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Globalization and market power

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Abstract

Economic theory suggests that the markup is the most appropriate measure of market power and that its relationship with trade is rich and complex. Trade liberalisation can reduce markups via a decline in the residual domestic demand but also increase it via several channels. First, the incomplete pass-through of the cost reductions produced by lower input tariffs. Second, trade leads to more concentrated markets via entry and exit, putting upward pressure on markups. Third, market shares reallocation toward larger, more powerful firms, increase the aggregate markup. We propose a simple model of trade under oligopoly which incorporates all these channels. Using a large episode of trade liberalisation in Spain, we test this rich set of mechanisms linking trade and markups. The overall effects of trade on firm-level and aggregate markups is pro-competitive but we find evidence of offsetting effects via the other channels. In particular, we show that firms protected by higher barriers to entry, measured as high intangible investment, R&D spending and patents, experience a weaker reduction in markups. Supporting a new theoretical insight emerging from our model that the feedback effect on trade-induced concentration on markups is stronger with higher barriers to entry.

Keywords: International trade, markups, oligopoly.

JEL Classifications: F12, F13, F60.

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1 Introduction

Recent decades have witnessed a substantial increase in several measures of firms market power. De Loecker et al. (2020) provide evidence of a substantial increase in markups in the US since the 1980s. The empirical results in De Loecker and Eckhout (2020), Bajgar et al. (2019), and Diez et al. (2021) suggest that the increase in markups is a global phenomena. Why are firms becoming more powerful? Market power can be driven by technological and institutional change and, since the dynamics of markups and concentration seem to be global, globalisation can undoubtedly be another important source.

This article explores the relationship between trade liberalisation and markups. The received view is that trade is pro-competitive and consequently globalisation should not be considered as a plausible source of rising markup power. Digging deeper into economic theory reveals a rich and complex relationship between trade and markups. We present a simple model of oligopoly trade highlighting several channels through which globalisation can put upward pressure on markups. These theoretical insights guide our empirical investigation of the trade-markup nexus which exploits a large episode of trade liberalisation experienced by Spain in the post EU entry period.

In our theoretical model trade affects markups via a a rich set of channels through. First, markups on domestic sales decline via the standard *pro-competitive effect*: lower trade barriers imply lower residual demand for domestic goods which forces firms to reduce their markups on domestic sales. Second, foreign firms' export markups increase via the standard *incomplete pass-through* channel. Firms transfer only part of the reduction in the cost of export onto consumers, with the remaining part going to markups. Third, due to the competitive pressure induced by trade, the number of firms competing in each market declines. This *concentration effect* which increases markups is stronger the larger the entry cost and the economies of scale, measures of barriers to entry. This is a novel insight highlighted by our model: when barriers to entry are high, firms operate in low competitive environments, with only very few competitors, so that even a small reduction in the number of firms has a strong impact on market power. Finally, a typical feature of our oligopolistic model with Cournot competition is that a firm's markup is positively related to its market share. Consequently, trade can increase the aggregate markup via a *reallocation* of market shares toward larger/more productive firms.

These theoretical predictions inform our empirical analysis of the effects of trade liberalisation on markups in the Spanish manufacturing industry in the period 1990-2010. In these years, especially in the first decade, Spanish import tariffs experience a substantial decline, perhaps related to EU access and the subsequent Single Market Program. We use firm-level data from a survey of Spanish manufacturing firms, the Encuesta sobre Estrategias Empresariales (ESSE), to estimate markups via the production function approach (De Loecker and Warzynski, 2012). The results suggest that the aggregate markup is declining for most of our sample period, although a partial reversion of the trend can be observed in the last years. Our empirical analysis reveals that the relationship between import tariff reductions and markups at the firm level is negative, thereby confirming the received view that trade has a pro-competitive effect. Offsetting forces operating via the incomplete pass-through and the concentration channels tame the pro-competitive effect of trade on firm-level markups but do not overturn it. Specifically, a decline in input tariffs is associated with an increase in markups. Markups decline less for firms operating in industries experiencing a bigger reduction in the number of firms. This is a first pass at testing the concentration effect, but there are endogeneity concerns as we are splitting the sample with respect to an endogenous variable, the number of firms. To tackle this issue directly test the model's prediction that larger entry and fixed operating costs produce a stronger concentration and therefore a weaker pro-competitive effect of trade. As typical in the IO literature we take R&D, intangible investment and patents as measures of barriers to entry (e.g. Demsetz, 1982; McAfee et al., 2004). We interact the change in import tariff with values of barriers to entry before trade liberalisation. We find that the pro-competitive effect is stronger for firms in the lower quartiles of the distribution of intangible investment, R&D expenditure and patents.

Moving from firm-level to aggregate analysis we find that the observed changes in the aggregate markup are essentially driven by within-sector variation. Moreover, decomposing the overall variation into a between and within-firm component reveals that both margins contribute to the aggregate changes. Trade liberalisation reduces the markup via its within-firm component, in line with our firm-level findings, but increases it via its between-firm component, in line with the reallocation channel. The effect of trade on the within component is stronger and the overall impact on sectoral markups is negative, suggesting that the within channel dominates and that the overall effect of trade on the aggregate markup is pro-competitive.

We run a large set of analyses to test the robustness of these results. To show that the trends inferred from our baseiline measures of markups are robust, we use an alternative measures that exhibits the same trends. We also perform a sanity check to corroborate our firm-level markup estimate trends by using publicly available sector-level and whole economy data from KLEMS. We also use cost share estimates of markups as robustness. Our production function approach to estimate markups uses a baseline specification where the input with respect to which the markup is measured is materials and the production function is translog. We perform robustness analysis with respect to both specifications, focusing on labor as the key input and using a Cobb-Douglas production function. We perform a direct test of the effect of trade on concentration, which we measure using typical market concentration ratios. Finally, we also use import penetration, instead of tariffs, as a measure of the trade shock, following the approach in Autor et al. (2014).

Literature review. Our work is related to the recent literature on the dynamics of market power and its possible sources. De Loecker et al. (2020), Autor et al. (2020), and Bajgar et al. (2019) document a remarkable increase in market power, measured as markup and concentration, in the US and Europe in the last three decades. De Loecker and Eckhout (2020) and Diez et al. (2021) show evidence suggesting that this trend is global - though differing in the size of the observed changes.[1]

Several recent papers provided explanations for these facts based on technological or institutional channels. Gutierrez and Philippon (2018) use a political economy model to show that countries in a single market tend to promote supranational regulation enforcing stricter competition. They test and validate the prediction of the model showing that European institutions enforce more competition. Another research line instead explores channels operating via innovation and technological change. Aghion et al. (2017) show that the IT revolution has enabled superstar firms, with high markups, to expand thereby increasing the average markup in the economy. Similar results are obtained in De Ridder (2020) where the source of rising market power is the increase in the use of intangible inputs. Akcigit and Ates (2019) focus instead on the slowdown of the diffusion of technology from frontier firms to laggards.[2] We contribute to this literature by analysing a different source of market power, globalisation.

Closely related to our work is the empirical literature on the impact of trade on markups. Early studies of the impact of trade on firm-level markups focused on reductions in output tariffs, finding evidence of pro-competitive effects (e.g. Harrison, 1994; Levinsohn, 1993). Recently, De Loecker et al. (2016) extend the analysis to reductions in tariffs on intermediate inputs, generating a decline in costs that can increase markups if firms do not pass it entirely to consumers. Studying an episode of large scale liberalisation in India, they find that both channels are important to understand the transmission mechanisms and measure the overall impact of trade on markups.[3] Our analysis digs deeper into the potential channels linking trade and markups. Specifically, our theoretical insights suggest that lower output tariffs are not necessarily pro-competitive, as trade can increase firm-level markups as a result of a concentration effect. We provide the first empirical test of this channel. Moreover, trade-induced reallocations of market shares toward more productive firms charging higher markups can produce upward pressure on aggregate markups. To the best of our knowledge we are also the first to provide a test of the reallocation channel. [4]

The pro-competitive and incomplete pass-through channels feature in a large class of theoretical models with variable markups. Arkolakis et al. (2019) show that in monopolistically

[1] Two recent books, Philippon (2019) and Eeckhout (2021) summarise the facts and provide a broad overview of potential causes and consequences of rising market power.

[2] Another line of work suggests that the slowdown of population growth can be at the roots of increasing market power, via its impact on the creation of new firms (Peters and Walsh, 2003; Hopenhayn et al., 2022). Liu et al. (2020) highlight the role of persistently low interest rates in shaping the innovation and productivity gap between market leaders and followers and consequently the dynamics of market power.

[3] Similarly, Brandt et al. (2017) find negative effects on markups of output tariff cuts related to China's access into the WTO, while input tariff cuts have positive effects. Baccini et al. (2018) find a negative effect of Vietnam entry into WTO on private firms but not on state owned enterprises.

[4] Results in Autor et al. (2020) suggest that the observed increase in the aggregate markup in the US is driven by a reallocation toward firms with higher markups but there is no direct empirical test of the sources of this reallocation.

competitive models where endogenous markups are obtained departing from CES preferences, the horse race between those two channels crucially depends on the choice of preferences. Under translog preferences the two offset each other, while if preferences are non-homothetic the incomplete pass-through channel dominates and trade increases markups.[5] Introducing heterogeneous firms opens up the possibility of a positive effect of trade on aggregate markups via the reallocation channel (e.g. Melitz and Ottaviano, 2008). Oligopolistic trade models feature these channels as well (e.g. Brander and Krugman, 1983; Atkeson and Burstein, 2008; Edmond et al., 2015). Moreover, Impullitti et al. (2021) show that in this class of models free entry generates the concentration effect of trade, a further channel through which globalisation can increase market power. Our model combines a version of Impullitti et al. (2021), simplified to obtain analytical results, with elements from Edmond et al. (2015) to illustrate the reallocation channel. This insight provides theoretical guidance for testing the concentration effects of trade.

2 Theoretical model

We present a simple theoretical framework where firms compete strategically for market shares in the global economy, and competition leads to endogenous markups. The economy features a continuum of product lines, each producing a different variety of goods, and varieties are imperfectly substitutable. The global economy is made of two symmetric countries, producing the same varieties with the same technologies. Each variety can be produced by a small number of home and foreign firms competing a la Cournot for market shares. It follows that firms are "large in the small but small in the large": relevant actors in their own market, interacting strategically with their competitors, but infinitesimal in the economy as a whole (e.g. Neary, 2010). The framework is essentially a general equilibrium version of the classic model of oligopoly trade (Brander and Krugman, 1983).

Environment. Households are endowed with one L units of labor and consume an homogenous good and a composite good deriving utility

$$U = \ln X + \beta \ln Y \tag{1}$$

where is Y, homogeneous good, and X composite good is a CES aggregate of a continuum of varieties,

$$X = \left(\int_0^1 x_j^{\alpha} dj \right)^{\frac{1}{\alpha}}. \tag{2}$$

The homogeneous good is produced under perfect competition using one unit of labor and

[5] For related analysis of the effects of trade on markups in monopolistic competitive frameworks see also Mrazova and Neary (2019), Feenstra and Weinstein (2017), Feenstra (2018), and Bertoletti and Epifani (2014), among others.

it is the numeraire of the economy. It follows that the equilibrium wage is equal to one.[6] Each variety of the differentiated good is produced by a small number of identical firms v n. Firms within a variety compete strategically a la Cournot, using the following production technology,

$$q = z\left(\ell - \lambda\right) \tag{3}$$

where q is the quantity produced, ℓ is labor, λ fixed operating cost in terms of labor and z is productivity, equal for all firms. Firms can export paying an iceberg trade cost $\tau > 1$.

Equilibrium price and markup. The symmetric Cournot equilibrium leads to the standard markup pricing in this class of oligopoly models. The unique price in both domestic and foreign markets is,

$$p(z) = \frac{1}{z\theta_d} = \frac{\tau}{z\theta_f},$$

θ_d is the inverse of the markup on domestic sales,

$$\theta_d = \frac{2n + \alpha - 1}{n\left(1 + \tau\right)}$$

and $\theta_f = \tau\theta_d$ is the inverse of the markup on export sales.[7] The inverse of a firm average markup can be written as

$$\theta \equiv \frac{q_d\theta_d + q_f\theta_f}{q_d + q_f} = \mathcal{A}\,\theta_d,$$

a weighted average of the domestic and export markups, using market shares as weights.[8] Notice that θ_f reaches one when $\tau = \bar{\tau} = n/(n + \alpha - 1)$, so $\bar{\tau}$ corresponds to prohibitive trade costs, a limit above which the export markup becomes negative and firms do not export. Hence, in this framework an equilibrium with two-way trade in identical goods is possible only if the trade cost is below its prohibitive level, $\bar{\tau}$.

Proposition 1 *In a symmetric Cournot equilibrium, for a given number of firms, a reduction in the trade cost reduces the domestic markup, increases the export markup, and reduces the average firm-level markup. Formally,*

- Pro-competitive effect:

$$\frac{\partial\theta_d}{\partial\tau}\frac{\tau}{\theta_d} = -\frac{\tau}{1+\tau} \in (-1, 0),$$

[6] The homogeneous good does not have any other role than simplifying the algebra.

[7] Another way to write the markup is $\theta_d = \left(n - (1-\alpha)s_d\right)/n$, where s_d is the share of each firm on the domestic market.

[8] The term $\left(q_d + \tau q_f\right) / \left(q_d + q_f\right) \equiv \mathcal{A} = \frac{(1-n-\alpha)(1+\tau^2)+2n\tau}{(1-\alpha)(1+\tau)} > 1$, is the distorsion associated to two-way trade in identical goods.

- Incomplete pass-through

$$\frac{\partial \theta_f}{\partial \tau}\frac{\tau}{\theta_f} = \frac{1}{1+\tau} \in (0,1)$$

- Average markup

$$\frac{\partial \theta}{\partial \tau} = -\frac{2n(\tau-1)\theta_d^2}{(1-\alpha)(1+\tau)} < 0.$$

The negative effect of a reduction in the trade cost on the domestic markup is the typical pro-competitive effect of trade. Foreign firms exert a stronger competitive pressure on home firms in their market, when the cost to access that market is lower. In addition to this, trade liberalisation pushes firms to increase their markup on export sales. Firms with market power transfer only a part of the reduction in the cost of accessing foreign markets cost onto prices, the other part is used to increase their markup. Finally, trade liberalisation decreases firms' average markups on total sales. This suggest that in our simple economy with CES preferences and without free entry, the pro-competitive effect of trade dominates the incomplete pass-through.

Free entry. We now introduce a simple entry strategy to analyse the feedback effect of entry on markups. To keep the analysis tractable we treat the number of firms as a real number, thus abstracting from the 'integer problem'.[9] As in Impullitti and Licandro (2018), entry is undirected, so that firms pay a fixed entry cost f_e and then draw the particular variety that they can produce. Firms enter until the expected profits are zero. Since entry is undirected and firms and varieties all operate the same technology, the equilibrium number of firms is the same for all varieties. Variable labor demand resulting from the symmetric Cournot equilibrium is $z^{-1}q = \theta e$, with $e = E/n$ being the expenditure share of each firm. The free entry condition sets profits net of entry cost to zero, $\pi = (1-\theta(n:\tau))e - \lambda = f_e$.

