts over time. See for instance (Central de Balances, 2017*a*,*b*) for a discussion on the accounting criteria harmonization of economic variables undertaken by the *Central de Balances* Division

The first step in the merging process consists of performing a simple cleaning strategy to eliminate potential outliers. The same criteria are applied to both datasets. First, we drop observations with employment and output reported as either negative or above the maximum reported values in the population. The latter criterion consists of identifying the maximum firm size in terms of employment and output per year and discard firms recorded as being above these census top values. Second, in order to discard extreme productivity observations, we replace output by a missing value for those firms with less than 50 employees and whose output/employees ratio is above the percentile 99.5 in the sample (i.e. small firms with unusually high labor productivity). Analogously, we replace employment by a missing value for those firms with more than 50 employees and whose output/employees ratio is below the percentile 0.5 in the sample (i.e. large firms that appear to have unusually low productivity). The rationale for these two criteria is that small firms with huge productivity ratios are suspicious of having undetected misreported output units; also, large firms with excessively low productivity ratios are candidates for having misreported employment figures. In all those cases, we replace the corresponding variable by a missing value but the remaining variables of the firm are kept in the database. We focus the analysis on the private productive sector of the economy and thus exclude firms whose main sector of activity is either the financial sector or it is related with the public sector (health, education, social services, defense, social security and public administration), as well as domestic use and professional activities that are sectors where firms are a minority with respect to households and self-employed. Finally, we exclude data from 1995 to 1999 given the relatively poorer quality and coverage of firms' information for those years.

The merging process of CBI and SABI datasets is conducted firm by firm and variable-by-variable in order to maximize coverage. Firms that exclusively appear in one of the datasets and overcome the statistical filters are incorporated in our database. Information from firms that appear in both datasets is combined in order to get the maximum amount of information for all variables reported in the financial statements.[9] As a result of the merging process, we expand the sample size the Bank of Spain database with SABI data to create a combined dataset with the maximum number of observations, aiming to represent the aggregate behavior of the productive private sector. The resulting micro-dataset has a panel structure from 2000 to 2013 with 13,5 millions of observations and includes for each firm: business name, fiscal identifier, 5-digit zipcode location, sector of activity (4-digit

[9]This implies that, for instance, a firm that has missing employment in SABI but not in CBI, and missing output in CBI but not in SABI is included in the dataset as a result of using employment from CBI and output from SABI (or vice versa).

CNAE-2009 code), and a selection of the most relevant and commonly used variables in both research and policy analysis that are reported in the Balance Sheet and Profit and Loss Account. In particular, the core dataset cleaned for economic analysis contains information for each firm on (i) annual net operating revenue; (ii) material expenditures, i.e. the cost of all raw materials and services purchased by the firm in the production process; (iii) labor expenditures, which accounts for the total wage bill of a firm, including social security contributions; (iv) total assets; (v) fixed assets; (vi) value-added; (vii) accounting profit before taxes, i.e. the gross profit reported in the corporate income tax (CIT); (viii) operating profit; (ix) corporate income tax expenditure; and (x) financial expenditures. The rest of information reported by firms in the Balance Sheet and the Profit and Loss Account are also available to download for analysts in either the CBI platform located in the Bank of Spain, or the on-line version of SABI.

3 Output and Employment: Coverage and Dynamics

In this section we first examine the yearly and the full-sample coverage of the firm-level *BdE-extended database* in terms of registered firms, aggregate wage-earners full-time equivalent employment and their wage bill with respect to the publicly reported official data. Second, we compare the dynamics of employment, wage bill and production reported in National Accounts with the aggregate evolution that results from adding micro-data reported by firms in their financial statements.

The official number of firms' data come from DIRCE Census on Business that is the one reported for Spain in Eurostat Structural Business Statistics.[10] Official data on employment, production and wage bill come from Production and Generation of Income Accounts by Branches of Activity included in National Accounts reported by the Spanish National Institute of Statistics (INE). We focus the analysis on firms that operate in the non-financial market economy and thus using data from the Production and Generation of Income Accounts we are able to discard production, employment and wage bill from i) public sector activities (public administration and defense, social security, health, education and social services activities); ii) financial sector activities; and iii) domestic use, professional and association activities.

