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The Spanish Productivity Puzzle in the Great Recession

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ABSTRACT

The Spanish Productivity Puzzle in the Great Recession*

While Spain had traditionally under-performed its European counterparts in terms of labor productivity, the trend is reversed after 2007. The evolution of aggregate productivity in Spain during the Great Recession largely responds to the adverse conditions in the labor market, but not only. Using a longitudinal sample of Spanish manufacturing and services companies between 1995 and 2012, we show that the recent increase in Spanish aggregate productivity also responds to the evolution of the total factor productivity (TFP) and to composition effects. By combining the information at the firm level on balance sheet items, collective agreements and imports-exports, we are able to establish that commitment to a collective agreement at the firm level and access to external markets are positively related to TFP performance during the whole period. In addition, we estimate that firm TFP was negatively correlated with the share of temporary workers during the expansion period, 1995-2007, whereas the sign of that correlation reversed completely during the crisis, 2008-2012. Finally, we relate this sign reversal with the changing composition of temporary workers in the labor market.

JEL Classification: J24, J21, J52

Keywords: labor productivity, TFP, temporary workers, collective agreements, exporting firms

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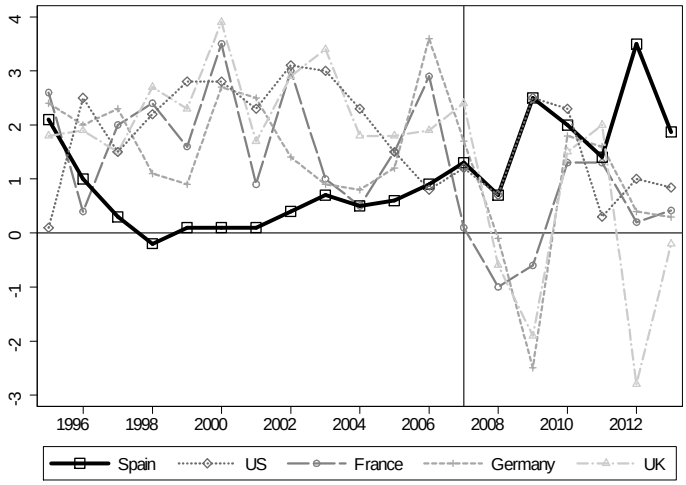
1 Introduction

The divergent productivity growth experiences of the United States and different countries in Europe during the current economic crisis has increased the interest in factors underlying labor productivity growth (see Figure 1). In particular, the slowdown of the Spanish labor productivity growth between the mid 1990s and the mid 2000s contrasts with the positive productivity growth in the US and other European countries.[1] After 2007, some convergence has been achieved. Determining the temporary or the permanent nature of factors justifying the recent increasing path constitutes a major determinant of Spanish future competitiveness.

Figure 1: Labor productivity growth in Spain, US, France, Germany, and UK (%).

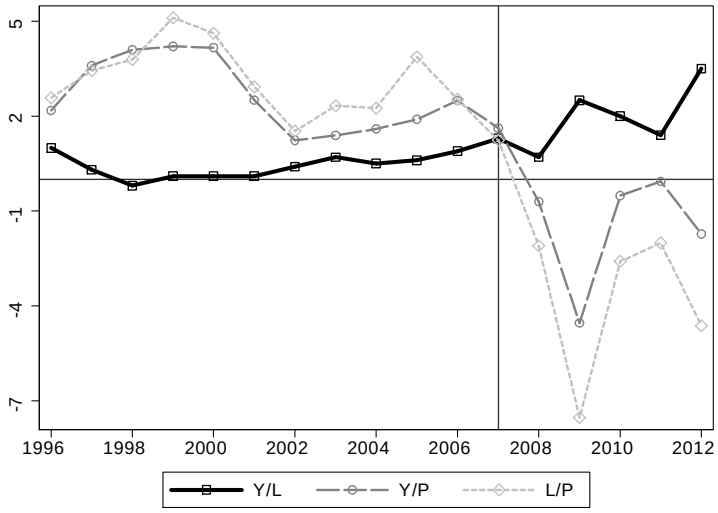


Notes: Source OECD. Labor productivity defined as GDP per hour worked.

From a strict accountability point of view, GDP per capita, Y/P, can be decomposed into labor productivity, Y/L, and employment, L/P, where Y is GDP, P population, and L labor (measured as number of workers or hours of work). In Spain, the divergent evolution of the GDP per capita and of labor productivity during the recent crisis have been seriously impacted by the very adverse conditions in the labor market (see figure 2). Since 2007, unemployment has increased (particularly for men due to the downsizing of the construction sector) reaching 25% of the active population in 2012 and 40% for people between 16 and 29 years old. This evolution of the unemployment rate has been mainly explained by the massive destruction of jobs rather than by the arrival of new entrants into the labor market. Moreover, job destruction has disproportionately affected employees with temporary contracts, which are usually associated with low productivity positions (see figure 3). Then, the recent improvement in labor productivity could be related to a mechanical effect associated to the sharp drops in employment, but it could also be a simple composition effect due to the massive destruction of temporary, less productive positions.

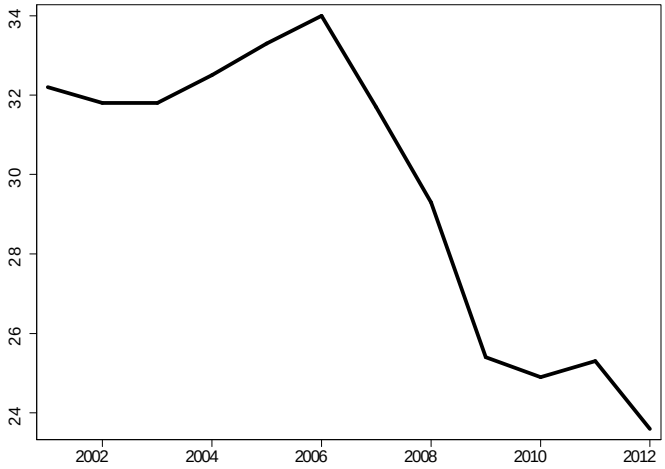
[1] See, for instance, Dolado *et al.* (2011).

Figure 2: GDP per capita, labor productivity and employment over total population in Spain (rates of growth, %).



Notes: Source OECD.

Figure 3: Share of temporary contracts in Spain (%).



Notes: Source Spanish National Statistical Institute.

Under the assumption of a standard Cobb-Douglas production function, $Y = AK^{\alpha}L^{1-\alpha}$, labor productivity equals

$$\frac{Y}{L} = A \cdot \left(\frac{K}{L}\right)^{\alpha}, \tag{1}$$

where A is the total factor productivity (TFP) traditionally associated with technological progress, K is capital, and the ratio K/L is known as capital deepening. Denoting labor productivity as $y = Y/L$, and capital deepening as $k = K/L$, we can rewrite equation (1) in growth terms as:

$$\dot{y} = \dot{A} + \alpha\dot{k}.$$

In the neoclassical framework, capital stock is an endogenous variable that depends on TFP growth. In a long run steady state (a situation where all per capita variables are growing at a constant rate) one can show that the growth of capital intensity is the same as the rate of growth of labor productivity, so that, $\dot{y} = \frac{\dot{A}}{1-\alpha}$. Hence, in the long run, TFP growth would be the most informative predictor of future trends in productivity.[2]

Under this conceptual framework, the contribution of the paper is twofold. First, our study estimates and compares the evolution of TFP at both the macro and the micro levels in Spain during the period 1995-2012. We seek to determine whether the evolution of aggregate productivity results from a change in TFP trends of the majority of firms or if rather reflects composition effects. Second, we study the relationship between the evolution of TFP at the firm level and alternative margins of adjustment, such as the mix of labor contracts used by the firm, the type of collective agreement, and the possibility of exporting or importing from abroad. In particular, we focus on the importance of these *flexibility* margins during the recent economic crisis (2008-2012).

We find that the evolution of aggregate productivity in Spain during the Great Recession largely responds to the adverse conditions in the labor market, but also to the evolution of TFP and composition effects. In addition, by combining the information at the firm level on balance sheet items, collective agreements and imports-exports, we are able to establish that commitment to a collective agreement at the firm level and access to external markets are positively related to TFP performance during the whole period. Moreover, we estimate that firm TFP was negatively correlated with the share of temporary workers during the expansion period, but positively correlated during the crisis. We interpret this sign reversal as the result of a changing composition of temporary workers in the labor market.