To close the model we need to characterise the labor market clearing condition. For ease of exposition, we assume that the potential number of entrants are proportional to the number of incumbents, that is $n_e = \bar{n}_e n$.[10] The market clearing condition is, $[(\theta(n;\tau)e+\lambda) + \beta e + \bar{n}_e n f_e] = 1$, where total labor used as variable input, fixed cost and entry cost is equal to total supply.

Proposition 2 *In a Cournot equilibrium with free entry, a reduction in the trade cost reduces the number of firms in both countries. This is the concentration effect:*

$$\frac{\partial n}{\partial \tau} > 0,$$

[9] Numerical analysis of the entry process with a discrete number of firms in this class of models in open economy can be found in Edmond et al. (2015) and Impullitti et al. (2021).

[10] The number of potential can be also be modelled independently from the number of incumbents without qualitative implications for the key results. See Impullitti et al. (2021)

which implies that the impact of trade on export markup is anti-competitive,

$$\frac{\partial \theta_f(n)}{\partial \tau} > 0,$$

while that on domestic markups is ambiguous,

$$\frac{\partial \theta_d(n)}{\partial \tau} = \begin{cases} > 0 & \text{if} \quad \xi_{n,\tau} > \left(\frac{2n}{1-\alpha} - 1\right)\frac{\tau}{1+\tau} \\ < 0 & \text{if} \quad \xi_{n,\tau} < \left(\frac{2n}{1-\alpha} - 1\right)\frac{\tau}{1+\tau}. \end{cases}$$

where $\xi_{n,\tau} = \frac{\partial n}{\partial \tau}\frac{\tau}{n}$ *is the elasticity of* n *with respect to* τ*.*

Trade liberalisation reduces the number of firms competing in each product line. As shown in Proposition 1, for a given number of firms, the pro-competitive effect on the domestic markup dominates the anticompetitive effect on the export markup, producing a reduction of the average markups. Absent any entry and exit then the reduction in average markups leads to a decline in profits. With free entry, this reduction in profits forces some firms out of the market. A lower number of firms, in turn, pushes markups upward. The export markup increases even more than in the scenario without free entry, as the impact of this *concentration effect* adds to that of the incomplete pass-through. The concentration effect also puts upward pressure on the domestic markup and under some conditions can completely overturn the direct effect of a reduction of trade costs on this markup seen in Proposition 1. This suggests that, along with the incomplete pass-through channel, there is another mechanism through which trade liberalisation can increase markups, and it operates via the entry/exit margin.[11]

Proposition 3 *If* $1/\theta < (\sqrt{\bar{n}_e} + 1)/(\sqrt{\bar{n}_e} - \beta)$*, the concentration effect is stronger the higher the barriers to entry, measured as entry cost,*

$$\frac{\partial^2 n}{\partial \tau \partial f_e} > 0.$$

If $1/\theta < 1/(1-\beta)$*, the concentration effect is stronger the higher the barriers to entry, measured as economies of scale,*

$$\frac{\partial^2 n}{\partial \tau \partial \lambda} > 0.$$

[11] In a richer version of this class of models, Impullitti et al. (2021) show that the concentration effect can be quantitatively powerful and totally overturn the pro-competitive effect of trade. Note that while the pro-competitive effect and the incomplete pass-through channel can be also obtained in versions of the monopolistic competitive model of trade, the feedback of the concentration effect on the markup is an original feature of models with strategic interaction. As shown in Bertoletti and Epifani (2014), when using additively separable utility functions to generate endogenous markups in monopolistic competition, the demand elasticity and so the markup is independent on the number of competitors. While with non-additively separable preferences, demand elasticity responds to the number of firms, but the latter increases with trade liberalisation (e.g. Melitz and Ottaviano, 2008).

Firm heterogeneity. Autor et al. (2020) show that key reason for the increase in the aggregate markup observed in the US data can be related heterogeneity of markups across firms and the reallocation of market shares toward high markup firms. Our model can be easily extended to incorporate heterogeneous productivity across firms generating size and markup heterogeneity. To keep the model tractable while highlighting the role of heterogeneity we follow Atkeson and Burstein (2008) and Edmond et al. (2015) and generalise the model assuming that oligopolistic each firm competing within each variety produce an imperfectly substitutable version of that good. Moreover, we assume that in each variety, which we now call sector, firms have different productivities. For the scope of this paper we do not need to solve the whole model, it suffices to derive the expression for firm-level markups showing the larger firms charge higher markups.

Let us assume that total quantity of sector j sold in the home country is made of a composite of domestic and imported varieties

$$x(j) = \left(\sum_{i=1}^{n(j)} q_{di}(j)^{\beta} + \sum_{i=1}^{n(j)} q^{*}_{fi}(j)^{\beta} \right)^{\frac{1}{\beta}},$$

where $\sigma_b = 1/(1-\alpha) < \sigma_w = 1/(1-\beta)$, that is the elasticity of substitution between goods from different sectors is smaller than that between varieties within each sectors. The optimal price of home firm i in domestic mkt.

$$p_i(j) = \frac{\epsilon_i(j)}{\epsilon_i(j)-1} \frac{1}{z_i(j)}$$

where

$$\epsilon_i(j) = \left[\omega_i(j) \frac{1}{\sigma_b} + (1-\omega_i(j)) \frac{1}{\sigma_w} \right]^{-1}$$

the demand elasticity on the domestic market, and $\omega_i(j)$ is firm i share of revenues in sector j on that market, and $z_i(j)$ is the productivity of firm i in sector j which is drawn from a given distribution at entry. The markup on domestic sales of firm i in sector (j) can then be written as,

$$\mu_i(j) = \frac{\epsilon_i(j)}{\epsilon_i(j)-1} = \left[\frac{\sigma_w - 1}{\sigma_w} - \left(\frac{1}{\sigma_b} - \frac{1}{\sigma_w} \right) \omega_i(j) \right]^{-1}.$$

Firms with higher market shares face lower demand elasticity and charge higher markups. Consequently, any reallocation of market shares toward large firms, originating from trade or other shocks, would increase the aggregate markup.[12] The impact of trade on market shares reallocation cannot be derived analytically, but numerical results in Edmond et al. (2015) and Impullitti et al. (2021) suggest that in this class of models, similarly to monopolistically competitive models of trade with firm heterogeneity (e.g. Melitz, 2003), trade reallocates resources toward larger and more productive firms.This reallocation channel then contributes to the dynamics

[12] Autor et al. (2020) obtain a similar result in monopolistic competition under a specific departure from CES preferences and with a particular form of productivity distribution.

of the aggregate markup response to globalisation alongside the firm-level channels described above. Taking stock, the relationship between trade and markups that emerges from our theory is complex and presents a rich set of testable predictions. Trade liberalisation:

1. Reduces domestic firm-level markups via the standard *pro-competitive effect*.
2. Increases domestic firm-level markups via a *concentration effect*. This effect is stronger the higher the domestic barriers to entry.
3. Increases export firm-level markups via the standard *incomplete pass-through* channel
4. Increases the aggregate markup via a *reallocation effect*.

In what follows, we will use these theoretical insights to guide our empirical investigation of the relationship between trade and markups.

3 Empirical Implementation and data

We lay out our empirical strategy to estimate markups and present a description of the main data sources we use in the analysis that follows.

3.1 The production function approach

We follow the now widely used production function approach (e.g. De Loecker and Warzynski, 2012) and derive firm level markups from the first order condition of a standard cost minimisation decision. The resulting markup can be expressed as a function of the cost share of any variable input in the optimal firm decision and the elasticity of production to that input.

$$\mu_{it} = \theta_{ivt} \frac{P_{it} Q_{it}}{P_{vit} V_{it}}, \tag{4}$$

where θ_{ivt} is the elasticity of firm i's output to input v and the second term is the cost share of this input. While the cost shares are usually directly available from the data, the elasticity is estimated using production function estimation. For our baseline measure of markups, we choose materials as the variable input of choice as it is the most flexible and least adjustment cost intensive of inputs in the production function - compared to capital and labour. We estimate a translog specification of the production function which allows for time varying θ_{imt} parameters. This allows us to capture sector and time varying technological changes in the data. A detailed overview of the production function estimation procedure is outlined in C.

3.2 Data

We use data from the longitudinal survey of Spanish manufacturing firms named Encuesta sobre Estrategias Empresariales (ESSE). This dataset has been designed to form a representative sample of the Spanish manufacturing sector. Firms with workers ranging from 10-200 are sampled randomly based on industry and size groups (retaining 5 percent). All firms with more than 200 workers are requested to participate and the collaboration rate is substantial at around 64 percent. The dataset comprises an unbalanced panel of 5,040 firms with a total of 43,733 observations from 1990 to 2014, belonging to 20 different industries.

The dataset contains information on firm's inputs and outputs. Firms report price changes from their main products and inputs, and ESSE uses this information to create annual estimation of firm specific input and output price changes. For our empirical analysis, we will clump these price changes together to build firm-specific price indices [5], normalising them to one at 1989, which will be our reference year. These price indices will be used to deflate our variables of interest. More specifically, we use the change in sales price to create a price index for deflating our output, and sales variables. We use the change in prices of intermediate consumption goods to deflate value added, and materials. For firms that were surveyed in years later than 1990, we use industry averages of the price index between the reference year and the year that they are included in the sample. We construct our variable for capital stock using the perpetual inventory method outlined in Olley and Pakes (1996). Firm's investments in equipment and machinery are deflated using industry-specific price indices produced by the Spanish Instituto Nacional de Estadstica (INE). Depreciation rates come from the INE as well.[6] We can find expenditure shares directly in the data, so we need not worry about having separate price values to obtain our firm-level markup estimates.

Our baseline measure for trade exposure is tariffs that Spain imposes to imports the rest of the world in each industry over the period 1990 to 2010, we call these *output* tariffs. We use MFN tariffs from TRAINS (provided by UNCTAD) accessed via the WITS software provided by the World Bank. We match these with our dataset at the three-digit industry level. Import tariffs on the inputs of an industry j are based on Spanish input-output tables from the WIOT (World Input-OutputDatabase). We compute an *input* tariff as a weighted average of the output tariffs as follows:

$$input\ tariff_t^k = \sum_j w_{jk}^t\ x\ output\ tariff_t^j, \tag{5}$$

where weights w_{jk}^t are the cost shares of industry j in the production of a good in industry k at

[5] For firms with missing values in price changes, we replaced them with their industry average.

[6] The book value of capital for year 1990 has been used to set the initial capital for firms; for firms entering the sample after, we use the book value of the corresponding observed year

time t. For example if industry k uses 70 percent steel and 30 percent rubber, we give a 70 percent weight to the steel tariff and a 30 percent weight to the rubber tariff.

3.3 Trade liberalisation in Spain

Historical background. In the 1980's Spain was in the process of political transition, with its previous statistic economic system being done away with in favour of a more globalised trading environment for firms. This transition period marked a series of adjustment problems for certain sectors as firms could no longer resort to keeping labour costs down by suppressing workers' rights, as was the case up until the late 1970's. With the eventual right to organize free trade unions becoming available to workers, a lot of firms could no longer operate profitably due to higher labour costs. By 1985, Spain had signed an agreement to join the European Union, and became a full member in 1986. In conjunction with these events, the European Union was also in the process of implementing one of the largest trade liberalisation programmes since the late 1960's, called the Single Market Programme [1]. Spain was also subject to a foreign direct investment boom in the late 1980s which increased domestic competition amongst firms to a significant degree. In light of these changes to the economic landscape, competition laws were enacted by the Spanish government to help regulate the domestic market [2] . In sum, the Spanish economy was subjected to a positive supply shock arising from three contemporaneous and orthogonal sources: domestic reform, EU membership and the Single Market Programme.

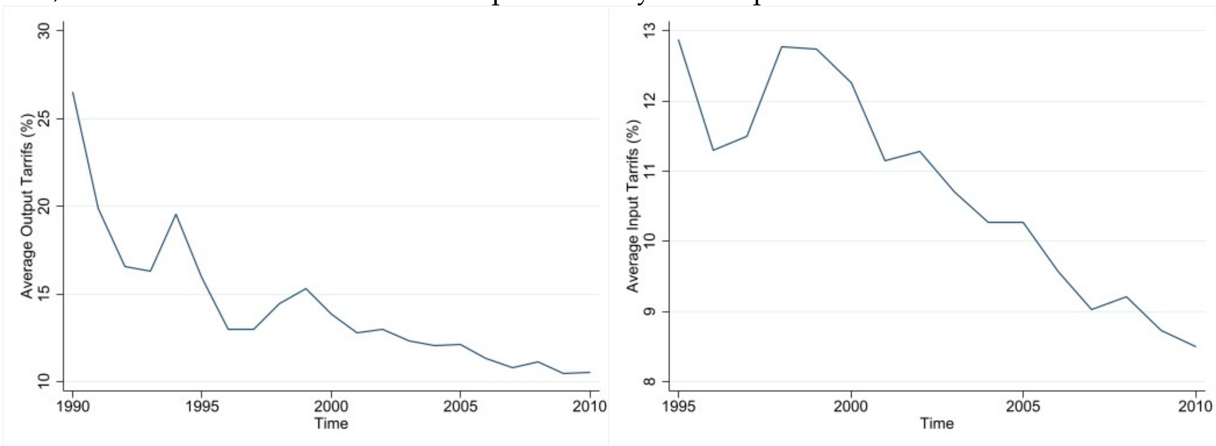
The dynamics of import tariffs. The purpose of outlining the trade liberalisation process above is to provide context for our rationale to explore the ramifications of changes in trade openness on firm-level markups. Given the scope of our dataset and the contemporaneous nature of the trade policy reforms discussed in the previous paragraph, our analysis cannot be conducted in the style of a "natural experiment", where the before and after effects of trade liberalisation on firm-level markups are captured. We are interested, instead, in empirically examining the effects of trade openness on markups, given this priori context of successive trade liberalisation episodes in Spain.

In this section, we present the trends for average output and input tariffs to illustrate the size and direction of the trade liberalization episode we focus on. Figure 1 below shows the average output tariff for the three-digit industries belonging to the Spanish manufacturing sector in the sample period 1990 to 2010. We can clearly see a sharp decline across time, dropping from 27 percent in 1990, to roughly 10 percent in 2010. The trend is common to the wide majority of sectors, as shown in Figure A.1. Average input tariffs, also exhibit a reduction across the sample period as illustrated in Figure 1 below. It drops from 13 percent in 1990 to less than 9 percent in

[1] This exercise involved the removal of roughly 300 non-tariff barriers (NTBs) that still existed in the EU. See Buiges et al. 1990 for more information on the latter.

[2] The Competition Law in Spain is based on the articles of the Treaty of Rome.

2010, a less severe decline than that experiences by the output tariff.



A) Output tariff

B) Input tariff

Figure 1: Average tariff, manufacturing: 100-2010

We also provide evidence that along with a reduction in tariff barriers came a substantial shock in the import shares of the Spanish economy. Figure A.2 shows the trend of average import penetration across the sample period. We can see a steady and remarkable increase in import penetration.

Endogeneity of trade policy. In order to use the variation in output and input tariffs effectively for testing our hypothesis, we need to examine whether the changes in Spanish tariffs are related to economic factors that might create endogeneity problems for these measures. It is therefore important to check whether changes in tariffs are a product of the lobbying power of the industry in question, or if politically important industry characteristics shape their movement.