To evaluate the macro-representativeness of the yearly average employment reported by firms in their financial statements, we use data on salaried employment by branches of activity (i.e. aggregate labor measure that excludes self-employed workers). This

[10] See section 4 for a detailed discussion on DIRCE Census.

magnitude is a full-time equivalent measure of employment by wage earners that is well-suited for comparisons with the average number of employees included in the financial statements. The yearly average wage bill in the BdE dataset is computed as the sum of firms' reported labor expenditures (wages and social security contributions). This micro-aggregated average wage bill is compared with the aggregate remuneration of wage earners from National Accounts. To assess the output dynamics, we use production data from the Production and Generation of Income Accounts. The micro-aggregated output in the BdE dataset is computed as the sum of firms' reported net operating revenue, although we make an important adjustment for firms undertaking wholesale activities as well as those operating in the real-estate sector. In fact, for firms whose main activity is in those sectors, we replace sales by reported profit margin in order to make it comparable with the definition of production in terms of National Accounts in that sector of activity.

The coverage results for both the yearly and the pooled 2000-2013 samples (see Table 1) show the remarkably high coverage of the database, cleaned of outliers and inconsistent observations, with rates above 80% of registered firms for the non-financial market economy being these ratios fairly constant over the time period. In terms of macro aggregates, the firm-level dataset also reaches high and stable coverage ratios for both wage-earners employment and remuneration of workers with average ratios of, respectively, 77% and 80% for the pooled data sample (2000-2013).

Besides the good aggregate coverage of the firm-level dataset, we evaluate the ability of the micro database to replicate the macro aggregates of production, employment and wage bill over the business cycle. This exercise focuses on dynamics and it is particularly relevant for any research that has a macroeconomic perspective. In particular, it evaluates whether the composition of the dataset is biased towards a certain subset of firms that dynamically behave differently than the rest of the economy. The analysis shows that the BdE dataset exhibits a high predictive power of the dynamics of the main macro aggregates (see Figures 1a, 2a and 3a). In fact, the correlation between micro-aggregated employment, wage-bill and output growth that emerge from the firm-level dataset and their counterparts in National Accounts is 0.91, 0.96 and 0.96 respectively for the non-financial market economy. It is important to notice that all these results hold once we discard unreliable observations and outliers detected in the robustness analysis. Indeed, the exhaustive cleaning reduces in 5 percentage points the aggregate coverage of registered firms, although it remains high at 80%, but improves the representativeness of the dataset and its predictive power of the macro dynamics.

4 Firm Size Distribution of Employment Categories

Evaluating the representativeness of a firms' micro database critically depends on its ability to replicate the firm size distribution (FSD) in terms of employment reported in the official statistics. By firms we consider businesses constituted as legal entities in the form of Corporation (*Sociedad Anónima*, SA), Limited Liability Companies (*Sociedad Limitada*, SL) and cooperatives. We focus the analysis on entities that operate in the non-financial market economy, i.e. exclude legal entities whose main sector of activity is either the financial sector or it is related with the public administration, as well as domestic use and professional activities.

To assess the coverage of the micro-dataset by ranges of employment we use the employment distribution by type of legal entity reported by the Central Business Register (DIRCE) that is the Business Census for Spain reported in Eurostat Structural Business Statistics.[11] It is important to notice that the DIRCE Census uses a slightly different method to calculate the number of employees than the one mandated by law in the financial statements. Indeed, DIRCE reports the total number of employees at the end of the year, without adjusting for the existence of temporary and part-time employees. Instead, financial statements report the average number of full-time equivalent employees throughout the year, considering temporary workers as a fraction of full-time workers. In spite of this methodological difference, the DIRCE Census is well-suited to evaluate the relative representativeness of the *BdE-extended dataset* over time given the stability of these differences during the sample period.