The rest of the paper is organized as follows. Section 2 incorporates a review of related literature. Section 3 describes the different data sources as well as the construction of our final sample. In Section 4 we explain our methodological approach. Section 5 documents the evolution of the Spanish TFP, both at the micro and macro levels, whereas in Section 6 we discuss the role of the flexibility margins in that evolution. Finally, Section 7 concludes.

[2] See Sargent and Rodriguez (2001) for a further discussion.

2 Related Literature

The interest concerning the evolution of Spanish productivity is not new. However, to our knowledge, none of the previous works considers the recent crisis period after 2007. The paper dealing with the closest period to ours is Mora-Sanguinetti and Fuentes (2012), who use data for 1996-2007. They claim that the relatively weak performance of Spain largely reflects the low growth of the TFP within a wide range of sectors (with a limited impact of composition effects), while capital stock and educational attaintment of the workforce have grown relatively strongly. They argue that Spain needs more flexible labor market, business environment and collective bargaining system, to improve productivity. They conclude that the acceleration of productivity in the mid-2006 was due to cyclical and temporary factors.

The role of institutions as a major determinant of productivity and allocative efficiency of the Spanish economy is also analyzed in Alonso-Borrego (2010), Boldrin *et al.* (2010) and Gonzalez and Miles-Touya (2012). Using the Balance Sheets of the Bank of Spain for the period 1983-2006, Alonso-Borrego (2010) reaches three major conclusions. First, the under-development in the service sector towards more competition may be preventing firms to increase their levels of specialization while outsourcing non-manufacturing activities. Second, increases in industry competition boost firms to improve their performance, especially in the case of service firms. Finally, the share of temporary employment tends to reduce productivity (while increasing employment), specially in the service sector.[3]

Boldrin *et al.* (2010) analyze the growth of the Spanish economy since the advent of democracy until today. They conclude that over the past 30 years Spain has experienced two long growth cycles. Between 1978 and 1993 the economy was characterized by a small increase in employment and a considerable rise in productivity, while between 1994 and 2008 there was a spectacular increase in employment and a small gain in productivity. The authors show that the characteristics of the labor market in Spain, with a dual system that protects permanent workers at the expense of temporary ones and an inefficient collective wage bargaining system, have played a very relevant role in explaining the observed growth pattern of Spain.

In a more recent work, Gonzalez and Miles-Touya (2012) analyze the impact on allocative efficiency of permanent labor of the labor market reforms in 1994, restricting the use of temporary contracts, and in 1997, reducing the severance payments of permanent contracts. They find that these reforms did affect the allocative efficiency of the permanent labor input. They interpret these results as implying that the expected labor adjustment costs increased when the severe restrictions on using temporary workers were not accompanied by a sufficient reduction in the severance payments due to permanent workers.

Pilat (2005) estimates that, for the second half of the 1990s, low levels of labor productivity account for two-thirds of the gap in income levels between Spain and the United States. He argues that, to improve productivity growth, Spain should reduce the gap in employment protection

[3] This latter result is consistent with Aguirragabiria and Alonso-Borrego (2009) and Dolado *et al.* (2011).

legislation between permanent and temporary workers, reinforce capital deepening and increase the level of human capital. He attributes the weak performance of TFP to the small contribution to productivity of the Information and Communication technologies (ICT) producing sector, the weak growth of TFP in ICT-using services, the relatively low investment in Research and Development (R&D), the strong regulations in the retailing sector, the relatively high administrative burdens on start-up firms, the strict employment legislation and the not favorable environment for entrepreneurship.

The importance of R&D expenditures in determining the differences in productivity across firms and the evolution of firm-level productivity over time is also analyzed in Doraszelski and Jaumandreu (2013) using an unbalanced panel of more than 1800 Spanish manufacturing firms in nine industries during the 1990s. They also show that the link between R&D and productivity is subject to a high degree of uncertainty, nonlinearity and heterogeneity.

Mas and Quesada (2006) point towards the construction sector, the wholesale, retail trade and repairs sector and hotels and catering sector, as the main responsible of the poor performance of Spanish productivity over the period 1995-2004. If their negative contribution is eliminated, labor productivity would have presented a positive rate of growth of 0.67%, instead of the actual negative rate of -0.29%. They underline the incapacity of Spain to extract all the benefit from large improvements in worker's training and educational levels. From their point of view, the negative contribution of TFP to economic growth in Spain is due to the small presence of ICT producing sectors, the relative small share of ICT-investment on total investment, the low penetration of ICT-assets, the higher cost of ICT, the low use of ICT at schools and the very poor technical formation and training.

Martinez *et al.* (2008) remark that the negative pattern of Spanish productivity since the mid-nineties (due to the bad behavior of TFP), occurred actually in a context where investment in ICT assets was increasing at high rates. They refer to this phenomenon as the Spanish Productivity Paradox. They argue that benefits of ICT need time to materialize. Adjustment costs and inefficiencies derived from inappropriate qualifications in the labor force lead to a transitional dynamics in which productivity suffers low and even negative growth rates. New organizational forms at the plant level and human capital accumulation adapted to the new equipment have to be carried out. Competitive factors, services and goods' markets also appear as a necessary condition for the optimal development of ICT because this environment minimizes adjustment costs.

Finally, although out of the scope of this paper, there also exists a wide literature analyzing the relationship between productivity growth and firm dynamics in Spain. Using data for the manufacturing sector in the 1990s, Fariñas and Ruano (2004) conclude that established firms are the main contributor to productivity growth; whereas Huergo and Jaumandreu (2004) conclude that, for some years, new firms display higher productivity growth than average. Jimeno and Sanchez-Mangas (2006) quantify that established firms account for 90% of total productivity growth. Lopez-Garcia *et al.* (2007) extend the analysis to the service sector in the period

1996-2003, and they conclude that the main engine of productivity growth in most sectors is the productivity improvement of established firms (particularly of large firms). Moreover, firms entering or exiting display a negative contribution (lower for large firms).

3 The Data

Our dataset combines information from several data sources. Data on the annual accounts of firms as well as on the number of employees by type of contract were obtained from the Banco de España's Central Balance Sheet Data Office (CBSO) and from the Mercantile Registries. Information on the type of collective agreements comes from the Collective Agreement Registries. Finally, information on imports and exports is provided by the Balance of Payment Registries. We explain in detail the content of these databases and the merging procedure below.

3.1 Data Sources and Definition of Main Variables

Since 1991, under the cooperation agreements signed with the Ministry of Justice and the Spanish Association of Property and Mercantile Registrars, the Banco de España's CBSO and the Mercantile Registries have been working together to facilitate the statistical use of the annual accounting reports that companies are legally required to fill with the mercantile registry of the province in which their registered office is located.[4] This cooperation allows us to have an unbalanced panel of firms in manufacturing and non-financial services industries from 1995 to 2012.

The information available for each firm in each year includes: business name, location (5-digit postal code), several balance sheet items, profit and loss account items, standard financial ratios, and sector of activity at the 4-digit level.[5] Employment is measured as the number of employees, disaggregated by contract type in permanent (those with an indefinite or permanent contract) and temporary employees (those with a fixed-term or temporary contract).[6]

Gross output at retail prices is calculated as total sales, plus the change in finished product inventories and other income from the production process, minus taxes derived on the production

[4] All firms in Spain are required by law to deposit their annual accounts at the Mercantile Registries. However, a large number of small firms do not fulfill the reporting requirement because it is costly for them and the associated fines are small. The main advantage of complying is that submitting the annual accounts is a usual requirement to obtain loans from commercial banks and government contracts. Almunia and López-Rodríguez (2012) compare the size of the dataset from the Mercantile Registries to the number of firms submitting corporate income tax returns to the tax agency, and they find that it contains information from approximately 85% of firms with annual revenue between €1.5-€60 million that submitted a corporate tax return to the Spanish tax agency. The percentage is close to 90% for firms larger than €60 million, but just below 50% for firms smaller than €1.5 million.

[5] In practice, we consider 10 different sectors: Agriculture, Extractive, Manufacture, Energy, Construction, Sales, Transport, Tourism, Education-Health, Other non-financial services.

[6] To maintain measurement consistency, the number of temporary employees is calculated in annual terms by multiplying the number of temporary employees along the year times the average number of weeks worked by temporary employees and divided by 52.