We follow Topalova and Khandelwal (2011) strategy for checking for endogeneity of tariffs by performing two exercises. We first check the extent to which tariffs move together across sectors. If tariffs do not move together then it is likely that industry specific lobbying power is shaping their variation, thereby exhibiting evidence of endogeneity. In Table A.4 and A.5 we report the correlation cross-sectoral correlation for both output and input tariffs for three-digit industries. The results suggest that their movements are surprisingly uniform throughout the sample period.

In our second exercise, we test whether our measures of trade liberalization are correlated with measures of politically important industry characteristics, by regressing the change in output tariffs between 1991 and 2010 on industrial characteristics in 1990. These characteristics include labor costs (policymakers might be interested in protecting industries with workers on lower wages which might be more vulnerable to international competition), employment (larger labour force may lead to more electoral power and consequently more protection), output, capital, and factor size (firms with larger plants will potentially be able to organise lobbying forces

Table 1: Tariff Correlations with Industry Characteristics

	OLS				
	(1)	(2)	(3)	(4)	(5)
	Log Labor Costs	Capital Labor Ratio	Log Output	Factory Size	Log Employment
Output Tariffs	7.546	2.219**	6.626	18.310	7.650
	(9.137)	(1.076)	(8.003)	(88.013)	(8.317)
N	11	11	11	6	11
R^2	0.218	0.248	0.175	0.072	0.278

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using OLS and includes year dummies, and standard errors are clustered at the three-digit industry level.

more effectively). From Table 1 below we can see that there is no statistical correlation between output tariffs and most of the industry characteristics, with the exception of capital-labour ratio.

4 The evolution of markups in the Spanish manufacturing sector

In this section, we present some key characteristics of our estimated markups. We first report the trend in the aggregate markup and in its distribution across firms. Then we decompose the aggregate trend between sectors and between firms within sectors.

4.1 Aggregate markup

Figure 2 shows the unweighted average firm markup across Spain's manufacturing sector, reporting both our baseline specification using the Translog production function and an alternative using a Cobb-Douglas. In our baseline estimation we choose materials as the input used to recover the relevant elasticity. The average markup has been declining consistently across the time period of our sample – for both specifications. The sharpest decline can be noted to occur between 1991 and 1994, where the markup fell from from 1.7 to 1.48 for the Translog and from 1.68 to 1.35 for the Cobb-Douglas case. From 1995 onwards, the negative trend persists but at a lower pace, and the average firms ends up charing 29 percent (Cobb-Douglas) and 42 percent (Translog) over marginal cost in 2009. A typical theoretical prediction of Cournot models, like the one we have presented above, is that markups are inversely related to firms' market shares. Market shares are directly available in our data set and their evolution, also shown in Figure 2, confirms the declining trend in market power uncovered by the markup estimation. We find that there is a steady decline in the average firm-level market share, the trend of which is very highly correlated with the decline in average markups.[10]

Figure 3 shows the weighted average markups which are calculated as below

[10]The magnitude of this correlation is 0.7

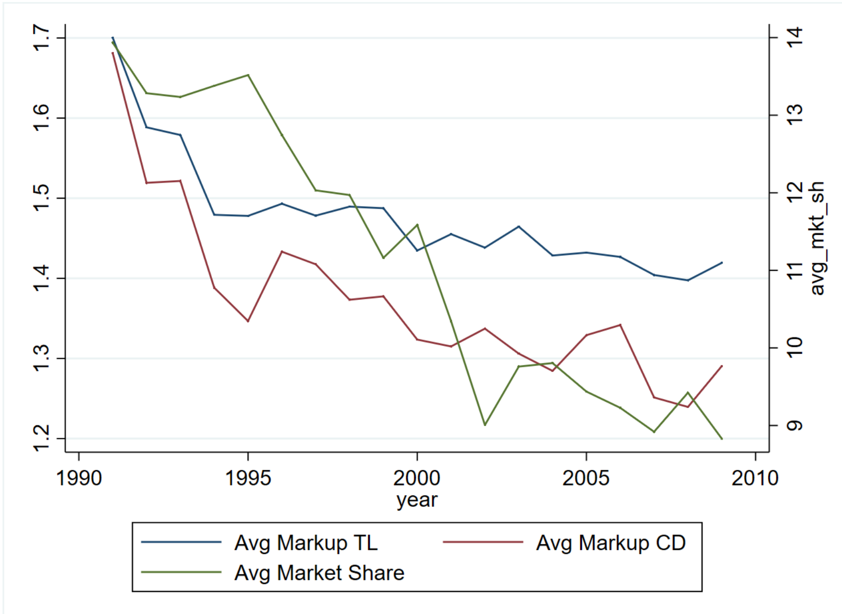
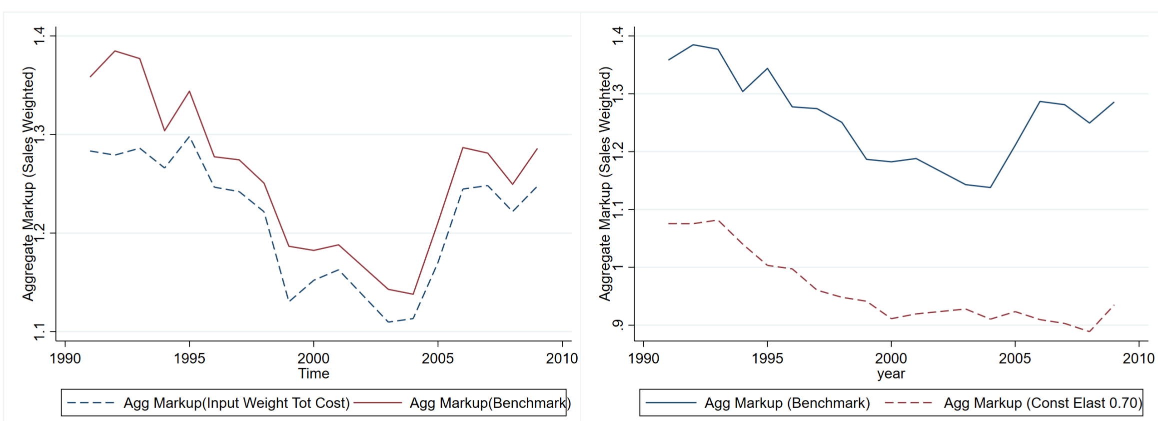


Figure 2: Unweighted average firm markup and market share

$$\mu_t = \sum_i m_{it}\mu_{it}, \tag{6}$$

where m_{it} is the weight of each firm in a given year t. For our benchmark speciification we will consider m_{it} to be the share of sales in the sample. From Figure 3 we can clearly see that similar to our unweighted average firm markup, sales weighted average markups decline fairly sharply between 1991 to 2004. We can see that in 1991 average markups started at 1.35 and by 2004 they stood at 1.13. Interestingly, and something not captured by our unweighted markups, sales weighted average markups start increasing from 2005 onwards and continue rising up till the end of the sample period 2010.



A) Aggregate markup sales weighted and total cost weighted

B) Constant elasticity comparison

Figure 3: Evolution of weighted markups

The measure of markups that are estimated using our empirical methodology is given by Equation 4. In it we multiply the output elasticity θ with the inverse of the material input revenue share. The former parameter is estimated from the data using the production function method approach, and the latter is measured in the data using the firm's income statement.

The measure of markups used in Equation 6 suggests that changes in the average firm markup can originate from three possible sources: (i) the weight (ii) the output elasticity, (iii) the inverse ratio of the cost share of sales (cost of materials in our baseline specification). First we examine the role of weight m_{it}. As outlined in De Loecker et al. (2020) firms that are able to charge a higher price over marginal cost tend to have higher revenue weights compared to their input weights. This intuition would infer that the levels of average markups calculated using input weights should be lower than those of their revenue-weighted counterparts. Figure 3 validates this intuition. For inputs, we use firm total costs from the income statement. We can see that the level of input weighted average markups are lower than the revenue weighted markups and that the gap between them is relatively stable throughout the sample, with the exception of the initial period between 1991 and 1995. A non-widening gap seems to suggest that reallocation of sales to low markup firms is not responsible for driving down average markups in the sample. It can also be observed that changing the weight to inputs (total cost) instead of revenue does not alter the declining trend either.

In order to understand whether the observed changes in the average markup are driven by changes in the output elasticity, which captures technological changes across industries and time, we fix the output elasticity at a value of 0.7 (the average cost share of firms). We get the following figure. Figure 3 shows us that the technological changes as measured by the output elasticity were not responsible for driving the decline in sales weighted average markups between 1991 and 2004 as the trends for the aggregate benchmark measure are similar to the measure of markups with constant output elasticity. This finding is in line with De Loecker et al. (2020) who also show that the variation in output elasticity is not responsible for driving the increase in average markups in the US economy. However, our analysis does seem to point to technological change playing some sort of role in driving the increase in our benchmark measure from 2005 onwards. The precise reasons for how and why we observe the latter are something we would like to leave for future research.

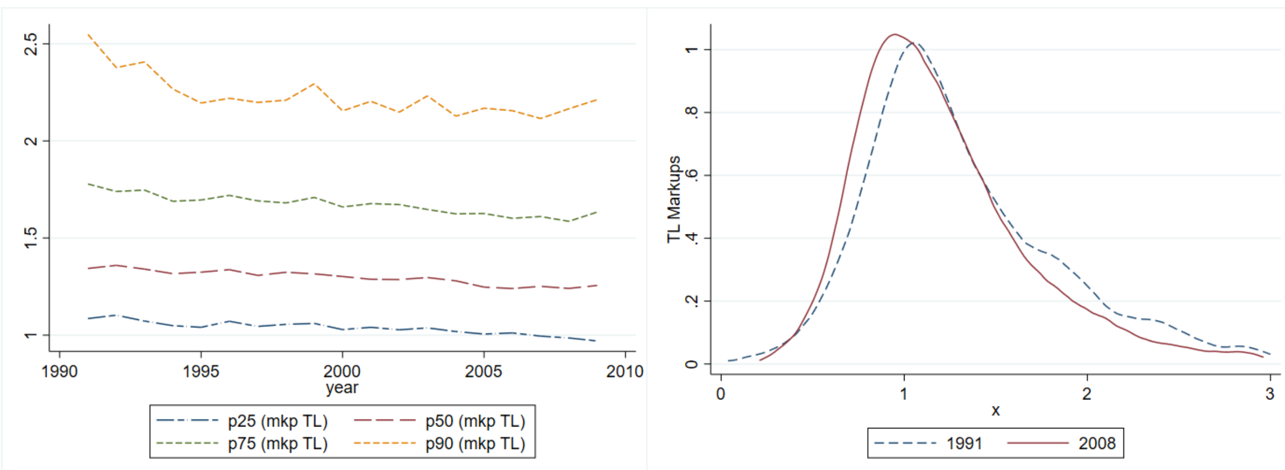
By ruling out the first two sources of the decline in average markups – technological change (as measured by output elasticity) and the choice of weight, we can infer that the bulk of the downward trend can be attributed to the decline in the wedge of sales to material expenditure.[13]

[13]Figure A.5 in the Appendix, showing the dynamics of the material share, confirms this insight. The small time variation observed in the elasticity is reported later in Table 2.

4.2 The Distribution of Markups

By being able to calculate markups for each firm using the empirical methodology outlined in the previous section, we have the ability to look at the entire distribution of markups. In order to understand how different moments of the distribution of markups are changing over time, firms are ranked by their markup and we obtain their percentiles by weighting each firm by its market share.[14]

Figure 4 shows that there is a decline in markups for each segment of the distribution. Although All firms experience some level adjustment in their margins, but the markup decline is stronger in the top two percentiles. Between 1991 and 2009, the 90th percentile of the distribution decreases from 2.5 to 2.1, a 16 percent drop. The 75th percentile declines from 1.8 to 1.5, a drop of similar magnitude. The 50th percentile instead experience a smaller reduction, about 5 percent and the 25th percentile decreases by roughly 7 percent. From this we can infer that there is some kind of a shock that is causing firms to decrease their markups across the entire distribution and has a stronger effect on firms at the top of the distribution.



A) Percentile distribution of weighted average firm markups

B) Kernel density of firm markups (unweighted)

Figure 4: Distribution of markups

Figure 4 presents the kernel density of unweighted markups for years 1991 and 2009 to understand their respective distributional differences. We can clearly see that the kernel density in 2009 has shifted to left, compared to 1991, indicating that average markups have been lowered by changes to all segments of the distribution. While our results pertain to a single sector, manufacturing, they are in stark contrast to the distributional findings from De Loecker et al. (2020) who attribute an increase in US economy-wide markups by a few firms (at the top of the distribution).

[14]This is comparable with the weighted average markup. These ranks are updated every year, which means different firms could be at the top each year.

4.3 Decomposition Analysis

To better understand the nature of the decrease in weighted average markups, we can decompose the reduction in weighted average markups into the component that is assigned to the decrease in the markup itself at the firm-level, and the component that is attributable to the reallocation of economic activity towards low-markup firms. Following De Loecker et al. (2020), we decompose the change in the average markup at the firm-level as follows[15]:

$$\Delta\mu_t = \underbrace{\sum_i m_{it-1}\Delta\mu_{it}}_{\Delta within} + \underbrace{\underbrace{\sum_i \mu_{it-1}\Delta m_{it}}_{\Delta marketshare} + \underbrace{\sum_i \Delta\mu_{it}\Delta m_{it}}_{\Delta cross}}_{\Delta reallocation}, \tag{7}$$

The $\Delta within$ term measures the average change that is only related to the change in firms' markup, while keeping their market shares unchanged from the previous period. The $\Delta marketshare$ term captures the changes due to variations in market share while keeping markups fixed for firms. If this term is decreasing, it means that lower markup firms are capturing a greater share of the economy - in our case, the manufacturing sector. The $\Delta cross$ term measures the joint changes in markups and market share.

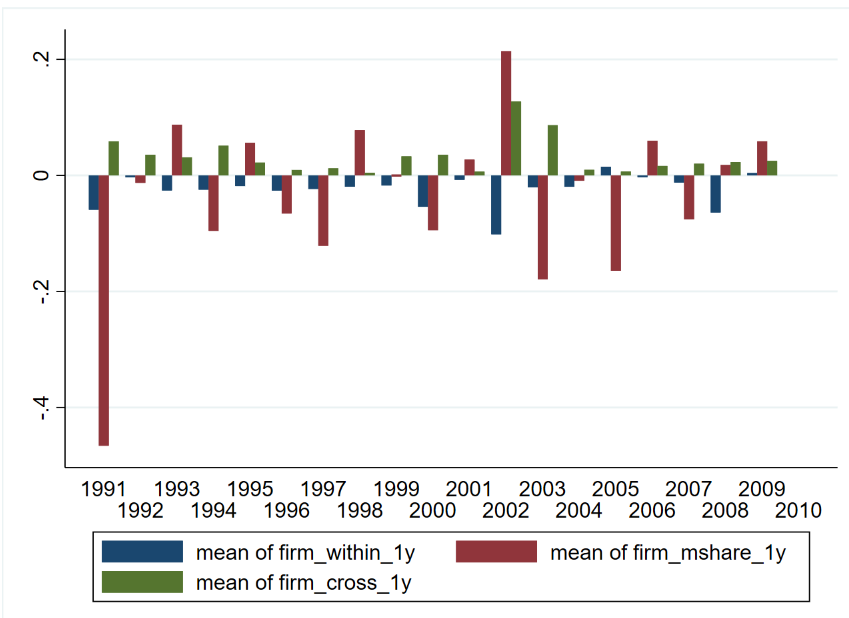


Figure 5: Decomposition: Firms

In Figure 5, we show an illustrative plot for this decomposition calculated for adjacent 1-year periods, for the period 1992-2010. From our 1-year decomposition we find that both the within and the between component both a role in the observed changes in the average markup. The

[15]This decomposition method was first outlined in Olley and Pakes (1996), Melitz and Polanec (2015) generalize it to account for exit and entry – something which we cannot account for given the limitations of the dataset.

within component is only responsible for negative changes, suggesting that an important driver of the decline in the average markup in our period of analysis is a reduction of firms markups. Reallocation plays as role as well although it contributes to both negative and positive markup variation. This justifies the choice in our simple theoretical model of focusing on intensive margin channels only.