Table 3 shows the average coverage rates by five size categories of employment from 2000 to 2013 (yearly and pooling samples). The table shows the high coverage of the dataset for small, medium and large firms with averages above 85% for firms with more than 10 employees. The left tail of the distribution populated by the smallest firms (i.e. average employment in the 0-9 range) exhibits relatively poorer representation with an average ratio of 75% in the pooled data sample. This lower coverage is due to both the concentration of missing data in employment among this category class and the relatively worse quality of their reported data. The latter increases the probability of being discarded once tagged as an outlier or inconsistent observation by the statistical filters exposed above. It is worth noting the jump in the coverage for small-medium firms in the range 20 to 49 (average ratio of 93%) and then the relative fall for larger firms with

[11] DIRCE Census data on employment size distribution by type of legal entity is available at `http://www.ine.es/jaxiT3/Tabla.htm?t=299&L=0`. The details on the construction of DIRCE register can be found at `http://www.ine.es/metodologia/t37/t3730201.htm`.

employment above 50 (average ratio of 87%). This gap can be rationalized by the methodological differences in the employment definition used in the DIRCE Census. Indeed, the average employment reported in the financial statements is a more conservative measure of employment given the stricter counting of temporary workers. This should create a leftward displacement in the FSD distribution of the *BdE-extended database* with respect to the DIRCE one. This factor could explain the over-representation of firms in the range 10-49 in the *BdE-extended dataset*, with respect to the census data, and consequently also an under-representation of big firms. Nevertheless, the methodological differences are homogeneous during the full period guarantying the validity of the representativeness analysis given the stability of the employment distribution over time. Notice that the relative coverage among the different employment size categories is stable over time indicating the ability of the *BdE-extended dataset* to replicate the relative FSD in terms of employment and discarding the existence of a sample-size bias in the database.

5 Manufacturing Sector

In this section we replicate for the manufacturing sector the representative analysis undertaken for the non-financial market economy in sections 3 and 4. We put special attention on manufacturing because of the relevance of this sector to examine productivity and misallocation of resources in the economy.

The coverage results for the manufacturing sector (see Table 2) show an average coverage ratio of registered firms above 85% for the pooled data sample (2000-2013). The ratios in the annual data samples are fairly constant over the time period although the coverage tends to grow over time. In terms of macro-aggregates, the firm-level dataset for the manufacturing sector also reaches high and stable coverage ratios for both wage-earners employment and remuneration of workers with average ratios of, respectively, 78% and 85% for the pooled data sample. Besides the good aggregate coverage of the manufacturing sector, the analysis shows that over time the *BdE-extended dataset* results for this sector in a representative firm size distribution according the employment-size categories reported in the official statistics. Table 4 shows the average coverage rates by five size categories of employment from 2000 to 2013 (yearly and pooling samples). The table shows the high coverage of the dataset for employment categories with averages ratios above 90% for firms with more than 10 employees. As in the case of the non-financial market economy, the smallest firms with average employment in the 0-9 range exhibit the poorer representation in the distribution for the same reasons discussed in the previous section (i.e. concentration of missing data and relatively worse quality of the

reported data). The evidence also indicates that the relative aggregate coverage of the number of firms within each employment-size category is stable but, particularly since 2008, increasing over time. Overall, the *BdE-extended dataset* is able to replicate the relative FSD in terms of employment for the manufacturing sector.

We also evaluate the ability of the firm-level database to replicate for the manufacturing sector the macro aggregates of production, employment and wage bill over the business cycle. The analysis shows (see Figures 1b, 2b and 3b) the high predictive power of the macro aggregates dynamics reported in National Accounts that results from aggregating micro-data on employment, wages and production reported by firms in their financial statements. Indeed, the correlation between micro-aggregated employment, wage-bill and output growth that emerge from the firm-level dataset and their counterparts in National Accounts is 0.94, 0.94 and 0.97 respectively for the manufacturing sector.