(net of subsidies). Output is deflated with the corresponding year and economic activity (2 digit national activity classification) value added deflator.

Intermediate inputs at retail prices are directly reported by firms in the CBSO. For those firms from the Mercantile Registries, intermediate inputs are obtained as the addition of provision supplies and operating expenses. Intermediate inputs are deflated by the intermediate input price index of the year and economic activity (2 digit national activity classification).

Value added is computed as the difference between gross output and intermediate inputs. Productivity results from the ratio between value added and the number of employees.

Capital includes both physical and intangible capital. It is recorded at book value and deflated using the price index of investment in equipment goods by year and economic activity (2 digit national activity classification).

We also use as control variables additional information at the firm level, such as sector of activity, size, age, location, or standard financial ratios. Particularly, we consider two financial ratios revealing the firm's debt structure. The first one, is referred as the debt ratio and is defined as the ratio between the firms' debt (long run and short run debts) over the firm's own financing (or equity financing). This debt ratio aims to measure the intensity of the debt compared to the firm's own funding and it reveals the degree of influence of third parties in the functioning and financial balance standing of the company. The second ratio is referred as the short term debt ratio and is defined as the share of short run debts over total liabilities (total debts).[7]

Information on collective agreements is obtained from the Collective Agreement Registries. In Spain, there exist five levels of collective agreement negotiation: at the firm level, at the municipality level, at the province level (geographical unit below the region), at the regional level and at the national level. The level of the collective agreement to which the firm is committed may have played an important role in determining the ability of the firm to adjust during the economic crisis. Collective agreements at the firm level allow to better take into account the particular economic context of the firm with respect to the agreements signed at the municipality, province, regional or national level. Intuitively, we can anticipate that firms committed to a collective agreement at the firm level, can better adapt working conditions to their particular circumstances and should then better perform during the crisis period.

Finally, to test whether firms have used foreign markets as a way of adjustment to circumvent the crisis, we require information on imports and exports. This data is provided by the Balanza de Pagos (Balance of Payment Registries). For every year, the database contains information on whether the firm exports, imports, the amount of the exports and imports, as well as the country of destination for the exports or origin for the imports.

[7] The main limitation when employing these two ratios is that they are only available in our sample for firms classified as "reliable" by the CBSO according to several statistical criteria.

3.2 Sample Selection

When working with data from the Central Balance Sheets and the Mercantile Registries, we have dropped from the sample those firms with missing or non-positive values for the number of employees, value added, intermediate inputs, physical capital, sector of activity, and year of firm creation.

Collective Agreement Registries do not contain information for all firms belonging to the database constructed from Central Balance Sheet and the Mercantile Registries. Firms for which there is no information on collective agreement are kept in the sample and are classified in the "No Agreement" category. For firms for which there is information on the type of collective agreement we implement the following merging procedure. We first consider firms from the Collective Agreement Registries being committed to an agreement at the firm level. This subsample is then merged with the Central Balance Sheet and the Mercantile Registries database using the Identifying Fiscal Code of the firm, the name of the firm or the name of the agreement. This first step allows us to identify all the firms appearing in the Central Balance Sheet and the Mercantile Registries that have signed a collective agreement at the firm level. Next, we identify firms having signed an agreement at the sectoral level. We start with sectoral agreements signed at the province level, by merging the Central Balance Sheet and the Mercantile Registries data using an indicator of the province and the economic activity branch (national classification of economic activities at 3 digits or 2 digits) to which the firm belongs. An equivalent procedure is developed to identify firms having signed a collective agreement at the municipality level, at the regional level and at the national level. Then, we merge the four databases containing firms being respectively committed to a collective agreement at the province level, at the municipality level, at the regional level and at the national level. The resulting database is merged with the base containing all firms in the Central Balance Sheet and the Mercantile Registries having signed an agreement at the firm level and with those firms for which there is no information on collective agreements. Finally, we use the Balance of Payments to add, when available, information on exports and imports.

To avoid outliers, we drop observations at the bottom and top 2.5% of the value of production, value added, capital stock, intermediate consumption and employees.[8] The final sample contains 964,284 firms and 5,627,598 observations.

3.3 Descriptive Statistics

In the sample, the average share of employees with temporary contracts by firm equals 22.8%. However, this share has evolved from 35.5% in 1995, to 22.9% in 2000, 21.3% in 2008, and only 17.7% in 2012.[9]

[8] Results are robust when implementing the estimation with samples where we keep 97% and 99% of the observations.

[9] In our sample, the share of temporary workers is computed at the firm level, so it is not directly comparable to the temporary rate obtained for the whole economy when the ratio of temporary workers over total active

Regarding the exporting and importing activity, 12.4% of firms in the sample develop an exporting/importing activity over the considered period. However, in 2008 there was an increase in the minimum threshold required by law to declare the export and import activity to the Balance of Payment (the new threshold was set to 45,000 euros while previously was equal 3,000 euros). If we use the 45,000 euros treshold for the entire period, 8.9% of firms in the sample develop an exporting or importing activity.

The relative shares of the different types of collective agreements vary depending of whether the merging procedure is done with the national classification of economic activities at 3 digits or at 2 digits. In the first case, among those firms with information on collective agreements, 0.2% are committed to a collective agreement at the firm level, 54.0% are committed to an agreement at the province level, 38.5% at the national level and 7.3% at the regional level (the share of firms committed to an agreement at the municipality level is negligible).[10] In the second case, 0.1% of firms are committed to a collective agreement at the firm level, 75.6% are committed to an agreement at the province level, 19.0% at the national level and 5.3% at the regional level. Although the share of firms with an agreement at the firm level is small, the percentage of workers covered by these agreements over the period equals 0.9% or 0.5%, respectively, since mainly large firms sign this type of collective agreements. In the case of sectoral collective agreements, the corresponding figures for workers are 57.2% (or 76.1%) for agreements at the province level, 35.0% (or 18.9%) at the national level and 6.8% (or 4.5%) at the regional level.[11]

4 Measuring TFP

The approach to measure total factor productivity at the firm level is based on the estimation of a technology of production using an output measure and information on the amount of all the observable inputs, and then computing TFP as the residual from the estimation. The main problem in the estimation of production functions is the endogeneity bias due to the possible correlation between the unobserved firm specific productivity shocks and the unobserved inputs (Griliches and Mairesse 1995). In such a case, OLS generates inconsistent estimates of the technological parameters. The two alternative approaches to treat the endogeneity problem are the estimation including firm fixed effects and the control function method. The key assumption underlying the fixed effects approach is that unobserved firm-specific productivity shocks are invariant over time, and therefore any fixed effects transformation, such as first-differences, allows

population is used instead. It is important though to notice that the evolution of the share of temporary workers by firm is parallel to the evolution observed for the temporary rate obtained when working with the Spanish Labor Force Survey or with administrative data from Social Security records (see figure A.1 of the appendix).

[10] Actually observations with agreements at the municipality level are excluded from the regression analysis.

[11] According to the statistics of the Spanish Ministry of Labour and Social Security, in 2008, among all firms subject to a collective agreement 0.3% of firms (and 10% of workers) were concerned by a collective agreement at the firm level while 99.7% were engaged in a collective agreement at a higher level. In particular, 66.6% were committed to a collective agreement at the province level, 27.3% at the national level and 5.7% at the regional level. Our sample then underestimates the share of workers committed to a collective agreement at the firm level.

to recover the parameter estimates by means of a GMM estimation. The main caveat of this approach is - however - the potential weakness of the instruments used in the GMM. In the control function approach, proposed by Olley and Pakes (1996), the firm-specific productivity shocks are assumed to follow a Markov process and they can be recovered by means of a variable which keeps a monotonic relationship with the firm-specific shock, such as capital investment or intermediate inputs.[12]

4.1 Estimation of the production function

Following Alonso-Borrego (2010), we characterize technology as a Cobb-Douglas production function with a double logarithmic specification on grosss output and inputs,

$$\begin{aligned} y_{it} &= \beta_0 + \beta_L l_{it} + \beta_M m_{it} + \beta_K k_{it} + u_{it}, \\ u_{it} &= \omega_{it} + \epsilon_{it}, \end{aligned}$$

where, for each firm i in year t, y_{it} denotes the log of gross real output, and l_{it}, m_{it}, denote the logarithms of the variable inputs, labor and intermediate inputs, k_{it} is the log of capital stock, and u_{it} is a random term containing any unobserved factors affecting production. In particular, we consider that u_{it} is the sum of two terms: the random variable ω_{it}, which represents firm-specific factors which affect productivity, such as managerial ability, firm specific human capital, efficiency in the use of technology and inputs, which are known to the firm when deciding the amounts of capital, labor and intermediate inputs but are unobserved to the econometrician; and the random variable ϵ_{it}, which is an idiosyncratic term, which includes measurement error in output or shocks affecting output that are unknown when the firm decided the amount of inputs. The random variable ω_{it} is usually referred as total factor productivity (TFP), and it is expected to be related with input decisions, whereas ϵ_{it} is assumed to be independent of ω_{it} and other inputs.