Along with the firm-level decomposition, we also perform a decomposition of markup changes at the sectoral level, that is, we measure variation within and between industries. Similar to the equation above, we can express the change in the average markup as below:

$$\Delta\mu_t = \underbrace{\sum_i m_{st-1}\Delta\mu_{st}}_{\Delta within} + \underbrace{\sum_i \mu_{st-1}\Delta m_{st}}_{\Delta between} + \underbrace{\sum_i \Delta\mu_{st}\Delta m_{st}}_{\Delta reallocation}. \tag{8}$$

The first expression of the right hand side of the equation, the Δ*within* component, expresses the contribution of changes in sectorial markups, for a give share of each sector in our economy. This tells us to what extent markups are changing at the industry level. The second expression, the Δ*between* component, computes the change in markups due to changes in the market shares of the sectors. The third and final expression is the Δ*cross* component which describes the decline of markups as a joint change in markup and the firm composition.

Given the limited range of time period of our sample, we consider 2-year changes in weighted markups starting from 1992 . The decomposition as presented in Table 2 the bulk of the changes in the average markup is driven by the within industry component. The changes in composition between industries is smaller in magnitude compared to the within component of the decomposition for almost every successive year. There is also no correlation in the direction of the components. The change in markups due to cross component i.e. the joint effect of the previous two components, is also smaller in magnitude compared to the within component, but it is comparable in size with the compositional change between industries.

Table 2: Sectoral Decomposition of Weighted Markup Evolution

2yr Period	Δ Markup	Δ Within	Δ Between	Δ Realloc.	Mean (ΔΘ)
1992-1994	-0.057	-0.035	-0.017	-0.005	0.007
1994-1996	-0.029	-0.007	0.043	-0.065	0.012
1996-1998	0.112	0.104	-0.021	0.029	0.017
1998-2000	-0.111	-0.129	0.008	0.010	-0.005
2000-2002	0.034	0.022	0.035	-0.023	-0.004
2002-2004	-0.115	-0.099	0.018	-0.034	0.000
2004-2006	0.149	0.145	0.003	0.001	-0.013
2006-2008	-0.040	-0.034	-0.019	0.013	0.001

This finding from the time series decomposition shows that most of the decrease in markups occurs within all industries across the manufacturing sector. Our results are similar to the findings from De Loecker et al. (2020) who when performing this decomposition for the US economy find that the rise in markups is also a within-sector phenomenon. We have established that the decline in average weighted markups takes place mostly within sectors and within firms in each sector. We will now attempt to analyse the role of trade liberalisation as a driver of these facts.

5 Globalisation and markups: firm-level analysis

We now turn to examine how firm-level markups adjusted as Spain liberalized its economy. We exploit the variation in our firm-level markup estimates and industry output tariffs over time through firm-fixed effects We use our translog firm-level estimates for markups over the entire sample and run the following specification:

$$ln\mu_{ijt} = \alpha_j + \alpha_t + \lambda\tau_{jt} + \zeta Z_{jt} + \epsilon_{jt}, \tag{9}$$

where μ_{ijt} is the markup of firm i in industry j at time t, α_j is the industry fixed effect, which allows us to control for all time-invariant differences across industries. The year fixed effect, α_t, controls for all yearly shocks that industries share, such as business cycles shocks. Tariffs, $\tau_j t$, are industry-level output tariffs. In an effort to isolate the impact of trade liberalization, we control for several time varying industry characteristics that might affect the distribution of firm-level markups. We use the degree of barriers to entry, proxied by industry-level fixed assets as one such control. We also control for the degree of foreign investment which might also influence markups (measured as the average foreign holding by industry). The other control that we use is industry export intensity (measured as the ratio of total exports to total output for an industry), as we want to focus our analysis on the effects of import competition. We also control for firm-level TFP. These controls are from the base year 1991.

We report the firm-level markup regression with just firm and year fixed effects in column (1) in Table 3. The coefficient on the output tariff is positive and strongly statistically significant, implying that a 10 percentage point decline in tariffs is associated with a 3.14 percent decline in markups for firms. Between 1990 to 2010, average output tariffs fell by 17 percent, this results in a precisely estimated average markup decline of 2.92 percent ($= 17 \times 0.176$). The fundamental message from our earlier result remains the same once we introduce industry controls and industry fixed effects throughout columns (2) to columns (5). In column (5) we can see that a 10 percentage point decline in industry output tariffs is associated with a 2 percent decline in firm-markups, this result being statistically significant as well. This result implies that the average decline in output tariffs resulted in a 4.37 percent ($= 17 \times 0.257$) decline in average markups.

Table 3: Trade liberalisation and firm-level markups

	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
Output Tariff	0.172***	0.173***	0.173***	0.197***	0.257***
	(0.061)	(0.061)	(0.061)	(0.061)	(0.060)
Average tangible fixed assets (excluding land and buildings) by Industry		-0.000	-0.000	0.000	−0.000***
		(0.000)	(0.000)	(0.000)	(0.000)
Average percentage foreign holding by Industry			0.000	0.000	0.000
			(.)	(.)	(.)
Export Intensity				−1.513***	1.945
				(0.304)	(1.595)
Firm TFP TL	0.005	0.007*	0.007*	0.015***	0.033*
	(0.003)	(0.004)	(0.004)	(0.004)	(0.018)
Firm Effects	X	X	X	X	X
Year Effects	X	X	X	X	X
Industry Effects					X
N	30,905	30,895	30,895	30,895	30,895
R^2 r2	0.001	0.001	0.001	0.005	0.020

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using fixed effects. It includes industry and year dummies, and standard errors are clustered at the three-digit industry level.

These results support our theoretical insight that increases in competitive pressures brought about by lower tariffs lead to a reduction in firm markups. Although the pro-competitive effect seems to be the dominant force driving the relationship between trade and markups, we show that the other channels highlighted in the theory are at work as well. First, the model highlights the possibility that a reduction in foreign tariff triggers an increase in export markups via the incomplete pass-through channel. Since we do not study changes in foreign tariffs (i.e. tariffs faced by Spanish firms in their export destinations), following De Loecker et al. (2016) we can test the this channel analysing the impact of Spanish input tariffs. Second, we provide a simple test of the concentration effect, which highlights the role of trade-induced changes in the number of firms competing in a sector in shaping the effects of trade on markups. Finally, although our decomposition analysis suggests that the key drivers of the observed trend in markups operate along intensive margins, we will also analyse the impact of trade on markup via reallocation across heterogeneous firms.

5.1 The concentration effect

One of the theoretical predictions from our model is that trade induces firm exit, which in turn can put upward pressure on surviving firms' markups. To evaluate whether or not this prediction holds in our data, we first plot the change in the number of firms for a given industry in our dataset in the following Figure 6:

We can clearly see that across most industries there is a fair bit of exit across time. Owing to the endogeneity problem of using the number of firms as a way of measuring firm exit, as the latter will be correlated with the trade shock, we use proxy measures of barriers to entry in the data to pin down the concentration effect. We use a measure of firm intangible fixed assets and group them into quartiles for each year. The measure of intangible fixed assets incorporates the

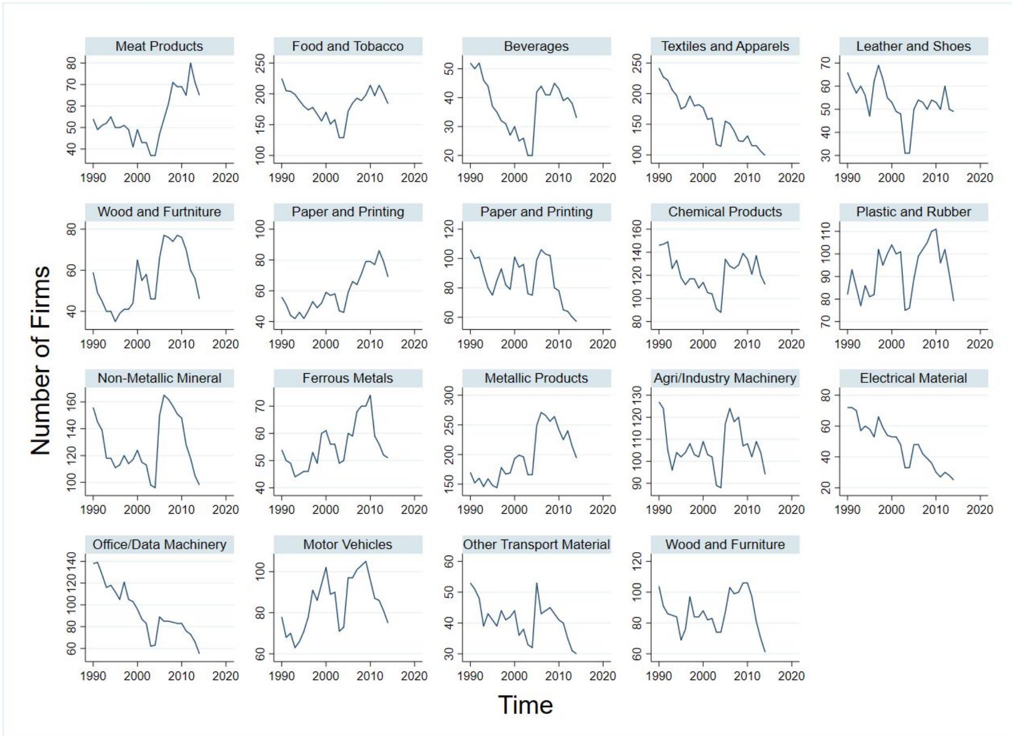


Figure 6: Evolution of number of firms in sample by industry

value of goodwill, copyrights, trademarks, and intellectual property for each firm and is available in ESSE. Based on our theoretical predictions we would expect the lower quartile distribution of firm intangible fixed assets to experience a lower concentration effect compared to the higher quartile distribiution due to lower entry costs. This channel should manifest in a greater pro-competitive being experienced at lower quartiles of firm intangible assets compared to higher ones. To test the latter, we perform the following regression specification:

$$ln\mu_{ijt} = \alpha_j + \alpha_t + \lambda\tau_{jt} + \beta Intanquartile_{it} \times \tau_{jt} + \kappa Intanquartile_{it} + \zeta Z_{jt} + \epsilon_{jt} \tag{10}$$

Where $Intanquartile_{it} = 1$ if firm i has intangible fixed assets below a given quartile and is $Intanquartile_{it} = 0$ for firms with intangible fixed assets above the given quartile. Our results in Table 5.1 show that all firms below the 75th and 90th percentile of the intangile fixed assets disribution undergo a higher pro-competitive effect, with a stastically significant interaction term parameter values. This is in line with our theoretical predictions highlighted in Proposition 3.

Next, we re-run specification (10) with different proxy measures of barriers to entry in addition to firm intangible assets. We first use firm-level RD intensity as a proxy measure for barriers to entry. We calculate firm-level RD intensity as the ratio of sales of a firm divided by their respective expenditure on RD activities. The intuition behind using this measure is similar to the intangible fixed assets measure we use before. Based on our theoretical predictions, high-

Table 4: Barriers to entry: intangible investment

	Fixed Effects			
	(1)	(2)	(3)	(4)
Output Tariff	0.248***	0.233***	0.180***	0.129*
	(0.060)	(0.063)	(0.066)	(0.069)
Average percentage foreign holding by Industry 1991	−0.000**	−0.000**	−0.000**	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Export Intensity 1991	4.761**	4.797**	4.759**	4.581**
	(1.848)	(1.877)	(1.869)	(1.893)
Firm TFP TL	0.034*	0.035*	0.038**	0.039**
	(0.018)	(0.018)	(0.018)	(0.018)
Intan_Firm_Dummy_25 × Output Tariff	0.101			
	(0.095)			
Intan_Firm_Dummy_50 × Output Tariff		0.032		
		(0.081)		
Intan_Firm_Dummy_75 × Output Tariff			0.134*	
			(0.078)	
Intan_Firm_Dummy_90 × Output Tariff				0.159**
				(0.079)
Firm Effects	X	X	X	X
Industry Effects	X	X	X	X
Year Effects	X	X	X	X
N	30,895	30,895	30,895	30,895
R^2	0.020	0.020	0.021	0.022

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using fixed effects. It includes industry and year dummies, and standard errors are clustered at the three-digit industry level.

lighted in Proposition 3, we would expect the lower quartile distribution of firm RD intensity to experience a lower concentration effect compared to the higher quartile distribiution due to lower entry costs. This channel should manifest in a greater pro-competitive being experienced at lower quartiles of firm RD intensity compared to higher ones. Below is our finding from re-running specification **??** using firm-level RD intensity as an interaction term with output tariffs, where the $RDintensityfirmdummy = 1$ if firm i has RD intensity below a given quartile and is $RDintensityfirmdummy = 0$ above the same quartile.

Our results in table 5.1 show that all firms below the 75th percentile of the RD intensity disribution undergo a higher pro-competitive effect compared to firms above the 75th percentile distribution. This corroborates what we find with the intangible fixed assets measure. We introduce a second additonal measure to verify our baseline findings. We use firm size measured as then number of employees, as a proxy measure for barriers to entry. Industries with larger firms should experience higher concentration effects thereby undergoing lower pro-

Table 5: Barriers to entry: R&D expenditure

	Fixed Effects (1)
Output Tariff	0.205**
	(0.092)
Average percentage foreign holding by Industry 1991	−0.000**
	(0.000)
Export Intensity 1991	4.986***
	(1.885)
Firm TFP TL	0.033*
	(0.018)
RD_Firm_Dummy_75 × Output Tariff	0.063
	(0.088)
Firm Effects	X
Industry Effects	X
Year Effects	X
N	30,895
R^2	0.021

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using fixed effects. It includes industry and year dummies, and standard errors are clustered at the three-digit industry level.

competitive pressure, compared to industries with smaller firms. Below is our finding from re-running specification **??** using firm size as an interaction term with the output tariffs, where the $firmsizedummy = 1$ if firm i has size below a given quartile and is $firmsizedummy = 0$ above the same quartile.

Our results in table 5.1 show that all firms below the 50th percentile of the firm size distribution undergo a higher pro-competitive effect compared to firms above the 50th percentile distribution. This is similar to results we observe for our baseline measure - firm intangible fixed assets and the first additional robustness measure - firm RD intensity.