6 Conclusions

This paper has documented the construction of a representative firm-level dataset of the Spanish non-financial market economy from 2000 to 2013. Using financial statements that firms annually submit to the Commercial Registry, we have built a dataset with rich information on firms' economic activity in terms of both flows and stocks that replicates over time the firm-size distribution by employment categories as well as the dynamics of production, full-time equivalent employment of wage earners and their wage bill according to the official statistics provided by the National Institute of Statistics of Spain (INE). The empirical exercises presented in the paper have shown that the manufacturing sector is particularly well-represented in the dataset. The latter is particularly relevant given that this sector, according to the economic literature, is the critical branch of activity to examine productivity dynamics and misallocation of resources.

The availability of this new representative firm-level dataset opens the door to combine it with other firm-level databases already available for research when these datasets share the same fiscal identifier for firms. The potential gains of combining different sources of micro-data information could allow analysts to exploit the heterogeneity of firms' behavior over time in order to obtain a better understanding of relevant policy issues for Spain that have been recently analyzed for other advanced economies. Indeed, studying the determinants of firms' investment and productivity, the roots of corporate credit cycles or the dynamics of exports over the business cycle, are promising avenues for new research using microeconomic analysis. In any case, each analyst will have flexibility to make her own decisions on how to combine and statistically treat the available firm-level information in order to address the policy or research question she intends to answer.

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Tables

Table 1: Employment, Wage Bill and Firms Coverage 2000-2013

Non-Financial Market Economy

	Employment	Wage Bill	Firms
Pooled Data			
2000-2013	76.7	80.3	82.0
Annual Data			
2000	66.2	78.5	72.4
2001	71.3	80.4	73.3
2002	74.2	81.8	79.1
2003	75.6	82.2	83.2
2004	76.8	81.8	83.8
2005	78.4	82.3	85.0
2006	80.6	83.3	85.0
2007	76.9	80.5	83.6
2008	78.0	79.1	84.1
2009	79.6	78.9	83.4
2010	79.1	78.1	82.9
2011	79.7	79.6	83.0
2012	78.3	78.5	82.8
2013	79.3	78.8	77.3

Note: Each cell corresponds to the coverage, expressed as a percentage with respect to the official census, of full-time equivalent employment, wage-earners remuneration and number of firms, respectively, in the non-financial market economy of the Bank of Spain database relative to the data publicly reported by the Spanish National Institute of Statistics (INE). Official data on employment and wage bill come from Production and Generation of Income Accounts by Branches of Activity and the number of firms data come from DIRCE Census on Business that is the one reported in Eurostat Structural Business Statistics.

Table 2: Employment, Wage Bill and Firms Coverage 2000-2013

Manufacturing Sector

	Employment	Wage Bill	Firms
Pooled Data			
2000-2013	77.6	84.5	85.8
Annual Data			
2000	70,2	84.7	77.9
2001	72.5	84.7	81.7
2002	74.8	86.3	84.7
2003	75.7	86.3	83.2
2004	76.5	86.8	85.2
2005	77.1	85.7	83.1
2006	79.7	85.6	84.5
2007	79.3	82.9	86.9
2008	79.7	83.2	87.0
2009	81.6	84.8	89.3
2010	80.4	82.8	90.8
2011	80.4	82.8	90.9
2012	79.8	83.4	88.4
2013	79.3	82.5	87.0

Note: Each cell corresponds to the coverage, expressed as a percentage with respect to the official census, of full-time equivalent employment, wage-earners remuneration and number of firms, respectively, in the manufacturing sector of the Bank of Spain database relative to the data publicly reported by the Spanish National Institute of Statistics (INE). Official data on employment and wage bill come from Production and Generation of Income Accounts by Branches of Activity and the number of firms data come from DIRCE Census on Business that is the one reported in Eurostat Structural Business Statistics.