The endogeneity problem arises from the fact that ω_{it} may be correlated with input choices. To overcome this problem we use the control function method, because given the time length of our panel (1995-2012) we claim the assumption that the firm-specific productivity shock is constant over time might be unrealistic.

Following Olley and Pakes (1996), we assume ω_{it} to follow a first order Markov process. Instead of instrumenting the endogenous regressors, we include external variables to approximate the productivity shock. As Olley and Pakes (1996), we require such external variables (for instance, investment) to keep a monotonic relationship with the productivity shock. Formally, we assume that k is a quasi-fixed input, and that there is some time-to-build, that is, investment installed in period t only becomes productive at $t+1$. Under this assumption, the investment demand function $i_{it} = i(\omega_{it}, k_{it})$ can be inverted to obtain the unobserved productivity as a non parametric function of investment and capital, $\omega_{it} = h_t(i_{it}, k_{it})$. However, the limitation

[12] For a complete discussion of the alternative approaches see, for example, Ackerberg *et al.* (2007) or Aguirregabiria (2009).

when using investment as proxy is that estimation must be restricted to the subsample of observations with positive investment in order to fulfill the monotonicity condition. Levinsohn and Petrin (2003) propose to use intermediate inputs instead of investment as a proxy, for which the monotonicity condition is more likely to hold for the whole sample. In this case, the materials' demand function $m_{it} = m(\omega_{it}, k_{it})$ is inverted to obtain $\omega_{it} = \omega_t(m_{it}, k_{it})$, under monotonicity plus some additional assumptions. The original justification for this alternative choice is that, while most firms report positive expenditure on materials every year, a much lower proportion undertake investment every year. In our specific case, we simply do not have information on investment in the data.

Letting v_{it} represent value added – gross output net of intermediate inputs – , we can write the production function equation as follows:

$$\begin{aligned} v_{it} &= \beta_0 + \beta_L l_{it} + \beta_K k_{it} + \omega_t(m_{it}, k_{it}) + \epsilon_{it} \\ &= \beta_L l_{it} + \phi_t(m_{it}, k_{it}) + \epsilon_{it}, \end{aligned} \tag{2}$$

where $\phi_t(m_{it}, k_{it}) = \beta_0 + \beta_K k_{it} + \omega_t(m_{it}, k_{it})$. Equation (2) is estimated in the first stage, using a non parametric estimation of $\phi_t(m_{it}, k_{it})$ or, similarly, a second or third order polynomial approximation in m_{it} and k_{it}.

In the first stage we have identified β_L, and the second stage of the routine identifies the coefficient β_K. It begins by computing the estimated value $\hat{\phi}_{it} = v_{it} - \hat{\beta}_L l_{it}$. Then, for any candidate value β_K^*, we can compute (up to a scalar constant) a prediction for ω_t for all periods using $\hat{\omega}_{it} = v_{it} - \hat{\beta}_L l_{it} - \beta_K^* k_{it} = \hat{\phi}_{it} - \beta_K^* k_{it}$.

Assume that productivity, ω_{it}, is governed by a first-order Markov process,

$$\omega_{it} = E[\omega_{it} | \omega_{it-1}] + \zeta_{it},$$

where ζ_{it} is an innovation to productivity that is uncorrelated with k_{it}, but not necessarily to l_{it}. Now, a consistent (nonparametric) approximation to $E[\omega_{it}|\omega_{it-1}]$ is given by the predicted values from the regression

$$\hat{\omega}_{it} = \gamma_0 + \gamma_1 \omega_{it-1} + \gamma_2 \omega_{it-2} + \gamma_3 \omega_{it-3} + \xi_{it},$$

which Levinsohn and Petrin (2003) call $\widehat{E[\omega_{it}|\omega_{it-1}]}$. Given $\hat{\beta}_L$, β_K^*, and $\widehat{E[\omega_{it}|\omega_{it-1}]}$, they write the sample residual of the production function as

$$\epsilon_{it} + \zeta_{it} = v_{it} - \hat{\beta}_L l_{it} - \beta_K^* k_{it} - \widehat{E[\omega_{it}|\omega_{it-1}]}.$$

Then, the estimate $\hat{\beta}_K$ is defined as the solution to

$$\min_{\beta} \sum_i \sum_t \left(v_{it} - \hat{\beta}_L l_{it} - \beta_K^* k_{it} - \widehat{E[\omega_{it}|\omega_{it-1}]} \right)^2. \tag{3}$$

Since estimation involves the use of predicted values, appropriate standard errors of the estimated coefficients $\hat{\beta}_L$ and $\hat{\beta}_K$ are computed by bootstrap methods.

5 Estimation results of the production function

Our dependent variable is the log of value added. We have used three alternative estimation procedures: ordinary least squares (OLS), fixed effects (FE) and Levinsohn and Petrin (LP). For our LP estimates, we have approximated the function $\phi_t(m_{it}, k_{it})$ by means of a third-order polynomial approximation in m_{it} and k_{it}. To allow for differences across industries, we estimate a production function for each industry separately. We consider a 10 sector classification: Agriculture, Extractive, Manufacture, Energy, Construction, Sales, Transport, Tourism, Education-Health, Non-financial Services. First, we report the OLS, FE, and LP estimation results of the technological parameters for each of the 10 groups. In addition, we consider an extended version of the production function in which the labor input is decomposed between permanent labor (that is, number of employees with indefinite positions) or temporary labor (workers with fixed-term contracts).

5.1 Estimation results

Table 1 reports OLS, FE, and LP estimation results of the technological parameters. We can see that the LP estimated coefficients for labor and capital are lower than the corresponding OLS estimates. The evidence reported is coherent with the successful bias correction provided by the control function approach.[13] Nevertheless, the magnitude of the capital coefficients seems to be too low in some cases.[14] This low estimated elasticities are though consistent with the estimations provided by Dolado *et al.* (2011) or Doraszelski and Jaumandreu (2013) on a panel of Spanish manufacturing industries.[15]

Next, we split the estimation period into two subperiods, 1995-2007 and 2008-2012, and estimate one different production function for each. We implement this analysis by sub-periods for two reasons: on the one hand, in 2007 there was a major change in the National Accountancy System that may have induced a break in the time series. On the other hand, the economic crisis started in 2008, so the distinction by subperiods allows us to evaluate the potential variation in the technological coefficients of the production function during the crisis.

Table 2 reports the LP estimates for both subperiods. For the first subperiod we find essentially the same results as in table 1. For the crisis period, however, we find that the coefficient associated with capital decreases heavily in most sectors.

[13] Table A.1 of the appendix reports LP estimation results of the technological parameters in two bigger samples: one in which we drop a 3% of the extreme values of production, value added, capital stock, intermediate consumption and employees; and another sample in which we have dropped only a 1%. Although results do not change substantially, we observe that estimates for the elasticity of capital increase slightly when the percentage of extreme values excluded from the sample decreases.

[14] Table A.2 of the appendix shows estimates for different definitions of capital in a small subsample of firms for which several measures for capital are available. It seems that in case of considering the tangible capital at market value instead of book value, estimates for the capital coefficients would be even smaller.

[15] Due to their econometric specification, Doraszelski and Jaumandreu (2013) estimate though a lower elasticity of the production function with respect to labor.

Table 1: Comparison of OLS, FE, and LP estimators (whole period).