5.2 The Incomplete Pass-through channel

Following De Loecker et al. (2016) we test the incomplete pass-through channel using changes in input tariffs. We do this by running the following regression,

$$\Delta ln\mu_{ijt} = \alpha_j + \alpha_t + \lambda\Delta\overset{o}{\tau}_{jt} + \beta\Delta\overset{i}{\tau}_{jt} + \epsilon_{jt}, \tag{11}$$

where $\Delta ln\mu_{ijt}$ is the change in firm-level markups (in logs), $\Delta\overset{o}{\tau}_{jt}$ is the change in industry-level output tariffs, $\Delta\overset{i}{\tau}_{jt}$ is the change in industry-level input tariffs. In Table 6, we directly examine how input and output tariffs affect markups. In line with the results in De Loecker et al. (2016),

	Fixed Effects (1)
Output Tariff	0.226***
	(0.071)
Average percentage foreign holding by Industry 1991	−0.000**
	(0.000)
Export Intensity 1991	4.817***
	(1.854)
Firm TFP TL	0.033*
	(0.018)
FirmSize_Dummy_50 × Output Tariff	0.065
	(0.105)
Firm Effects	X
Industry Effects	X
Year Effects	X
N	30,895
R^2	0.021

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using fixed effects. It includes industry and year dummies, and standard errors are clustered at the three-digit industry level.

the coefficient on the change in input tariffs is is negative. Similar to our baseline regression, the coefficient on the output tariff is positive. This suggests that a reduction in input tariffs produced cost reductions that were not fully passed to prices, allowing firms with market power to increase their markups. Although the signs of effects of both the output and input tariff are in line with the theoretical prediction, they are not statistically significant.

Table 6: Regressions of the change in output and input tariffs on markups for firms

	OLS (1) $ln\mu_{ijt}$
$\Delta\tau^{o}_{jt}$	0.149
	(0.120)
$\Delta\tau^{i}_{jt}$	-0.371
	(0.336)
Industry Effects	X
Year Effects	X
N	20,462
R^2	0.001

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using OLS and includes industry and year dummies, and standard errors are clustered at the three-digit industry level.

Unfortunately, our ESSE dataset does not contain information on firm-level prices and thus we cannot retrieve marginal costs. As a result we will not be able to comment on how the input and output tariffs interact with prices and marginal costs. Although, differently from De Loecker et al. (2016), we are not able to precisely assess whether the trade liberalisation episode that we are analysing had an overall pro or anti-competitive effect, our results suggest the following. First, we find a statistically significant and robust pro-competitive effect of output tariffs cuts on markups. Second, the effect of input tariffs cuts is anti-competitive but not significant. Finally, the contribution of the two channels to the overall dynamics of the average markup is also likely to be affected by the larger size of the output tariff decline compared to that of the input tariff, as shown in Figure 1.

6 Trade and the aggregate markup

We have established that there is a negative relationship between trade liberalisation and firm-level markups. Our firm-level analysis then suggests that the pro-competitive effect dominates the offsetting channels operating via concentration and incomplete pass-through highlighted featured in our theory. We now move on to analyse the relationship between trade and the aggregate markup which allows us to add to our firm-level channels the between firm reallocation channel. Standard trade models predict that trade-induced reallocations increases market shares of large/more productive firms. If, as suggested by our theory, these firms charge a higher markups, trade should put upward pressure on aggregate markups via this reallocation channel. This is the *superstar hypothesis* popularised by Autor et al. (2020). Below we first provide an empirical test of this hypothesis and then analyse the relationship between trade costs and markups at the sector level. The scope of these exercises is to shed some light on the role of within and between firm channels in shaping the effects of globalisation on the aggregate markup.

Reallocation and the superstar hypothesis. We explore the reallocation channel by running a reduced-form equation between the change in output tariffs for industries and each component of the firm Olley-Pakes decomposition performed in section 4.3 as follows:

$$\sum_i s_{ijt-1}\Delta M_{ijt} = \alpha_t + \lambda \Delta \overset{o}{\tau}_{jt} + \epsilon_{jt}, \tag{12}$$

where, $\sum_i s_{ijt-1}\Delta M_{ijt}$, is the change in the markup due to the within-firm component, $\sum_i M_{ijt-1}\Delta s_{ijt} + \sum_i \Delta M_{ijt}\Delta s_{ijt}$, is the change attributable to the reallocation-firm component, and $\Delta \overset{o}{\tau}_{jt}$ are changes in industry-level output tariffs.

The results shown in table 7 suggest a strong correlation between falling industry output tariffs and the within component of the change in markups for firms. The positive and statis-

Table 7: Regressions of the change in output tariffs on the components of the change in markups for firms

	(1) $\Delta Within - Firm$	(2) $\Delta Realloc - Firm$
$\Delta\tau^{o}_{jt}$	0.014***	-0.023
	(0.002)	(0.015)
Year Effects	X	X
Industry Effects	X	X
N	31,635	31,635
R^2	0.001	0.023

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using OLS and includes year dummies, and standard errors are clustered at the three-digit industry level

tically significant coefficient of the change in output tariffs on the within component point to the pro-competitive effect of trade liberalisation, whereas the sign of the coefficient on the reallocation component supports the superstar hypothesis, albeit this relationship is not statistically significant. This hypothesis is also corroborated by the inspection of the relationship between markups and firm size. In figure 7, we show that firm with larger sales charge higher markups. The same size/markup correlation is confirmed using other measures of size, as shown in Figure A.3 and A.4.

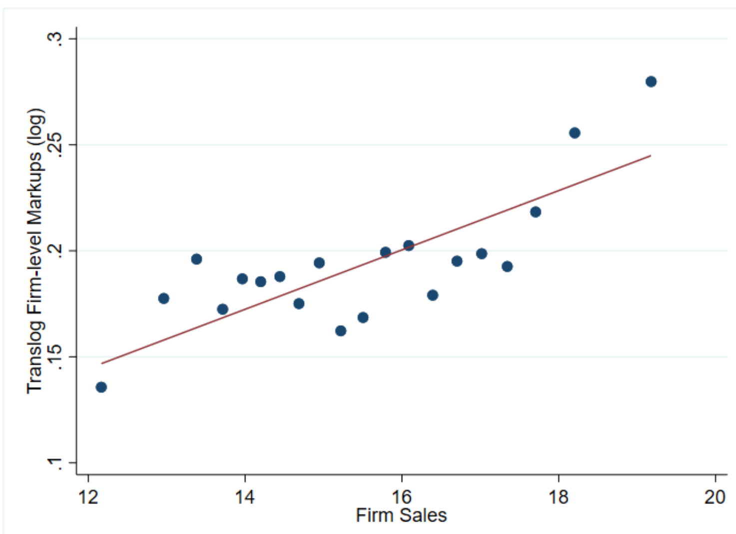


Figure 7: Markups and Firm Size

To summarise, we observe that a reduction in output tariffs is strongly correlated with a reduction in markups through the within component and an increase in markups via the reallocation components. Since, the overall effect of the output tariff cuts on firms' markups shown in Table 3 is negative, we can conclude that the pro-competitive effect is the dominant force driving the relationship between trade and markups.

Trade and markups: sector level analysis. Having established that globalization is operating primarily via the within channel in driving down markups at the aggregate, we would now like to explore the overall effect of trade on the aggregate/average markup. As the reduction of aggregate markups is occurring by within changes at the firm-level, we would intuitively expect trade liberalization to be negatively related to aggregate markups, in addition to firm-level margins as well. To test this intuition, we run the following regression specification:

$$ln\mu_{jt} = \alpha_j + \alpha_t + \lambda\tau_{jt} + \zeta Z_{jt} + \epsilon_{jt}, \tag{13}$$

where μ_{jt} is the sales-weighted markup of in industry j at time t. When running this regression in table 8 , we find a positive statistically significant co-efficient for λ (co-efficient of τ_{jt}), at the 1 percent level. This is in-line with our finding for the firm-level markup result (as the dependent variable) and seems to suggest that the reduction is tariffs is also leading to a reduction in sales-weighted markups for industries/sectors. This outcome corroborates our decomposition analysis 7 and supports the assertion that trade liberalization dominates through the within channel at the aggregate.

Table 8: Trade liberalisation and sales weighted sectoral markups

	Fixed Effects
	(1)
Output Tariff	0.228***
	(0.022)
Average tangible fixed assets (excluding land and buildings) by Industry	-0.000***
	(0.000)
Average percentage foreign holding by Industry	0.000
	(.)
Export Intensity	5.938***
	(0.503)
Firm Effects	X
Year Effects	X
Industry Effects	X
N	30,906
R^2	0.096

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using fixed effects. It includes industry and year dummies, and standard errors are clustered at the three-digit industry level.

7 Robustness Analysis

7.1 Robustness of markup estimates and trends

Alternative measure of markups. To corroborate the trends inferred from our estimated markups, we follow the methodology developed by Domowitz et al. (1986) to construct an alternate measure for markups (price cost margins) as follows

$$Markup_{ijt} = \frac{ValuedAdded_{ijt} - Payroll_{ijt}}{ValuedAdded_{it} + MaterialCost_{ijt}}$$

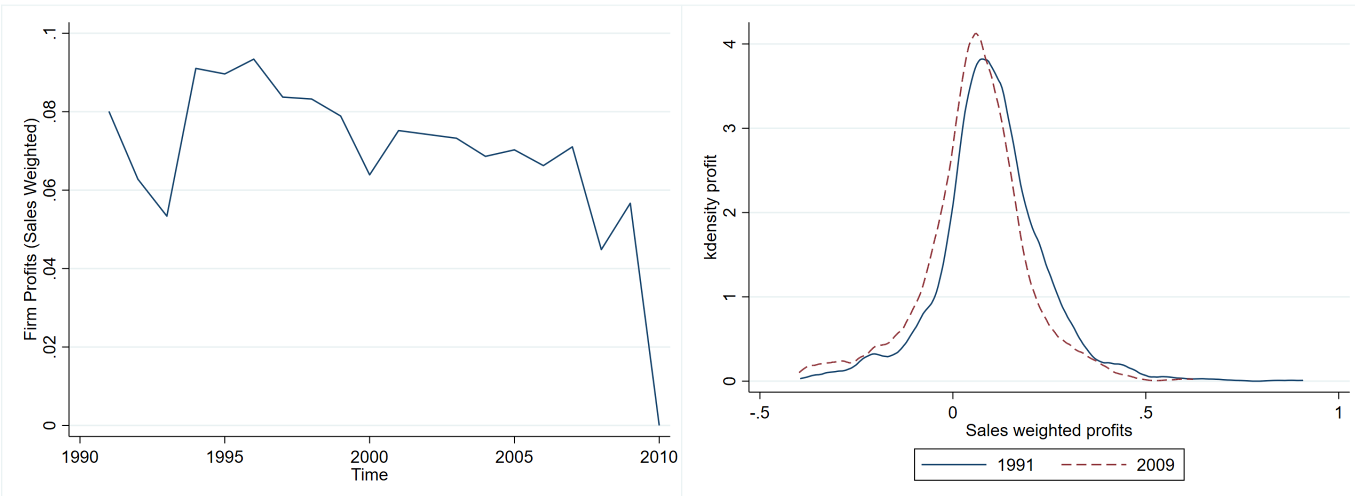
We are able to construct these measures at the firm-level from our dataset as variables pertaining to value added, payroll (labour costs) and material costs are all present in ESSE. When plotting the average values of this measure A.8, we find that the trend seems to roughly match the ones from our baseline anaylsis estimates.

Material shares with sectoral and aggregate data. We perform a sanity check to corroborate our firm-level markup estimate trends by using publicly available sector-level and whole economy data from KLEMS. Having established in Section 4.1 that the wedge of sales to material expenditure is the primary driving force for the decline in firm-level markups, we construct a proxy measure in KLEMS at the manufacturing (sector-level) and whole-economy level to see whether or not we find similar trends observed in ESSE. We compute the intermediate consumption shares (as a fraction of total output) to proxy for the material to sales expenditure ratio for both manufacturing and the entire Spanish economy. Figure A.6 and A.7 shows that the intermediate consumption to output ratio is increasing across time (between 1995-2010), similar to what we observe in our ESSE firm-level dataset, thereby corroborating our markup estimate trends and their key source.

Market power and profitability. In order to make any inference on the state of market power in our sector of interest, it will be important to link markups with profits. Our documented decline in markups does not necessarily imply that firms have lower market power and thus have less economic profits. Before linking the two measures, it is important to bear in mind, as highlighted in De Loecker et al. (2020) that markups could decrease for a variety of reasons, without necessarily influencing the progression of firm economic profits. Markups can decrease, independent of profits, if there is an increase in marginal costs, a decrease in fixed costs, a decrease in demand or its elasticity, or changes to market structure or product varieties. To link markups with profits, we follow De Loecker et al. (2020) and use the markup measure, properly accounting for all cost types, including overhead (or fixed) costs and the expenditure on capital. We calculate the following equation as the net profit rate for each firm for a given period.

$$\pi_{it} = 1 - \frac{\theta_{st}}{\mu_{it}} - \frac{r_{it}K_{it}}{S_{it}} - \frac{P_t^X X_{it}}{S_{it}}$$

This measure of profit incorporates the output elasticity of the production technology, which accounts for the variable factors of production V. The figure below 8 plots the average sales-weighted profit rate for firms in our sample period.



A) Sales Weighted Firm Profits

B) Kernel Density Unweighted Firm Profits

Figure 8: Evolution of firm profits

We find that profits have gone down by more than 2 percentage points between 1991 and 2009. When looking at the distributional differences of unweighted profits between 1991 and 2009, we can see in Figure 8 that the entire kernel density of 2009's profit rates has shifted to the left compared to 1991. Similar to our findings for markups, the drop in unweighted profit rate occurs throughout the entire distribution. This underpins the fact that the decline in average profits has been driven primarily by a within firm pricing change across the entire sample due to the pro-competitive impact of trade liberalization.

Cost Share Estimates. In light of the technical concerns regarding the identification of elasticities, that go on to form the foundation for our markup estimates for firms, we use the cost share approach highlighted in De Loecker et al. (2020). For each firm, we compute the cost share $\alpha_{it}^V = \frac{P_t^V V_{it}}{P_t V_{it} + r_{it} K_{it}}$. In the numerator we report the material cost and in the denominator we have a measure of total cost (which includes financial expenditures) from the ESSE. For each industry we compute the median of the cost shares at a given point in the time as a measure for the output elasticity $\theta_{st} = median\alpha_{it}^V$.

From the Figure 9 below, we can see a decreasing trend in the sale-weighted average of markups with output elasticity derived from the cost share. This is similar to the trend reported in Figure 3.