Table 3: Firm Size Distribution by Employment Categories 2000-2013

Non-Financial Market Economy

	0 to 9	10 to 19	20 to 49	50 to 200	> 200
Pooled Data					
2000-2013	75.1	88.1	92.8	87.0	87.4
Annual Data					
2000	63.1	73.6	78.7	75.4	78.9
2001	71.9	79.1	83.2	80.1	82.2
2002	77.8	83.2	88.8	85.0	81.0
2003	80.0	84.4	91.4	87.4	83.5
2004	81.7	86.9	90.6	88.3	81.8
2005	83.3	87.9	91.8	87.1	83.3
2006	79.7	89.3	93.3	88.1	81.9
2007	76.1	85.3	89.4	83.5	78.6
2008	74.9	92.3	98.4	88.2	98.3
2009	75.3	97.2	98.9	89.7	99.8
2010	75.1	94.8	99.5	91.3	98.6
2011	75.4	97.7	99.1	92.4	98.6
2012	69.8	91.6	99.0	90.2	89.2
2013	67.4	90.5	96.7	91.1	88.5

Note: Each cell corresponds to the coverage of the number of firms by employment size-category, expressed as a percentage with respect to the official census of firms in that size-category, in the non-financial market economy of the Bank of Spain database relative to the data publicly reported by the Spanish National Institute of Statistics (INE). Official data on the number of firms come from the DIRCE Census on Bussiness that is the one reported in Eurostat Structural Business Statistics.

Table 4: Firm Size Distribution by Employment Categories 2000-2013

Manufacturing Sector

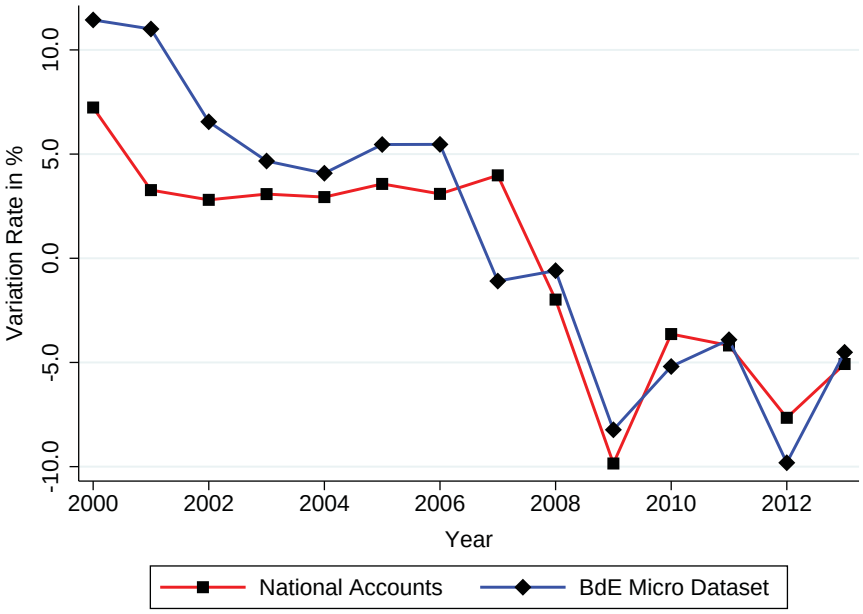
	0 to 9	10 to 19	20 to 49	50 to 200	> 200
Pooled Data					
2000-2013	73.6	90.7	92.4	90.8	94.8
Annual Data					
2000	56.9	76.9	82.2	80.5	87.0
2001	63.5	81.0	86.0	81.2	88.4
2002	67.8	84.8	90.4	87.8	86.2
2003	68.3	85.6	89.4	87.5	92.1
2004	71.8	87.9	91.8	89.0	90.3
2005	74.3	89.1	90.2	83.3	95.2
2006	73.8	91.4	90.5	85.0	94.9
2007	76.3	90.5	91.5	92.7	94.5
2008	76.8	98.7	97.2	97.7	100.0
2009	80.1	98.9	97.7	97.0	99.4
2010	81.3	98.0	99.6	96.8	99.5
2011	82.5	99.8	99.9	96.3	100.0
2012	79.2	95.1	95.2	97.2	100.0
2013	78.0	92.4	92.8	98.9	99.9