	OLS		FE		LP	
	β_L	β_K	β_L	β_K	β_L	β_K
Agriculture	0.7042	0.1679	0.3675	0.1612	0.5507	0.0645
	(0.0044)	(0.0026)	(0.0039)	(0.0028)	(0.0041)	(0.0068)
Extractive	0.8035	0.2238	0.6473	0.1874	0.5862	0.1415
	(0.0151)	(0.0088)	(0.0121)	(0.0083)	(0.0178)	(0.0195)
Manufacture	0.8709	0.1602	0.6387	0.1341	0.6824	0.0627
	(0.0018)	(0.0010)	(0.0012)	(0.0007)	(0.0019)	(0.0017)
Energy	0.7507	0.2321	0.5317	0.1575	0.5657	0.1064
	(0.0089)	(0.0059)	(0.0094)	(0.0056)	(0.0106)	(0.0138)
Construction	0.7842	0.1555	0.6802	0.0927	0.5909	0.1061
	(0.0015)	(0.0009)	(0.0013)	(0.0008)	(0.0016)	(0.0013)
Sales	0.8500	0.1493	0.5618	0.1143	0.6445	0.0748
	(0.0014)	(0.0008)	(0.0010)	(0.0005)	(0.0015)	(0.0012)
Transport	0.8415	0.1815	0.5884	0.1665	0.6695	0.0939
	(0.0030)	(0.0019)	(0.0021)	(0.0013)	(0.0037)	(0.0032)
Tourism	0.8572	0.1376	0.4827	0.1057	0.4662	0.0838
	(0.0024)	(0.0012)	(0.0017)	(0.0011)	(0.0033)	(0.0021)
Education-Health	0.7651	0.1419	0.5172	0.0947	0.5701	0.0766
	(0.0036)	(0.0020)	(0.0025)	(0.0014)	(0.0038)	(0.0038)
Other non-financial services	0.7734	0.1603	0.5523	0.0940	0.6140	0.0806
	(0.0014)	(0.0008)	(0.0012)	(0.0006)	(0.0015)	(0.0015)

Notes: Observations=5,627,598. Bootstrap standard errors in parentheses (100 replications).

Table 2: LP estimates (subperiods).

	1995-2007		2008-2012	
	β_L	β_K	β_L	β_K
Agriculture	0.5352	0.1016	0.5742	0.0408
	(0.0058)	(0.0112)	(0.0061)	(0.0110)
Extractive	0.5572	0.1274	0.6142	0.0636
	(0.0233)	(0.0158)	(0.0226)	(0.0391)
Manufacture	0.6650	0.0579	0.7071	0.0579
	(0.0031)	(0.0022)	(0.0026)	(0.0033)
Energy	0.5796	0.0842	0.5434	0.1292
	(0.0109)	(0.0150)	(0.0160)	(0.0235)
Construction	0.5555	0.0865	0.6111	0.0594
	(0.0017)	(0.0019)	(0.0023)	(0.0030)
Sales	0.6317	0.0802	0.6640	0.0629
	(0.0019)	(0.0013)	(0.0017)	(0.0026)
Transport	0.6361	0.0974	0.7359	0.0629
	(0.0033)	(0.0038)	(0.0051)	(0.0072)
Tourism	0.4383	0.0783	0.4899	0.0838
	(0.0038)	(0.0026)	(0.0047)	(0.0046)
Education-Health	0.5528	0.0833	0.5950	0.0754
	(0.0051)	(0.0042)	(0.0047)	(0.0063)
Other non-financial services	0.5967	0.1041	0.6369	0.0629
	(0.0020)	(0.0018)	(0.0021)	(0.0023)
Observations	3,526,396		2,101,202	

Notes: Bootstrap SE in parentheses (100 replications).

Finally, table 3 reports LP estimation results for a production function with permanent and temporary labor, L_p and L_t, respectively. We can see that the estimated coefficients for temporary labor are always lower than the corresponding estimates for permanent workers.[16] Our results are consistent with the estimations of Dolado *et al.* (2011). Using a dataset of Spanish manufacturing firms, Dolado *et al.* (2011) estimate the elasticity of the production function with respect to temporary labor, permanent labor, intermediate materials and capital, imposing constant returns to scale (CRS). In our case, we do not impose CRS and our database covers both manufacturing and non-financial firms, which implies that we have a different industrial classification than in Dolado *et al.* (2011). Coefficients estimates associated with capital, permanent and temporary labor for agriculture, extractive, energy and manufacturing industries are of the same order of magnitude as the estimations provided by Dolado *et al.* (2011), which makes us confident in our results.[17]

5.2 Evolution of the estimated TFP

Once we have estimated the technological parameters of the production function, our estimation of the TFP at the firm level is obtained by plugging in them into the production function,

$$\widehat{TFP_{it}} \equiv \exp(\widehat{\omega}_{it}) = \exp(\upsilon_{it} - \hat{\beta}_0 - \hat{\beta}_L l_{it} - \hat{\beta}_K k_{it}),$$

where we have replaced the estimated technological parameters for those corresponding to the economic activity to which firm i belongs.

In subsection 5.1 we report estimates of the production function using various estimators, specifications and subsamples. Since TFP is estimated as a residual, we have different TFP estimations for each of theses cases. Figure 4 compares the evolution of the estimated TFP growth at the firm level with that at the aggregate level.[18] With respect to the different specifications, in general we do not observe much of a difference in the estimated TFP. Given that, for our regressions we will use the estimated TFP obtained from results in Table 1.

Regarding the comparison between the micro and the macro levels, we can see that the growth rate of average TFP by firm has been continuously negative and decreasing since the beginning of the crisis (between 2010 and 2012 there is a slight increase in the growth rate, which remains though below -5%). For aggregate TFP, the growth rate is negative but closer to zero during the crisis period. Moreover, in 2012 the growth rate becomes positive. Composition effects seem thus to have played a major role in justifying the slightly better performance of TFP at the macro level. That is, firms having a relatively larger size within the total population of firms

[16] Indeed, the differences between the LP coefficients associated with permanent and temporary labor are all statistically significant at 1% level.

[17] Coefficients associated with permanent labor seem slightly higher in the agriculture industry for Dolado *et al.* (2011), but this may be explained by the fact that their classification of agriculture includes also industrial machinery.

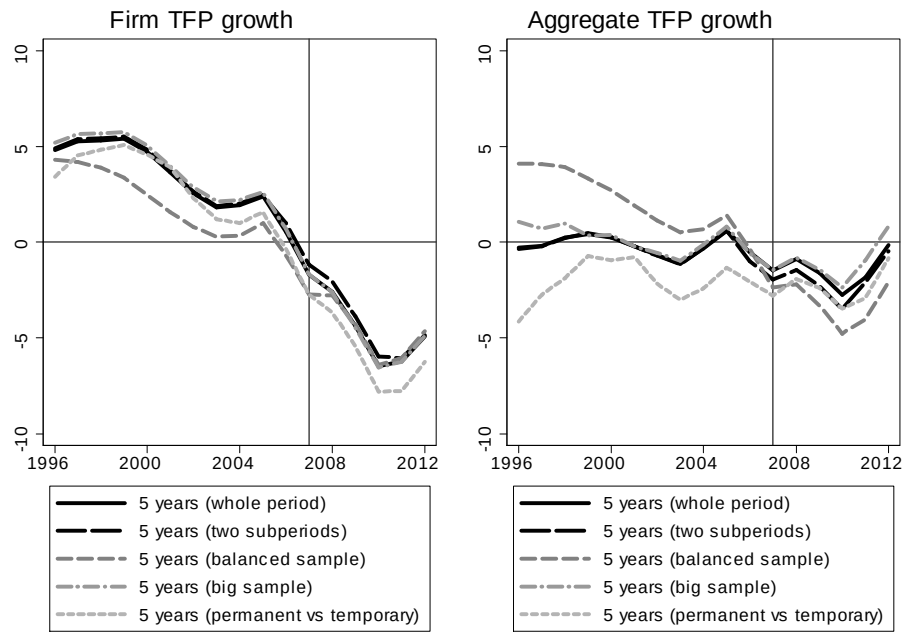
[18] Aggregated figures are obtained by aggregating firms using employment weights.

Table 3: LP estimates (permanent *vs.* temporary labor).