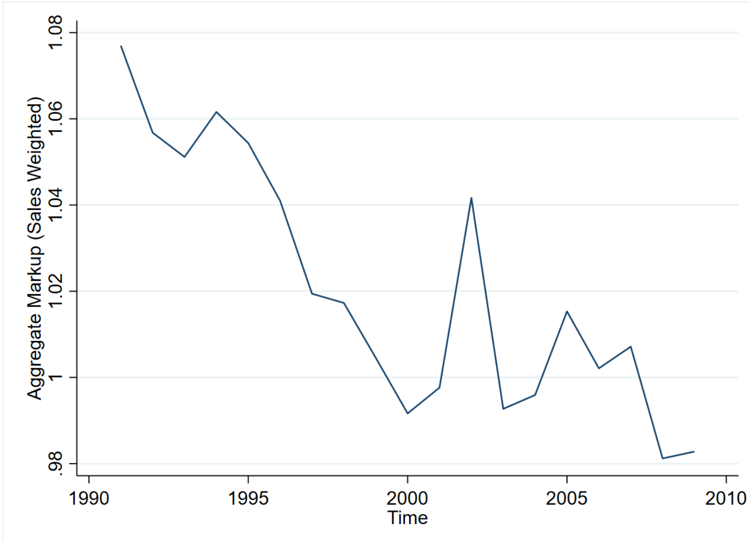


Figure 9: Sales-Weighted Average Cost Share Markups

7.2 Trade liberalisation and markups: robustness and further analysis

Using a different measure for trade exposure. For robustness, our baseline measure for trade exposure is the import penetration ratio for an industry *j* over the period 1990 to 2010, following the approach outlined in Autor et al. (2014). A logical concern with using the import penetration ratio as a measure of trade exposure is that this variable will also capture import demand driven domestic shocks for industries in the Spanish manufacturing sector as they trade with other firms from the rest of the world. These import demand shocks have the possibility of contaminating our trade exposure variable as a measure of trade flows between Spanish industries and the rest of the world. To capture the supply driven component of imports by Spanish industries and To account for the possible correlation between industry-level EUR imports and demand/productivity shocks, we instrument for EUR imports into the Spanish manufacturing sector by using industry-matched (3-digit SIC) EUR import penetration values from 4 similar European countries (from the World Input Output tables)[17].The identification strategy follows Autor et al. (2014) and Bloom et al. (2011). The motivation for using this instrument is that the share of imports for an industry from Europe would not be determined by demand-driven decisions from Spanish industries, rather this share will incorporate the supply driven trade liberalization shock caused by EU member states' ascension to the Single Market Programme.

We re-run our baseline analysis using import penetration as the main regressor - instrumented, and find similar pro-competitive effects on markups. Our results are outlined in the appendix.

[17]For more information, visit http://www.wiod.org/database/wiots13

Running baseline regression with Cobb-Douglas markups. In this section we run our baseline regression between industry tariffs and firm-level markups, but instead of using translog estimates (for markups), we use Cobb-Douglas markups. The Cobb-Douglas production function is generated by removing β_{kk}, β_{ll}, β_{mm} and their respective interaction terms in C. The remaining estimation procedure remains the same. The output elasticity of materials becomes only β_m and remains constant across time. Keeping the output elasticity fixed is a reasonable econometric assumption to make as we have demonstarted in Figure 3, that time varying elasticity coefficients do not play a role in driving down aggregate markups. Table 9 shows that the co-efficient of output tariff for Cobb-Douglas markups is higher in magnitude, compared to their Translog counterparts shown in Table 3 and remains positive. This result supports our baseline findings.

Table 9: Baseline regression using Cobb-Douglas Markups

	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
Output Tariff	0.306***	0.267***	0.257***	0.239***	0.203***
	(0.067)	(0.062)	(0.051)	(0.069)	(0.051)
Average tangible fixed assets (excluding land and buildings) by Industry		−0.000***	−0.000***	−0.000***	−0.000***
		(0.000)	(0.000)	(0.000)	(0.000)
Average percentage foreign holding by Industry			0.001	0.001	-0.000
			(0.001)	(0.001)	(0.001)
Export Intensity (1990-2009)				−0.130***	−0.131***
				(0.033)	(0.031)
Firm Effects	X	X	X	X	X
Year Effects	X	X	X	X	X
Industry Effects					X
N	30,916	30,906	30,906	30,906	30,906
R^2	0.001	0.002	0.002	0.003	0.017

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using fixed effects. It includes industry and year dummies, and standard errors are clustered at the three-digit industry level.

Running baseline regression with labour markups. In this section we run our baseline regression between industry tariffs and firm-level markups, but instead of using markups estimated using the elasticity co-efficient of materials from the production function, we use labour to verify whether or not using it produces the same results. Table 10 column 5 shows that the co-efficient of output tariff while not statistically significant, is positive in direction and the magnitude is roughly similar to the materials elasticity based markup estimates in Table 3.

Trade liberalization and Industry Concentration. For each industry, we measure industry concentration as a share of the largest firms in sales[16]. We mainly focus on the share of the 4 largest firms (CR4), but also perform robustness exercises using 8 of the largest firms (CR8) in an industry. We calculate industry concentration as follows:

[16]ESSE defines firms as business groups, so our measure of concentration will not suffer from bias by not accounting for business groups

Table 10: Baseline regression using Translog Markups (labour co-efficent from production function)

	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
Output Tariff	-0.178	-0.337	-0.327	0.382	0.283
	(0.693)	(0.717)	(0.709)	(0.685)	(0.826)
Average tangible fixed assets (excluding land and buildings) by Industry		-0.000*	-0.000*	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)
Average percentage foreign holding by Industry			-0.001	-0.007	-0.010
			(0.008)	(0.009)	(0.008)
Export Intensity (1990-2009)				0.170	0.135
				(0.147)	(0.293)
Firm Effects	X	X	X	X	X
Year Effects	X	X	X	X	X
Industry Effects					X
N	29,038	29,028	29,028	29,028	29,028
R^2	0.000	0.000	0.000	0.030	0.031

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using fixed effects. It includes industry and year dummies, and standard errors are clustered at the three-digit industry level.

$$CR4_{jt} = \sum_{i=1}^{4} s_{ijt}. \tag{14}$$

We calculate the industry sales shares of each firm as

$$s_{ijt} = \frac{s_{it}}{s_{jt}}. \tag{15}$$

where s_{it} is the sales of each firm in industry j and s_{jt} is the total sales for that corresponding industry. To understand what the industry concentration response is to a trade shock, we run the following reduced-form equation:

$$lnCR4_{jt} = \alpha_j + \alpha_t + \lambda\tau_{jt} + \zeta Z_{jt} + \epsilon_{jt}. \tag{16}$$

where $lnCR4_{jt}$ refers to the concentration index by industry, top-4 firms (in logs). $\alpha_{j/t}$ are the industry and time fixed effects. τ_{jt} are industry-level output tariffs. We use the same industry controls as defined in section 6. The results from our regression confirm the hypothesis that trade liberalization induces a positive affect on industry concentration levels, as exit of firms that are unable to compete/achieve threshold levels of productivity, raise market share of incumbent firms. The results from 11, column (1) show that a 10 percent reduction leads to 1 percent increase in industry concentration. When we introduce industry controls and corresponding industry/year fixed effects, the co-efficent of output tariffs drops to in magnitude but the sign of the relationship remains the same.

Table 11: Regressions of output tariffs on industry concentration

	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
Output Tariff	-0.101^{***}	-0.037^{*}	-0.030^{*}	-0.114^{***}	-0.015^{*}
	(0.020)	(0.020)	(0.017)	(0.010)	(0.008)
Average tangible fixed assets (excluding land and buildings) by Industry		0.000^{***}	0.000^{***}	0.000^{***}	0.000^{***}
		(0.000)	(0.000)	(0.000)	(0.000)
Average percentage foreign holding by Industry			-0.001^{**}	-0.004^{***}	-0.003^{***}
			(0.000)	(0.000)	(0.000)
Export Intensity (1990-2009)			-0.054^{***}	-0.076^{***}	-0.120^{***}
			(0.009)	(0.008)	(0.016)
Firm Effects	X	X	X	X	X
Industry Effects				X	X
Year Effects					X
N	31,578	31,578	31,578	31,578	31,578
R^2	0.003	0.067	0.074	0.209	0.274

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using fixed effects. It includes industry and year dummies, and standard errors are clustered at the three-digit industry level. Column 1 is without industry controls and industry fixed effects. Column 2-5 includes industry controls and industry fixed effects.

8 Conclusion

In our paper we present a simple model of oligopoly trade highlighting several channels through which globalisation can put upward pressure on markups. We use these theoretical insights to guide our empirical investigation of the trade-markup nexus which exploits a large episode of trade liberalisation experienced by Spain in the post EU entry period. We use firm-level data to estimate markups and find that the aggregate markup is declining for most of our sample period.

Our model produces a rich set of testable channels through which trade affects markups. First, we investigate the relationship between trade and markups on domestic sales via the standard *pro-competitive effect*. Lower trade barriers imply lower residual demand for domestic goods which forces firms to reduce their markups on domestic sales. Our empirical analysis reveals that the relationship between import tariff reductions and markups at the firm level is negative, thereby confirming the received view that trade has a pro-competitive effect.

Second, foreign firms' export markups increase via the standard *incomplete pass-through* channel. Firms transfer only part of the reduction in the cost of export onto consumers, with the remaining part going to markups. In the data we find evidence of this phenomenon, as a decline in input tariffs is associated with an increase in markups.

Third, due to the competitive pressure induced by trade, the number of firms competing in each market declines. This *concentration effect* which increases markups is stronger the larger the entry cost and the economies of scale, measures of barriers to entry. Our empirical analysis reveals to us that markups decline less for firms operating in industries experiencing a bigger reduction in the number of firms and also for firms with higher shares of intangible assets, a measure of barriers to entry. When looking at these channels collectively, despite the offsetting forces operating via the incomplete pass-through and the concentration channels, the pro-competitive effect of trade on firm-level markups dominates.

At the aggregate we find that the observed changes in the markup are essentially driven by within-sector variation. To reconcile the forces at play at the firm-level with whats going on at the aggregate, our paper shows that trade liberalisation reduces the markup via its within-firm component, but increases it via its between-firm component, in line with the reallocation channel. The effect of trade on the within component is stronger and the overall impact on sectoral markups is negative, suggesting that the within channel dominates and that the overall effect of trade on the aggregate markup is pro-competitive.

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For Online Publication: Appendices

A Model derivation and proofs

Let q_d and τq_f be the quantities produced by a home firm for the domestic and export markets, respectively, and let $q = q_d + \tau q_f$ be total firm's output. Total domestic consumption of a particular variety is $x = n(q_d + q_f)$, smaller than total production nq_x. As in Brander and Krugman (1983), trade in identical goods occurs because firms play separate Cournot games in the domestic and foreign markets.

Equilibrium production and pricing. A firm producing a particular variety solves,

$$
\begin{aligned}
V_s = & \max_{(q_d, q_f)} \left[\left(p_d - z^{-1} \right) q_d + \left(p_f - \tau z_t^{-1} \right) q_f - \lambda \right] \\
& s.t. \\
& p_d = \frac{E}{X^\alpha} x_d^{\alpha-1} \qquad \text{and} \qquad p_f = \frac{E}{X^\alpha} x_f^{\alpha-1} \\
& x_d = \hat{x}_d + q_d \qquad \text{and} \qquad x_f = \hat{x}_f + q_f \, .
\end{aligned}
\tag{A.1}
$$

The first two constraints are the domestic and foreign inverse demand for each variety derived from the CES utility function. The second two are the quantity constraints. The home market is split between the firm own production and that of its competitors $\hat{x}_d$. Similarly for the export market. Symmetric countries implies $E_d = E_f = E$ and $X_d = X_f = X$. The first order conditions of the symmetric Cournot equilibrium, $x_d = x_f = x$ and $p_d = p_f = p$, are,

$$
\left[(\alpha - 1) \frac{q_d}{x} + 1 \right] p = z^{-1} \tag{A.2}
$$

$$
\left[(\alpha - 1) \frac{q_f}{x} + 1 \right] p = \tau z^{-1}. \tag{A.3}
$$

Add (A.2) and (A.3), and use $q_d/x + q_f/x = 1/n$ to obtain

$$
p = \frac{1}{z\theta_d} = \frac{1}{z\theta_f},
$$

$$
\theta_d = \frac{2n - 1 + \alpha}{n(1 + \tau)} \quad \text{and} \quad \theta_f = \tau\theta_d
$$

where θ_d and θ_f are the inverse of the markups charged in the domestic and export markets, respectively. Substitute them in the inverse demand function to obtain

$$
z^{-1} = \theta_d \frac{E}{X^\alpha} x^{\alpha-1}.
$$

Multiply both sides of the above equation by total quantity produced q, to obtain

$$qz^{-1} = \frac{q}{x}\theta_d\, E\left(\frac{x}{X}\right)^{\alpha}.$$

Substituting $x = \left(z^{-1}\left(X^{\alpha}/\theta_d E\right)\right)^{\frac{1}{\alpha-1}}$ into equation (2) leads to $(x/X)^{\alpha} = 1$. Finally, use the definition of $\mathcal{A}$ to derive the equilibrium variable cost $qz^{-1} = \theta e$.

Markup and the number of firms. Our economy is in autarky at the prohibitive tariff level $'bar\tau$ and the autarky markup is $1/\tau_a = n/(n+\alpha-1)$. The difference between the inverse of the markup under costly trade and the autarky inverse markup can be written

$$\theta - \theta_a = \frac{\tau(1-\alpha)^2 - n(\tau-1)^2(n+\alpha-1)}{n(1+\tau)^2(1-\alpha)}$$

which is positive for all $\tau \leq \bar{\tau}$.

Proof of Proposition 2. Putting together the free entry and the market clearing conditions we obtain,

$$F(n,\tau) = \frac{\frac{L}{n} - \lambda - \bar{n}_e f_e}{\beta+\theta} - \frac{\lambda + f_e}{1-\theta}$$

Using the implicit function theorem we get,

$$\frac{\partial n}{\partial \tau} = -\frac{\frac{\partial F}{\partial \tau}}{\frac{\partial F}{\partial n}} = -\left[\frac{N}{(\beta+\theta)^2}\frac{\partial \theta}{\partial \tau} + \frac{\lambda+f_e}{(1-\theta)^2}\frac{\partial \theta}{\partial \tau}\right] / \left[\frac{\frac{L}{n^2}(\beta+\theta) + N\frac{\partial \theta}{\partial n}}{(\beta+\theta)^2} + \frac{\lambda+f_e}{(1-\theta)^2}\frac{\partial \theta}{\partial n}\right] > 0.$$

where $N = L/n - \lambda - \bar{n}_e f_e$, $\partial\theta/\partial n > 0$ and $\partial\theta/\partial\tau < 0$.

Proof of Proposition 3. The relevant cross-partial is,

Using the implicit function theorem we get,

$$\frac{\partial^2 n}{\partial \tau \partial f_e} = -\frac{\frac{\partial \theta}{\partial \tau}}{\frac{\partial \theta}{\partial n}}\frac{\left[(\beta+\theta)^2 - \bar{n}_e(1-\theta)^2\right]}{\left[(\beta+\theta)^2 - \bar{n}_e(1-\theta)^2\right]},$$

which is positive if $1/\theta < (\sqrt{\bar{n}_e}+1)/(\sqrt{\bar{n}_e}-\beta)$. Similarly,

$$\frac{\partial^2 n}{\partial \tau \partial f_e} = -\frac{\frac{\partial \theta}{\partial \tau}}{\frac{\partial \theta}{\partial n}}\frac{\left[(\beta+\theta)^2 - (1-\theta)^2\right]}{\left[(\beta+\theta)^2 - (1-\theta)^2\right]},$$

which is positive if $1/\theta < 1/(1-\beta)$.

B Markup measure theoretical framework

We consider an economy with N firms indexed by $i = 1, ..., N$, where firms are heterogeneous in their productivity and otherwise have access to a common production technology.