Note: Each cell corresponds to the coverage of the number of firms by employment size-category, expressed as a percentage with respect to the official census of firms in that size-category, in the manufacturing sector of the Bank of Spain database relative to the data publicly reported by the Spanish National Institute of Statistics (INE). Official data on the number of firms come from the DIRCE Census on Bussiness that is the one reported in Eurostat Structural Business Statistics.

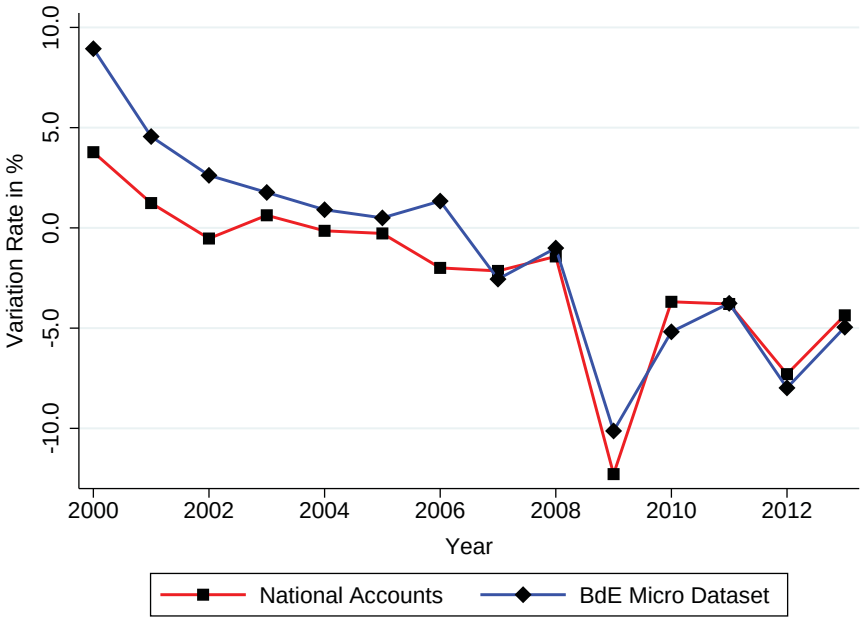
Figures

Figure 1: Employment Dynamics

(a) Non-Financial Market Economy



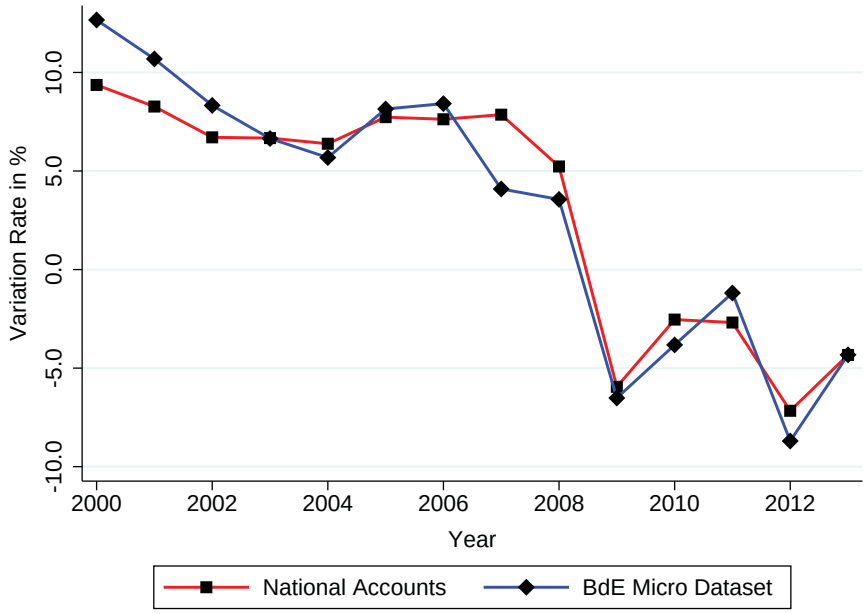
(b) Manufacturing Sector



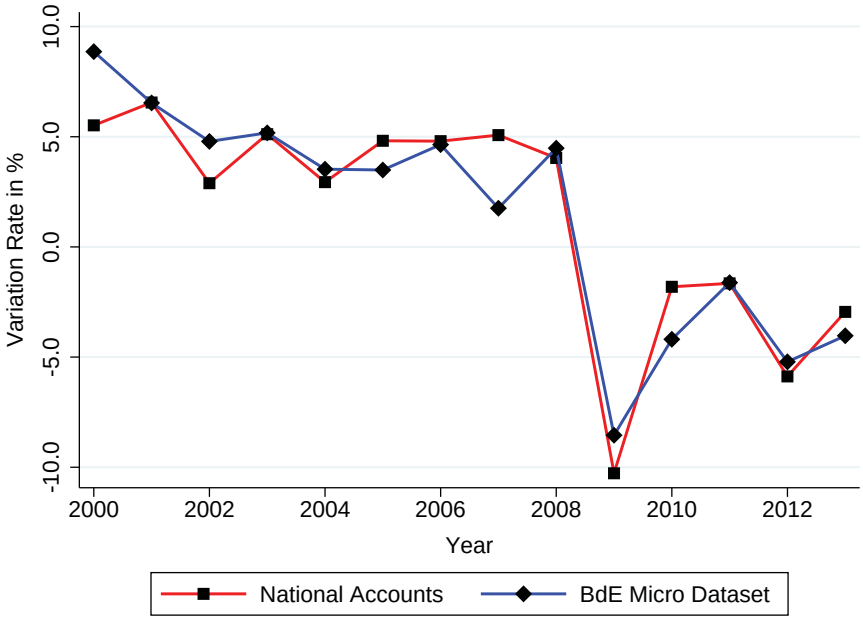
Note: Figures plot the yearly average employment growth rate in the firm-level Bank of Spain (BdE) dataset and the yearly aggregate full-time equivalent employment by wage earners growth rate obtained from the Production and Generation Income Accounts by Branches of Activity reported by the the Spanish National Institute of Statistics (INE) from 2000 to 2013 in a) the non-financial market economy (i.e. total economy excluding public and financial sectors as well as domestic use and professional and association activities); and b) the manufacturing sector. The micro-aggregated employment in the BdE dataset is computed as the sum of firms' reported average employment. The correlation rate among these series is 0.91 for the non-financial market economy and 0.94 for the manufacturing sector.