	β_{Lp}	β_{Lt}	β_K
Agriculture	0.1363	0.1125	0.0889
	(0.0020)	(0.0011)	(0.0079)
Extractive	0.1547	0.0601	0.1715
	(0.0105)	(0.0038)	(0.0208)
Manufacture	0.2755	0.0715	0.0937
	(0.0017)	(0.0004)	(0.0022)
Energy	0.2179	0.0885	0.1318
	(0.0071)	(0.0021)	(0.0128)
Construction	0.1414	0.1062	0.1454
	(0.0008)	(0.0005)	(0.0016)
Sales	0.2657	0.0690	0.0987
	(0.0011)	(0.0003)	(0.0012)
Transport	0.2245	0.0775	0.1393
	(0.0023)	(0.0007)	(0.0033)
Tourism	0.1164	0.0465	0.1135
	(0.0013)	(0.0005)	(0.0027)
Education-Health	0.2221	0.0858	0.0921
	(0.0022)	(0.0011)	(0.0036)
Other non-financial services	0.2679	0.0929	0.0948
	(0.0012)	(0.0004)	(0.0014)

Notes: Obs=5,627,598. Bootstrap SE in parentheses (100 replications).

Figure 4: Estimated TFP growth (non-weighted and weighted averages, %).



Notes: Firm TFP=simple average across firms; Aggregate TFP=firms aggregated using employment weights. Five years moving average of annual growth rates.

have displayed a rising behavior of TFP during the crisis which has partially compensated the bad TFP performance of the vast majority of (smaller) firms.

After computing TFP at the firm level, the longitudinal variation year-by-year can be exploited to enquire how the adjustment margins of the firm, measured through the share of temporary contracts, the type of collective agreement and the imports-exports information, relate to the estimated TFP.

6 Adjustment margins

In this section we quantify the relationship between TFP at the firm level and some margins that firms have in order to adjust to changing economic conditions. More precisely, we consider two distinct types of adjustment margins. On the one hand, input adjustment margins concern the type of contract proposed to workers, or the type of collective agreement. On the other hand, the output adjustment margin concerns the markets where firms sell their products. More precisely, we consider the exporting activity as an output adjustment margin.

First, we consider the collective bargaining system, as it is a fundamental mechanism for explaining the working of the Spanish labour market. The vast majority of workers in Spain see their wage (and, generally, working conditions) set in collective bargaining between trade union

and employers' representatives. The system is based in two main principles. On the one hand, the Principle of statutory extension claims that any minimum condition established in a collective agreement at higher than firm level apply to every worker forming part of the corresponding geographical and/or industry unit. On the other, the Principle of ultra-activity imposes that any agreement remains valid after its expiry, if it has not been renewed. Although collective agreements at the firm level allow to better take into account the particular economic context of the firm, even in that case - due to the two previous principles - it is very difficult for a firm to easily adjust to adverse economic conditions.[19]

Alternatively, firms can adjust their situation internally by adjusting the number of workers. In the particular case of Spain, firms have massively opted to destroy temporary positions.

Finally, it is well documented in the literature that exporting firms display better productivity performance. By facing international competition, these firms are obliged to be at the efficiency frontier if they want to survive. During a crisis period in a particular country, exporting firms may circumvent the bad economic conditions of their own country.

6.1 Estimation results

Formally, we regress the log of our estimated TFP for firm i at year t, $\widehat{\omega}_{it}$, on variables capturing those flexibility margins plus additional controls:

$$\widehat{\omega}_{it} = \gamma_a a_{it} + \gamma_z z_{it} + \eta_i + \eta_t + \kappa_{it}$$

where a_{it} denotes the adjustment margins (the type of collective agreement, the share of workers with temporary contracts, an indicator of being importer-exporter), z_{it} is a vector of dummy variables for the size, age, region, economic sector, and debt structure of the firm, η_i are firm fixed effects, η_t are time dummies, and κ_{it} is a random error term.

Similarly to Alonso-Borrego (2010), it is important to note that given the lack of a theoretical model to justify the set of explanatory variables, our estimates are capturing partial correlations, which cannot be given a causal interpretation. The evidence provided can only help to understand what variables are related to TFP, but further research is needed to support a causal interpretation of the estimated effects.

Table 4 reports fixed effects estimates of the correlation between the adjustment margins and firm's TFP controlling for debt ratios, time dummies and for indicators of firm's size, age, region and sector. Column (1) considers the whole sample of firms and does not include financial ratios. To asses the possible existence of sample selection, column (2) consider the subsample of firms for which we have information on the financial ratios only. Column (3) adds financial ratios to the estimations provided in column (2). Finally, column (4) considers financial ratios as well as the tighter definition of the exporting/importing activity of firms.

Several conclusions can be drawn from the estimations reported in table 4. First, we find that the share of temporary workers is negatively correlated with TFP performance during the

[19] See Izquierdo *et al.* (2003) for details.

Table 4: Firm fixed effects regression of estimated TFP.

	[1]	[2]	[3]	[4]
Share of temporary workers	-0.0511***	-0.0373***	-0.0372***	-0.0372***
	(0.00144)	(0.00216)	(0.00215)	(0.00215)
Importer-exporter	0.0865***	0.0603***	0.0631***	
	(0.00124)	(0.00154)	(0.00154)	
Importer-exporter (2008 threshold)				0.0907***
				(0.00192)
Firm agreement	0.122***	0.0753***	0.0758***	0.0756***
	(0.0168)	(0.0198)	(0.0199)	(0.0199)
Province agreement	-0.0254***	-0.0192***	-0.0190***	-0.0190***
	(0.00187)	(0.00245)	(0.00245)	(0.00245)
Regional agreement	-0.0273***	-0.0343***	-0.0326***	-0.0321***
	(0.00336)	(0.00439)	(0.00438)	(0.00438)
National agreement	-0.00654***	-0.00388	-0.00339	-0.00334
	(0.00189)	(0.00247)	(0.00247)	(0.00247)
Debt ratio			-0.0464***	-0.0463***
			(0.000651)	(0.000651)
Short term ratio			-0.00502***	-0.00494***
			(0.000547)	(0.000547)
10-19 employees	0.0243***	0.0122***	0.0113***	0.0108***
	(0.00138)	(0.00175)	(0.00175)	(0.00175)
20-49 employees	0.0503***	0.0395***	0.0397***	0.0383***
	(0.00246)	(0.00308)	(0.00308)	(0.00308)
>50 employees	-0.00147	0.0174***	0.0183***	0.0159**
	(0.00576)	(0.00654)	(0.00654)	(0.00654)
2-3 years	0.191***	0.0846***	0.0873***	0.0874***
	(0.00120)	(0.00201)	(0.00201)	(0.00201)
4-5 years	0.232***	0.126***	0.131***	0.131***
	(0.00149)	(0.00234)	(0.00233)	(0.00233)
6-8 years	0.250***	0.147***	0.153***	0.153***
	(0.00183)	(0.00270)	(0.00269)	(0.00269)
9-12 years	0.256***	0.160***	0.167***	0.167***
	(0.00235)	(0.00327)	(0.00327)	(0.00327)
13-17 years	0.253***	0.163***	0.172***	0.172***
	(0.00305)	(0.00406)	(0.00406)	(0.00406)
> 17 years	0.235***	0.159***	0.166***	0.167***
	(0.00392)	(0.00507)	(0.00507)	(0.00507)
Constant	3.292***	3.256***	3.258***	3.263***
	(0.0962)	(0.107)	(0.109)	(0.108)
Observations	5,618,004	2,862,843	2,862,843	2,862,843

Notes: Robust standard errors in parentheses. Year, region and sector dummies included.