In each period t, firm i minimizes the contemporaneous cost of production given the production function that converts inputs into the quantity of output Q_{it} produced by the technology $Q(.)$:

$$Q(\Omega_{it}, V_{it}, K_{it}) = \Omega_{it} F_t(V_{it}, K_{it}) \tag{A.4}$$

Where $V_{it} = (V^1, ..., V^m))$ captures the set of variable inputs of production (including labour, intermediate inputs and materials), K_{it} is the capital stock (dynamic input) and Ω_{it} is the firm specific Hicks-neutral productivity term.

Following De Loecker and Eeckhout (2017), we consider below Lagrangian function, in which in each period t, firm i minimizes the contemporaneous cost of production:

$$L(V_{it}, K_{it}, \Lambda_{it}) = \overset{v}{P}_{it} V_{it} + r_{it} K_{it} + \Lambda_{it}(Q(.) - Q_{it}) \tag{A.5}$$

Where P^V is the price of the variable input, r is the user cost of capital and Λ_{it} is the lagrangian multiplier.

The first order condition of the lagrangian function with respect to the variable input V (free of adjustment costs) is as follows:

$$\frac{\partial L_{it}}{\partial V_{it}} = \overset{v}{P}_{it} - \Lambda_{it} \frac{\partial Q(.)}{\partial V_{it}} = 0 \tag{A.6}$$

Multiplying all terms of the FOC with $\frac{V_{it}}{Q_{it}}$ we get the elasticity of output for each variable input, a result of conditional cost minimization (condition on dynamic inputs - capital):

$$\theta_{it} \equiv \frac{\partial Q(.)}{\partial V_{it}} \frac{V_{it}}{Q_{it}} = \frac{1}{\Lambda_{it}} \frac{\overset{v}{P}_{it} V_{it}}{Q_{it}} \tag{A.7}$$

In which the lagrangian parameter Λ is a direct measure of marginal cost. By defining mark-up as ratio of P (price of output good) and , we get

$$\mu_{it} = \frac{P_{it}}{\Lambda_{it}} \qquad (5) \tag{A.8}$$

Substituting marginal cost for the mark-up to price ratio, we obtain the following expression for mark-up:

$$\mu_{it} = \theta_{it} \frac{P_{it}}{\overset{v}{P}_{it}} \frac{Q_{it}}{V_{it}}. \tag{A.9}$$

C Production function estimation

In line with this approach, we obtain estimates of inputs elasticity by estimating production functions by industry. In our baseline specification, for each firm i, we consider the Translog production function,

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{lk} l_{it} k_{it} + \beta_{lm} l_{it} m_{it} + \beta_{km} k_{it} m_{it} + \beta_{lkm} l_{it} k_{it} m_{it} + \omega_{it} + \epsilon_{it}.$$

where q_{it} is gross output, l_{it} and m_{it} are vectors of labour and materials inputs respectively that are static but free to move at each point in time t, k_{it} is a vector of capital inputs that are determined partly by their previous stock at time $t-1$. Firm-level total factor productivity is represented by ω_{it}, and is observed by the firm, while ϵ_{it} is an unobserved random noise. All variables are logged and deflated.

A well-known issue that is faced when estimating production functions is the 'transmission bias' that occurs in input elasticity estimates due to correlation between factor inputs and unobserved productivity. Firm-level productivity ω_{it} is potentially linked to inputs' choice, and thus correlated, as it is observable to firms. We assume that ϵ_{it} is strictly orthogonal to a firm's input choices $(l_{it}, k_{it},)$ and productivity (ω_{it}). When estimating this production function using OLS, we will get biased and inconsistent estimates of β_l and β_k respectively, as the firm's choice of inputs will be dependent on their productivity levels.

Structural estimation approaches such as Olley and Pakes (1996) and its extensions deal with transmission bias by expressing productivity shocks (ω_{it}) as a function of observable variables that in-turn 'control' for it. We follow De Loecker and Warzynski (2012) and control for simultaneity and selection bias by relying on a control function approach, paired with an AR(1) process for productivity to estimate the output elasticity of labor input. De Loecker and Warzynski (2012) rely on material demand to proxy for productivity,

$$m_{it} = m_t(k_{it}, \omega_{it}, z_{it})$$

where z_{it} are the additional control variables affecting input choices. By inverting $m_t(.)$ we get an expression which can act as a proxy for productivity,

$$\omega_{it} = h_t(k_{it}, m_{it}, z_{it}).$$

Productivity follows the AR(1) process, $\omega_{it} = g_t(\omega_{it-1}) + \varepsilon_{it}$. Using the production function specified above, we run a two-step regression. First we run,

$$y_{it} = \phi_t(l_{it}, k_{it}, m_{it}, z_{it}) + \epsilon_{it}.$$

From the above we obtain estimates of expected gross output $\hat{\phi_{it}}$ and ϵ_{it}, as $\phi_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{lk} l_{it} k_{it} + \beta_{lm} l_{it} m_{it} + \beta_{km} k_{it} m_{it} + \beta_{lkm} l_{it} k_{it} m_{it} + h_t(k_{it}, m_{it}, z_{it})$. Using the first stage, we compute productivity for any value of β, where $\beta = (\beta_l, \beta_k, \beta_m, \beta_{ll}, \beta_{kk}, \beta_{mm}, \beta_{lk}, \beta_{lm}, \beta_{km}, \beta_{lkm})$, as $\omega_{it}(\beta) = \hat{\phi_{it}} - \beta_l l_{it} - \beta_k k_{it} - \beta_m m_{it} - \beta_{ll} l_{it}^2 - \beta_{kk} k_{it}^2 - \beta_{mm} m_{it}^2 - \beta_{lk} l_{it} k_{it} - \beta_{lm} l_{it} m_{it} - \beta_{km} k_{it} m_{it} - \beta_{lkm} l_{it} k_{it} m_{it}$. We then nonparametically regress $\omega_{it}(\beta)$ on its lag and other controls that affect it to recover $\varepsilon_{it}(\beta)$. The following moment condition is then used to estimate β,

$$E(\varepsilon_{it}(\beta) \begin{pmatrix} k_{it} \\ l_{it-1} \\ m_{it-1} \\ k_{it}^2 \\ l_{it-1}^2 \\ m_{it-1}^2 \\ k_{it} m_{it-1} \\ k_{it} l_{it-1} \\ m_{it-1} l_{it-1} \\ k_{it} l_{it-1} m_{it-1} \end{pmatrix}) = 0$$

Estimated values of $\hat{\beta_m}$ are used to compute values of markups for each firm from the data, by plugging them into equation (4). The material expenditure share of gross output is corrected for measurement error by dividing it by $exp(\epsilon_{it})$.

D Empirical results

D.1 Descriptive statistics

Table A.1: Values are in 10,000 Euro deflated using our firm-specific price index with 1990 as the base year. Labor is measured in yearly number of firms. Period between 1990-2010

Variable	Mean	Median	Nr Obs
Output	4,440	4,414	31,595
Capital	1,630	1,296	31,595
Materials	2,770	2,221	31,595
Labor	228	48	31,595

Table A.2: Average sectoral markups with Translog and Cobb-Douglas: 1990-2010

Industry	Mean TL	Mean CD
1 Meat and Meat Products	1.23	1.09
2 Food and Tobacco	1.46	1.60
3 Beverages	1.28	1.39
4 Textiles and Apparels	1.90	1.96
5 Leather products and shoes	1.88	1.40
6 Wood and furniture	1.25	1.16
7 Paper, paper products and printing products	1.26	1.41
8 Chemical products	1.55	0.98
9 Plastic products and rubber	1.49	0.86
10 Non-metallic mineral products	1.57	1.54
11 Ferrous and non-ferrous metals	1.42	1.41
12 Metallic products	1.25	1.19
13 Agricultural and industrial machinery	1.19	1.32
14 Electrical Material and Electrical Accessories	1.29	1.47
15 Office Machinery, Data Processing Machinery, etc.	1.39	1.19
16 Motor Vehicles	1.19	1.54
17 Other transport material	1.61	1.02
18 Wood and furniture	2.02	1.34
Average	1.47	1.37

Table A.3: Average output elasticities by sector, translog specification: 1990-2010

Industry	Observations	Labour	Materials	Capital	RTS
1 Meat and Meat Products	944	0.00	0.91	0.01	0.92
2 Food and Tobacco	3,179	0.15	0.87	0.01	1.03
3 Beverages	662	0.21	0.72	0.08	1.01
4 Textiles and Apparels	3,082	0.30	0.81	0.06	1.17
5 Leather products and shoes	964	0.11	1.11	-0.10	1.12
6 Wood and furniture	980	0.19	0.75	0.04	0.98
7 Paper, paper products and printing products	2,613	0.24	0.65	0.10	0.99
8 Chemical products	2,126	0.19	1.00	0.09	1.28
9 Plastic products and rubber	1,698	0.45	0.90	0.09	1.44
10 Non-metallic mineral products	2,344	0.37	0.85	0.02	1.24
11 Ferrous and non-ferrous metals	946	-0.01	0.92	0.07	0.98
12 Metallic products	3,488	0.36	0.66	0.03	1.05
13 Agricultural and industrial machinery	1,939	0.29	0.66	0.07	1.02
14 Electrical Material and Electrical Accessories	942	0.26	0.70	0.07	1.03
15 Office Machinery, Data Processing Machinery, etc.	1,804	0.19	0.79	0.00	0.98
16 Motor Vehicles	1,487	0.13	0.77	0.03	0.93
17 Other transport material	762	0.01	0.85	0.06	0.92
18 Wood and furniture	1,624	0.57	1.17	0.16	1.90

D.2 Tariff endogeneity checks

Table A.4: Output Tariff Cross-Correlations

Variables	Meat Products	Food and Tobacco	Beverages	Textiles and Apparels	Leather and Shoes	Wood and Furtniture	Paper and Printing	Chemical P > roducts	Plastic and Rubber	Non-Metallic Mineral	Ferrous Metals	Metallic Products	Agri/Industry Machinery	Electrical Material	Office/Data Machinery	Motor Vehicl > es	Other Transport Material
Meat Products	1.000																
Food and Tobacco	-0.237	1.000															
Beverages	-0.259	0.927	1.000														
Textiles and Apparels	-0.436	0.541	0.519	1.000													
Leather and Shoes	-0.386	0.395	0.385	0.861	1.000												
Wood and Furtniture	-0.404	0.128	0.060	0.740	0.800	1.000											
Paper and Printing	-0.577	0.275	0.238	0.773	0.745	0.810	1.000										
Chemical Products	-0.495	0.635	0.588	0.857	0.724	0.687	0.813	1.000									
Plastic and Rubber	-0.266	0.633	0.550	0.547	0.428	0.378	0.469	0.777	1.000								
Non-Metallic Mineral	-0.075	0.448	0.417	0.455	0.312	0.307	0.326	0.585	0.512	1.000							
Ferrous Metals	-0.356	0.644	0.592	0.773	0.675	0.610	0.637	0.821	0.588	0.469	1.000						
Metallic Products	-0.361	0.655	0.604	0.770	0.670	0.599	0.628	0.816	0.584	0.474	0.987	1.000					
Agri/Industry Machinery	-0.644	0.613	0.592	0.883	0.812	0.697	0.817	0.893	0.591	0.453	0.830	0.836	1.000				
Electrical Material	-0.660	0.625	0.605	0.877	0.803	0.684	0.806	0.886	0.585	0.451	0.817	0.823	0.990	1.000			
Office/Data Machinery	-0.670	0.632	0.611	0.873	0.798	0.677	0.801	0.882	0.581	0.450	0.810	0.816	0.984	0.994	1.000		
Motor Vehicles	-0.334	0.617	0.537	0.400	0.369	0.255	0.171	0.405	0.407	0.260	0.569	0.584	0.496	0.519	0.531	1.000	
Other Transport Material	-0.355	0.641	0.562	0.392	0.354	0.233	0.155	0.398	0.404	0.256	0.552	0.566	0.484	0.507	0.520	0.966	1.000

Table A.5: Input Tariff Cross-Correlations

Variables	Meat Products	Food and Tobacco	Beverages	Textiles and Apparels	Leather and Shoes	Wood and Furtniture	Paper and Printing	Chemical P > roducts	Plastic and Rubber	Non-Metallic Mineral	Ferrous Metals	Metallic Products	Agri/Industry Machinery	Electrical Material	Office/Data Machinery	Motor Vehicl > es	Other Transport Material
Meat Products	1.000																
Food and Tobacco	0.967	1.000															
Beverages	0.954	0.984	1.000														
Textiles and Apparels	0.888	0.843	0.856	1.000													
Leather and Shoes	0.869	0.801	0.820	0.921	1.000												
Wood and Furtniture	0.918	0.894	0.906	0.934	0.923	1.000											
Paper and Printing	0.885	0.831	0.839	0.940	0.948	0.950	1.000										
Chemical Products	0.900	0.864	0.875	0.941	0.942	0.949	0.977	1.000									
Plastic and Rubber	0.886	0.848	0.860	0.928	0.944	0.935	0.965	0.986	1.000								
Non-Metallic Mineral	0.890	0.873	0.888	0.913	0.915	0.930	0.928	0.966	0.970	1.000							
Ferrous Metals	0.892	0.868	0.876	0.902	0.895	0.917	0.932	0.957	0.956	0.943	1.000						
Metallic Products	0.889	0.866	0.873	0.900	0.894	0.912	0.928	0.954	0.953	0.941	0.994	1.000					
Agri/Industry Machinery	0.853	0.820	0.829	0.892	0.899	0.886	0.923	0.947	0.951	0.934	0.963	0.969	1.000				
Electrical Material	0.844	0.813	0.822	0.884	0.892	0.873	0.914	0.940	0.942	0.927	0.951	0.957	0.988	1.000			
Office/Data Machinery	0.839	0.809	0.818	0.880	0.889	0.867	0.909	0.936	0.938	0.923	0.945	0.950	0.982	0.994	1.000		
Motor Vehicles	0.752	0.708	0.722	0.838	0.830	0.809	0.877	0.889	0.876	0.864	0.850	0.854	0.890	0.898	0.903	1.000	
Other Transport Material	0.744	0.700	0.714	0.835	0.827	0.803	0.874	0.885	0.871	0.857	0.844	0.848	0.884	0.892	0.896	0.992	1.000

D.3 Sectoral decomposition

1yr Period	Δ Markup	Δ Within	Δ Between	Δ Realloc.	Mean (ΔΘ)
1992-1993	0.013	0.017	-0.014	0.010	-0.003
1993-1994	-0.070	-0.063	0.008	-0.015	0.010
1994-1995	0.035	0.043	-0.002	-0.006	0.013
1995-1996	-0.065	-0.052	0.017	-0.030	-0.001
1996-1997	0.128	0.116	-0.015	0.027	0.011
1997-1998	-0.016	-0.016	0.001	-0.001	0.006
1998-1999	-0.106	-0.116	0.013	-0.003	-0.011
1999-2000	-0.005	-0.011	0.002	0.004	0.006
2000-2001	-0.040	-0.042	0.003	-0.002	-0.001
2001-2002	0.074	0.071	0.022	-0.019	-0.004
2002-2003	-0.118	-0.093	0.018	-0.043	0.000
2003-2004	0.003	0.000	0.003	0.000	0.001
2004-2005	0.006	0.003	-0.010	0.012	-0.012
2005-2006	0.143	0.136	0.021	-0.014	-0.001
2006-2007	0.005	0.007	0.002	-0.004	0.005
2007-2008	-0.045	-0.035	-0.024	0.014	-0.004
2008-2009	0.011	0.005	0.001	0.004	-0.026