Figure 2: Wage Bill Dynamics

(a) Non-Financial Market Economy



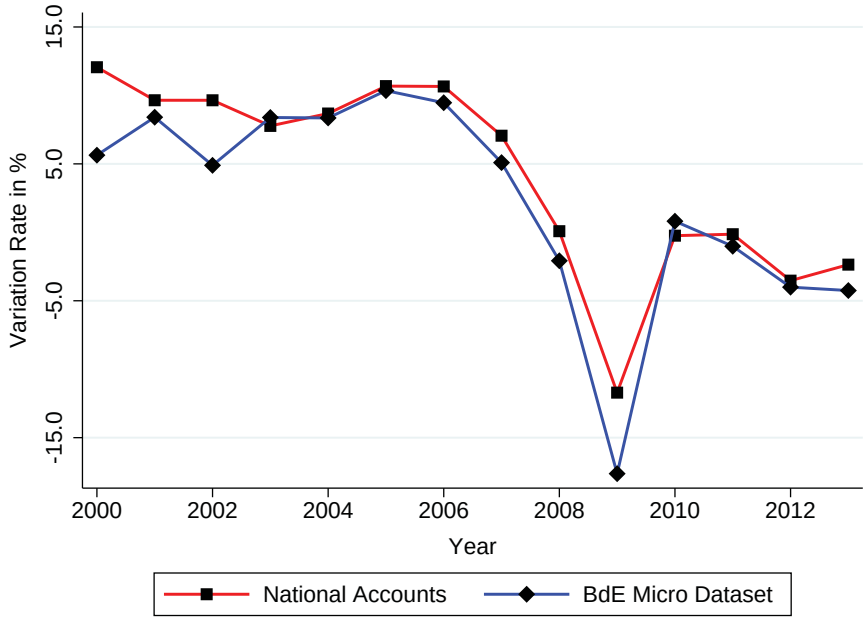
(b) Manufacturing Sector



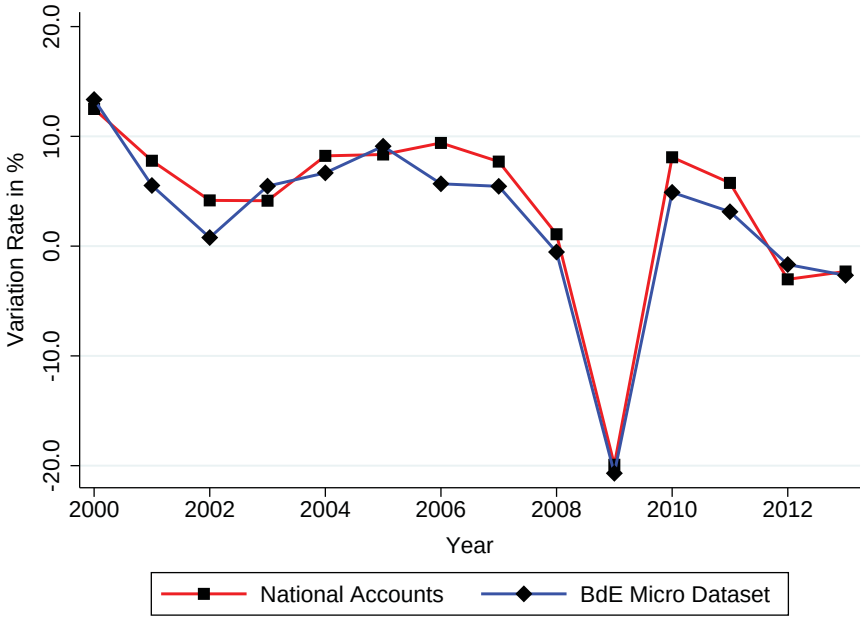
Note: Figures plot the yearly average wage bill growth rate in the firm-level Bank of Spain (BdE) dataset and the yearly aggregate remuneration of wage earners growth rate obtained from the Production and Generation Income Accounts by Branches of Activity reported by the the Spanish National Institute of Statistics (INE) from 2000 to 2013 in a) the non-financial market economy (i.e. total economy excluding public and financial sectors as well as domestic use and professional and association activities); and b) the manufacturing sector. The micro-aggregated wage bill in the BdE dataset is computed as the sum of firms' reported labor expenditures (wages and social security contributions). The correlation rate among these series is 0.96 for the non-financial market economy and 0.94 for the manufacturing sector.

Figure 3: Output Dynamics

(a) Non-Financial Market Economy



(b) Manufacturing Sector



Note: Figures plot the yearly average output growth rate in the firm-level Bank of Spain (BdE) dataset and the yearly aggregate production growth rate obtained from the Production and Generation Income Accounts by Branches of Activity reported by the the Spanish National Institute of Statistics (INE) from 2000 to 2013 in a) the non-financial market economy (i.e. total economy excluding public and financial sectors as well as domestic use and professional and association activities); and b) the manufacturing sector. The micro-aggregated output in the BdE dataset is computed as the sum of firms' reported net operating revenue. The correlation rate among these series is 0.95 for the non-financial market economy and 0.97 for the manufacturing sector.

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