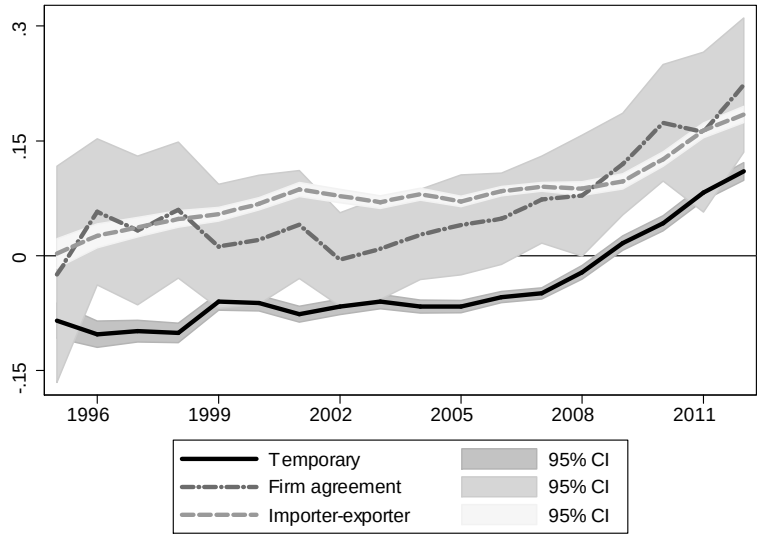
(***) Significant at 1%; (**) 5%; and (*) 10% level, respectively.

considered period, 1995-2012. Firms with a larger share of temporary workers are associated with poorer performance in terms of TFP. Second, firms having signed a collective agreement at the firm level perform better, in terms of TFP, than firms subject to a sectoral agreement. Third, being an importer-exporter positively correlates with TFP performance, whatever the definition we adopt for this indicator. Fourth, a negative and significant correlation arises between the debt ratio and TFP. Similarly, the short term debt ratio negatively correlates with TFP. Concerning other control variables, age is positively correlated with TFP performance, with older firms displaying better TFP performance than firms younger than 2 years. Finally, firm's size positively correlates with TFP performance as well.

6.2 Time variation

In order to assess the differentiated relationship of adjustment margins with respect to TFP over time, we allow the coefficients of the adjustment margins to vary year by year. The time variation of coefficients associated with the share of temporary workers, the firm agreement level and the use of foreign markets is displayed in figure 5. As previously, we control for time dummies, debt ratios and for indicators of firm's size, age, region and sector.[20]

Figure 5: Time variation in flexibility indicators.



Notes: Estimates from firm fixed effect regressions of TFP on firm's age, size, region, sector, debt ratios, adjustment indicators, and interactions of these latter with year indicators.

Figure 5 shows that firms committed to a collective agreement at the firm level perform better than the average in TFP terms since the beginning of the crisis, although the estimated effect

[20] In pratice, we add to every coefficient associated with the interacted variable the coefficient of the time dummy of the corresponding year. This allows us to obtain the differentiated relation between TFP and the explanatory variable year by year.

is imprecise. Similarly, firms using external markets perform better than average since the late nineties. On the contrary, firms with a larger share of temporary workers had performed worse in TFP terms during years preceding the crisis. This situation is reversed from 2009. Firms with a larger share of temporary workers perform increasingly better during the period 2009-2012.[21] This sign reversal, could be explained by the massive destruction of temporary jobs that yielded a selection process. As shown in figure A.1 of the appendix, the share of temporary contracts decreased substantially since 2007. Temporary workers surviving to this massive job destruction are likely to have different characteristics from those occupying temporary positions during years preceding the crisis.[22] Indeed, administrative records show that the proportion of high-skilled workers has increased among temporary employees since 2007.

6.3 Robustness check: TFP growth rate

Up to now, we have evaluated the correlation between adjustment margins and the level of firm TFP. However, the "Spanish Productivity Puzzle" refers to the different evolution of the productivity growth displayed by Spain relative to its European neighbors and the US. In this section then we seek to analyze how input adjustment margins (represented by the share of temporary workers and the type of collective agreement) and output adjustment margins (proxied by the fact of being an importer-exporter) may have influenced TFP growth. To do so, we simply modify the previous regression to introduce the yearly variation of the log of our estimated TFP for firm i, $(\Delta\widehat{\omega_{it}})$, as the dependent variable.

Estimation results are provided in table A.3 of the appendix. As previously, column (1) considers the whole sample of firms and does not include financial ratios. Column (2) includes only firms for which information on financial ratios is available. Column (3) introduces financial ratios to the estimations provided in column (2). Finally, column (4) considers the tighter definition of the exporting/importing activity of firms. Results are fairly consistent with previous estimates on TFP levels. The share of temporary workers is negatively correlated to TFP growth, while being an importer-exporter positively correlates with TFP growth, whatever the definition of importer-exporter we adopt. Now, however, the type of the collective agreement does not display a significant relationship with respect to TFP growth.

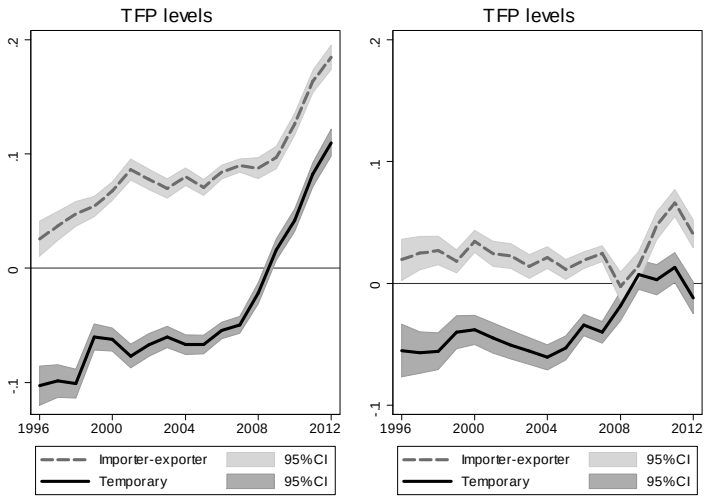
Finally, we allow the coefficients of the adjustment margins to vary year by year, in order to

[21] We have also implemented a fixed effects estimation of the correlation between the adjustment margins and firm's TFP in the two subperiods, 1995-2007 and 2008-2012. We find that being an importer-exporter positively correlates with TFP performance in both subperiods. Firms having signed a collective agreement at the firm level or at the national level perform better, in terms of TFP, during the expansion period. During the crisis, the situation is modified. Only firms committed to a national agreement perform relatively better. The share of temporary workers negatively correlates with TFP from 1995 to 2007, while after 2008 the correlation is positive. Estimates are available upon request.

[22] The improvement in the relative performance of firms employing a larger share of temporary labor during the crisis persists in constant sample of firms that survive from 1995 to 2012 (see figure A.2). Hence, we cannot disregard the changing composition of workers within firms as a plausible explanation for this evolution.

assess the differentiated relationship of these variables with respect to TFP growth over time. Figure 6 compares the time varying relationship between exporter-importer firms, the share of temporary workers and the evolution of TFP in levels (left hand side panel) and in growth terms (right hand side panel). As before, importer-exporter firms out-perform the rest over the whole period but even more after 2008. Concerning the share of temporary workers, when considering TFP growth, the negative since becomes insignificant during the crisis period.

Figure 6: Time variation in flexibility indicators: TFP levels *vs.* TFP growth.



Notes: Estimates from firm fixed effect regressions of TFP growth on firm's age, size, region, sector, debt ratios, adjustment indicators, and interactions of these latter with year indicators.

7 Conclusions

This paper seeks to gain insights on the apparent puzzling behavior of labor productivity in Spain during the economic crisis. While Spain had traditionally under-performed its European counterparts in terms of productivity, the trend is reverted during the crisis. Since 2007 Spain displays growth rates of aggregate labor productivity which are above France, Germany, the UK and as high as the US. Our analysis shows that this puzzling behavior of Spanish labor productivity results from a composition effect, with larger firms displaying a better TFP performance during the crisis.

Our econometric estimations suggest that, while the share of temporary workers is negatively correlated to TFP during the whole period 1995-2012, when we focus on the crisis period, the sign of this correlation is reverted. Again, compositional changes in the population of temporary workers during the crisis can justify this sign reversal. On the other hand, firms having committed to a collective agreement at the firm level display over the whole period a better TFP performance than firms engaged in sectoral collective agreements. Firms being exporters-importers also display

a better TFP behavior than average.

In sum, the most recent "Spanish productivity puzzle" does not seem to respond to permanent factors as average TFP has decreased during the crisis period. Instead, the recent improvement in labor productivity results from massive job destruction and an increased weight of large firms displaying better TFP performance.

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A Appendix

Table A.1: LP estimates (bigger samples).