2yr Period	Δ Markup	Δ Within	Δ Between	Δ Realloc.	Mean (ΔΘ)
1992-1994	-0.057	-0.035	-0.017	-0.005	0.007
1994-1996	-0.029	-0.007	0.043	-0.065	0.012
1996-1998	0.112	0.104	-0.021	0.029	0.017
1998-2000	-0.111	-0.129	0.008	0.010	-0.005
2000-2002	0.034	0.022	0.035	-0.023	-0.004
2002-2004	-0.115	-0.099	0.018	-0.034	0.000
2004-2006	0.149	0.145	0.003	0.001	-0.013
2006-2008	-0.040	-0.034	-0.019	0.013	0.001

Table A.6: Sectoral Decomposition of Weighted Markup Evolution

4yr Period	Δ Markup	Δ Within	Δ Between	Δ Realloc.	Mean (ΔΘ)
1992-1996	-0.087	-0.071	-0.013	-0.003	0.018
1996-2000	-0.030	-0.021	-0.008	-0.001	0.012
2000-2004	-0.081	-0.104	0.021	0.002	-0.004
2004-2008	0.109	0.108	0.002	-0.002	-0.012

D.4 Baseline result using import penetration as main regressor

			Fixed Effects					Fixed Effects IV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Industy EUR Import Penetration Ratio (1990-2009)	-0.162^{***}	-0.123^{***}	-0.152^{***}	0.236^{***}	0.291^{***}	1.833^{***}	1.894^{***}	2.098^{***}	2.670^{***}	1.725^{***}
	(0.035)	(0.034)	(0.031)	(0.030)	(0.027)	(0.310)	(0.283)	(0.365)	(0.562)	(0.209)
Average tangible fixed assets (excluding land and buildings) by Industry		-0.000^{***}	-0.000^{***}	0.000^{***}	0.000^{***}		-0.000^{***}	-0.000^{***}	0.000	
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	
Average percentage foreign holding by Industry			0.001^{***}	0.002^{***}	0.004^{***}			-0.003^{**}	-0.004^{*}	
			(0.001)	(0.001)	(0.000)			(0.001)	(0.002)	
Year Effects				X	X				X	X
Industry Effects					X					X
N	31,589	31,578	31,578	31,578	31,578	24,645	24,645	24,645	24,645	24,645
R^2	0.001	0.003	0.004	0.111	0.147					

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Regression is performed using fixed effects. It includes industry and year dummies, and standard errors are clustered at the three-digit industry level.

D.5 Output tariffs by industry

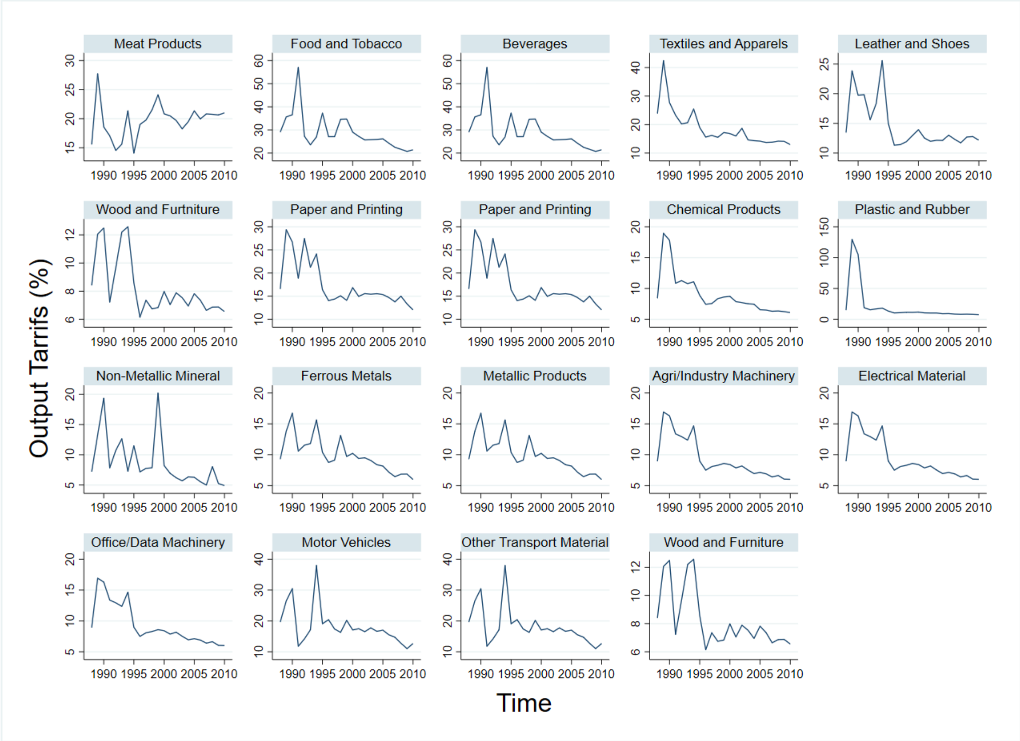

Figure A.1: Output Tariffs by 3-digit industries

D.6 Import penetration trends

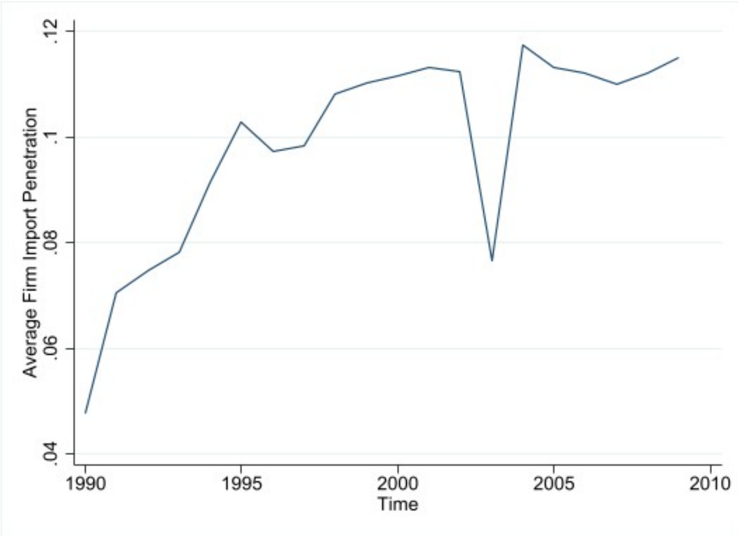

Figure A.2: Average Import Penetration

D.7 Superstar hypothesis robustness

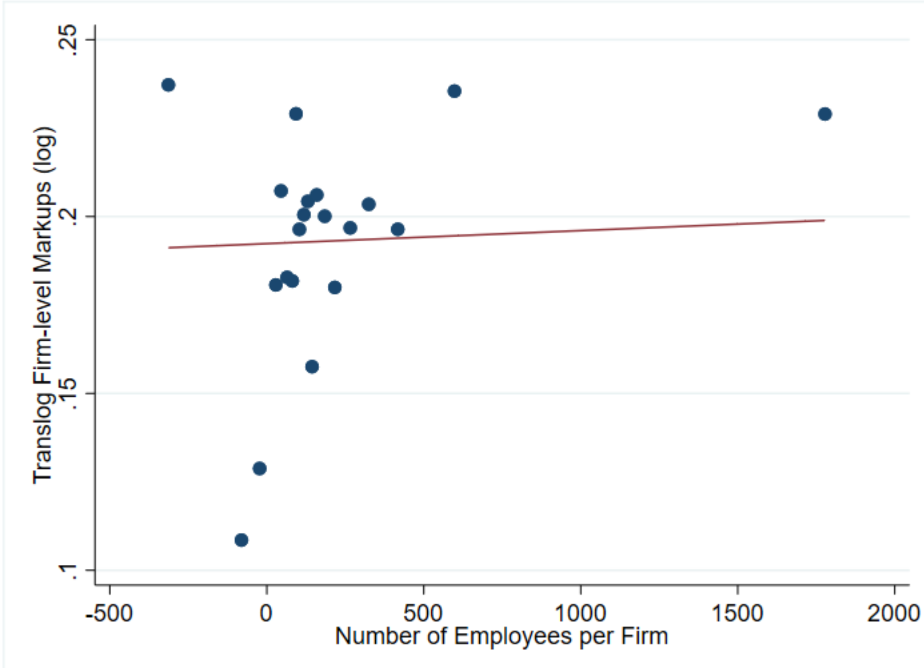

Figure A.3: Markups and Firm Size

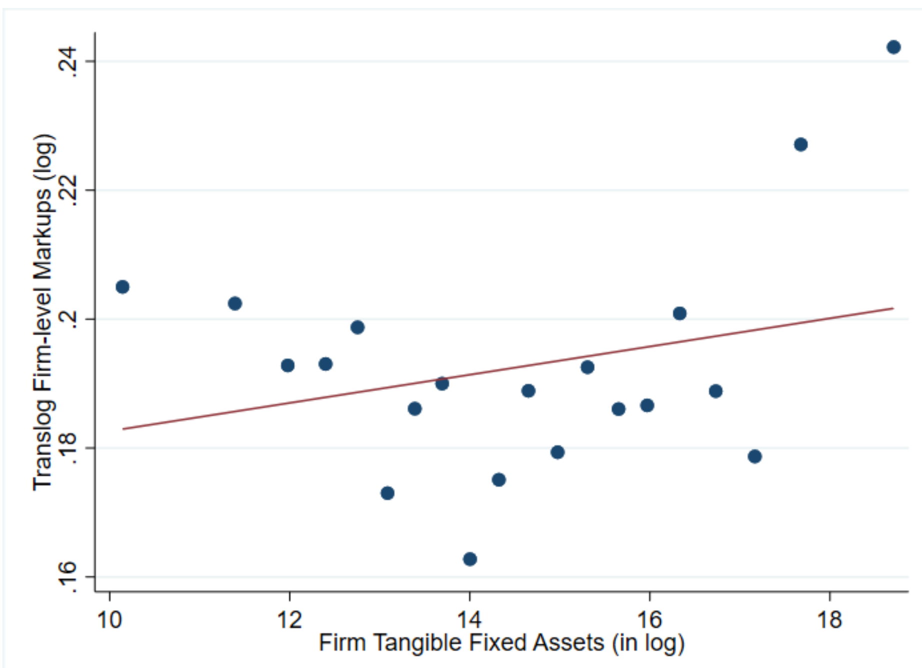

Figure A.4: Markups and Firm Size

D.8 Evolution of material share in ESSE

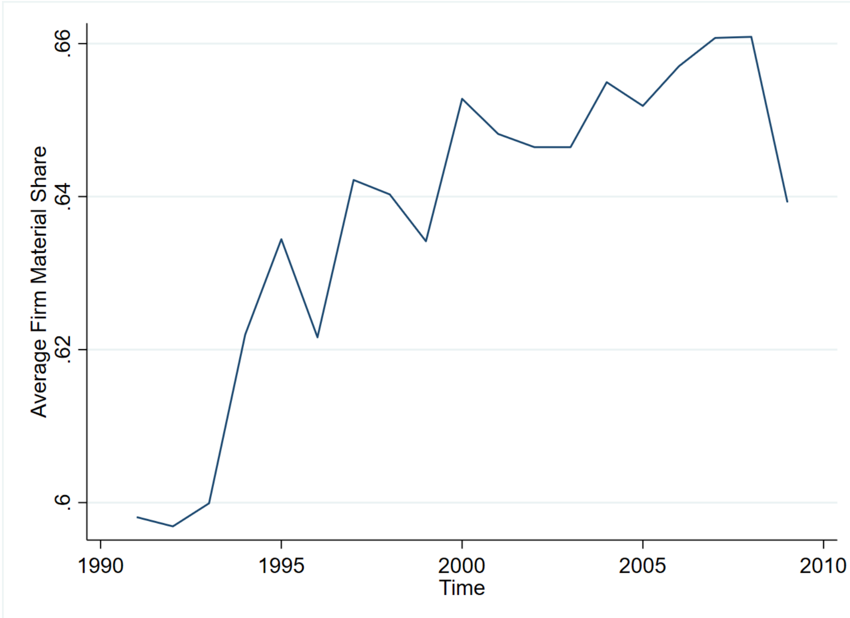

Figure A.5: Average firm material share.

D.9 KLEMS trends

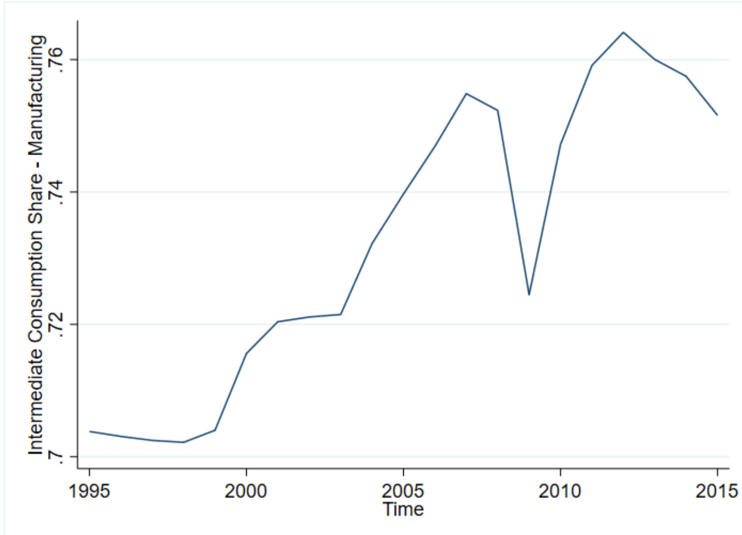

Figure A.6: Intermediate consumption share as a fraction of total output for Spanish Manufacturing

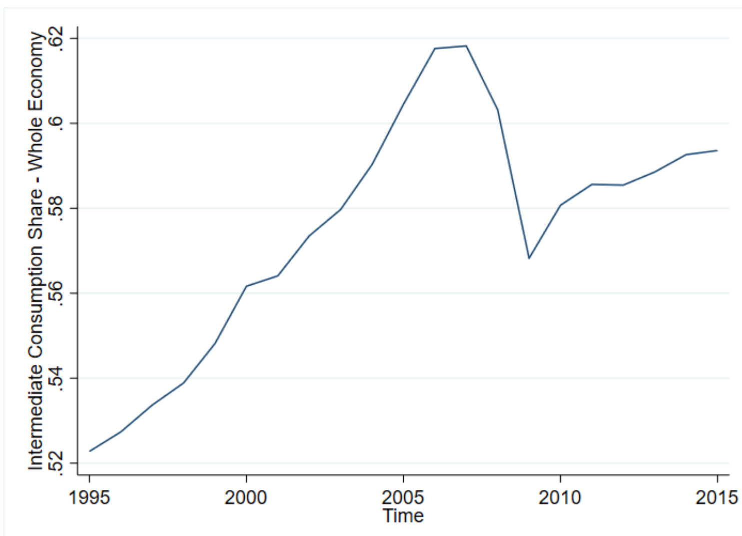

Figure A.7: Intermediate consumption share as a fraction of total output for the entire Spanish economy

D.10 Alternate markup measurement

Figure A.8: Unweighted average markup (alternate measure