	97% of the original sample		99% of the original sample	
	β_L	β_K	β_L	β_K
Agriculture	0.5459	0.0650	0.5328	0.0794
	(0.0044)	(0.0059)	(0.0048)	(0.0071)
Extractive	0.5869	0.1374	0.5611	0.2205
	(0.0159)	(0.0188)	(0.0154)	(0.0189)
Manufacture	0.6818	0.0664	0.6603	0.1122
	(0.0019)	(0.0017)	(0.0024)	(0.0029)
Energy	0.5482	0.1125	0.5084	0.1455
	(0.0105)	(0.0155)	(0.0116)	(0.0155)
Construction	0.5893	0.1091	0.5775	0.1217
	(0.0017)	(0.0014)	(0.0011)	(0.0014)
Sales	0.6467	0.0781	0.6345	0.0994
	(0.0015)	(0.0011)	(0.0011)	(0.0010)
Transport	0.6727	0.0967	0.6594	0.1147
	(0.0039)	(0.0029)	(0.0042)	(0.0038)
Tourism	0.4613	0.0905	0.4439	0.1118
	(0.0029)	(0.0029)	(0.0030)	(0.0029)
Education-Health	0.5733	0.0826	0.5662	0.1024
	(0.0039)	(0.0036)	(0.0044)	(0.0047)
Other non-financial services	0.6197	0.0829	0.6104	0.0986
	(0.0015)	(0.0014)	(0.0016)	(0.0011)
Observations	5,971,647		6,347,775	

Notes: Bootstrap standard errors in parentheses (100 replications).

Table A.2: Comparison of LP estimates for different definitions of capital (1995-2012).

	Total capital at book value		Tangible capital at book value		Tangible capital at market value	
	β_L	β_K	β_L	β_K	β_L	β_K
OLS	0.6608	0.1125	0.6702	0.0934	0.6700	0.0997
	(0.0065)	(0.0032)	(0.0066)	(0.0031)	(0.0065)	(0.0031)
FE	0.7752	0.0931	0.7893	0.0636	0.7860	0.0740
	(0.0057)	(0.0030)	(0.0057)	(0.0028)	(0.0057)	(0.0029)
LP	0.5630	0.0787	0.5658	0.0731	0.5710	0.0778
	(0.0069)	(0.0086)	(0.0066)	(0.0067)	(0.0068)	(0.0060)

Notes: Obs=86,185. Bootstrap standard errors in parentheses (100 replications).

Figure A.1: Changing composition of temporary workers.

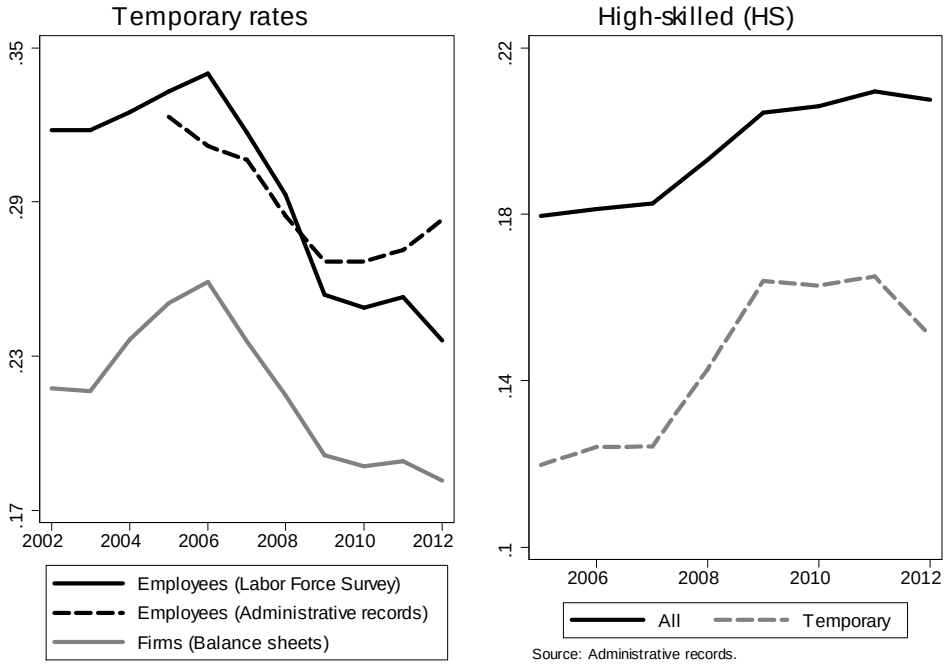


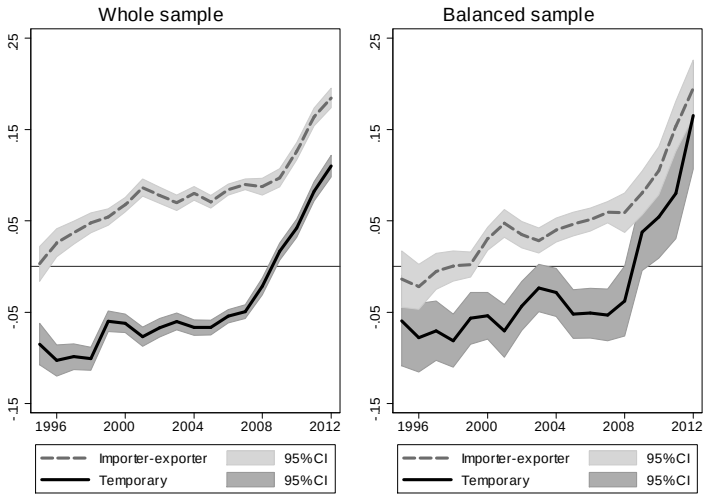
Table A.3: Firm fixed effects regression of estimated TFP growth.

	[1]	[2]	[3]	[4]
Share of temporary workers	-0.0267***	-0.0314***	-0.0315***	-0.0315***
	(0.00157)	(0.00230)	(0.00230)	(0.00230)
Importer-exporter	0.0305***	0.0189***	0.0195***	
	(0.00125)	(0.00156)	(0.00156)	
Importer-exporter (2008 threshold)				0.0258***
				(0.00193)
Firm agreement	0.0215*	-0.00501	-0.00493	-0.00496
	(0.0128)	(0.0168)	(0.0169)	(0.0169)
Province agreement	-0.00386**	-8.85e-05	-1.04e-05	7.59e-06
	(0.00156)	(0.00219)	(0.00219)	(0.00219)
Regional agreement	-0.00420	-0.00154	-0.00111	-0.000959
	(0.00291)	(0.00403)	(0.00403)	(0.00403)
National agreement	-0.00459***	-0.000969	-0.000834	-0.000817
	(0.00167)	(0.00231)	(0.00231)	(0.00231)
Debt ratio			-0.0108***	-0.0108***
			(0.000556)	(0.000556)
Short term ratio			0.00140***	0.00143***
			(0.000525)	(0.000525)
10-19 employees	-0.0884***	-0.0820***	-0.0822***	-0.0823***
	(0.00123)	(0.00156)	(0.00156)	(0.00156)
20-49 employees	-0.153***	-0.142***	-0.142***	-0.142***
	(0.00209)	(0.00259)	(0.00259)	(0.00259)
>50 employees	-0.246***	-0.215***	-0.215***	-0.216***
	(0.00532)	(0.00612)	(0.00612)	(0.00611)
2-3 years	-0.407***	-0.357***	-0.357***	-0.357***
	(0.00271)	(0.00383)	(0.00383)	(0.00383)
4-5 years	-0.474***	-0.415***	-0.414***	-0.414***
	(0.00274)	(0.00389)	(0.00389)	(0.00389)
6-8 years	-0.490***	-0.428***	-0.426***	-0.426***
	(0.00282)	(0.00401)	(0.00401)	(0.00401)
9-12 years	-0.492***	-0.427***	-0.426***	-0.425***
	(0.00304)	(0.00430)	(0.00430)	(0.00430)
13-17 years	-0.485***	-0.420***	-0.418***	-0.418***
	(0.00340)	(0.00477)	(0.00477)	(0.00477)
> 17 years	-0.478***	-0.413***	-0.411***	-0.411***
	(0.00402)	(0.00555)	(0.00555)	(0.00555)
Constant	0.570***	0.514***	0.515***	0.517***
	(0.102)	(0.159)	(0.158)	(0.158)
Observations	4,655,781	2,603,968	2,603,968	2,603,968

Notes: Robust standard errors in parentheses. Year, region and sector dummies included.

(***) Significant at 1%; (**) 5%; and (*) 10% level, respectively.

Figure A.2: Time variation in flexibility indicators: whole sample *vs.* balanced sample.



Notes: Estimates from firm fixed effect regressions of TFP growth on firm's age, size, region, sector, debt ratios, adjustment indicators, and interactions of these latter with year indicators.