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GLOBALIZATION AND MARKET POWER

Abstract

Economic theory suggests that the markup is a key 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. Trade-induced increases in competition leads to more concentrated markets via entry and exit, putting upward pressure on markups. Market shares reallocation toward larger, more powerful firms, increase the aggregate markup. We use a large episode of trade liberalisation in Spain to test this rich set of transmission mechanisms linking trade and markups. The overall effect of reductions in Spanish import tariffs 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 with high intangible investment experience a weaker reduction in markups. Supporting the theoretical insight that the feedback effect via concentration is stronger with higher barriers to entry. Increases in markups are also produced by reallocations effects but the results are weaker, suggesting that the link between trade and markups is mostly driven by changes at the intensive margin.

JEL Classification: F12, F13, F14, F60

Keywords: International trade, Oligopoly, Markups

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Globalization and Market Power*†

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Abstract

Economic theory suggests that the markup is a key 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. Trade-induced increases in competition leads to more concentrated markets via entry and exit, putting upward pressure on markups. Market shares reallocation toward larger, more powerful firms, increase the aggregate markup. We use a large episode of trade liberalisation in Spain to test this rich set of transmission mechanisms linking trade and markups. The overall effect of reductions in Spanish import tariffs 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 with high intangible investment experience a weaker reduction in markups. Supporting the theoretical insight that the feedback effect via concentration is stronger with higher barriers to entry. Increases in markups are also produced by reallocations effects but the results are weaker, suggesting that the link between trade and markups is mostly driven by changes at the intensive margin.

Keywords: International trade, markups, oligopoly.

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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 use a simple model of oligopoly trade to highlight 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 a tractable two-country Cournot model of oligopoly trade we show that lower trade barriers reduce markups on firms' domestic sales via the standard *pro-competitive effect*. Lower trade barriers imply lower residual demand for domestic goods which forces firms to reduce their domestic markups.[1] Competitive pressure induced by trade reduce the number of firms competing in each market, this increase in concentration, in turn, leader to higher markups. This *concentration effect* is stronger the larger the entry cost and the economies of scale, measures of barriers to entry. When barriers to entry are high, firms operate in low competitive environments, so that even a small reduction in the number of firms has a strong impact on market power. Finally, a typical feature of Cournot models is that a firm's markup is positively related to its market share. Trade can then 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-

[1] The standard incomplete pass-through channel operates as well. Firms transfer only part of the reduction in the cost of export onto consumers, with the remaining part going to markups. Due to data limitation we do not devote our primary attention to this channel.

2010. The measure of trade barriers we focus on is import tariffs on final goods. 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 the survey of Spanish manufacturing firms, the Encuesta sobre Estrategias Empresariales (ESEE), 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 concentration channel tame the pro-competitive effect on firm-level markups but they are not strong enough to offset it. Markups decline less for firms operating in industries with higher barriers to entry measured as intangible assets and, within a given sector, for firms with higher intangibles.[2] This is in line with the model's prediction that larger entry and fixed operating costs produce a stronger concentration effect of trade. We also perform a direct test of the effect of trade on concentration and find that the reduction in Spanish import tariffs is strongly associated with an increase in concentration, measured using the typical concentration ratios, the sales shares of top firms.

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, although the latter result is not significant. The effect of trade liberalisation on the within component is stronger and the overall impact on sectoral markups is negative. Thus our results suggest that the overall impact of trade on markups is pro-competitive and driven by changes at the *intensive margin*, that is reductions the in markup at the firm level.

We run a large set of analyses to test the robustness of these results. We use an alternative measure of markups and show that the trends inferred from our baseline measure are confirmed. We also perform a sanity check to corroborate our firm-level

[2] Intangible investment such as R&D, software, advertising, market research, design, and branding are typical examples of barriers to entry discussed in the IO antitrust literature (e.g. Demsetz, 1982; McAfee et al., 2004).

markup estimate trends by using publicly available sector-level data from KLEMS. We also obtain cost share estimates of markups and show that they yield a similar picture. 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 show that our test of the concentration effect via barriers to entry is robust to using R&D and firm size as a measure of these barriers.

Finally, we follow De Loecker et al. (2016) and consider also tariffs on intermediate goods, input tariffs. This allows us to provide a simple test of the incomplete pass-through channel, according to which a reduction in input tariffs leads to cost reductions which are not fully passed onto prices, as part of them goes into higher markups. Although our analysis here is constrained by data limitation, our findings confirm the results in De Loecker et al. (2016) that input tariffs liberalisation increase markups.

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.[3]

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.[4] We contribute to this literature by

[3]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.

[4]Another line of work suggests that the slowdown of population growth can be at the roots of increas-

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 effects 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 while the reduction of tariffs on final goods, output tariffs, has pro-competitive effects on markups, declining input tariffs have the opposite effect.[5] We complement their findings showing that trade can have anti-competitive effects above and beyond the incomplete pass-through. Our finding suggest that lower output tariffs can be anti-competitive as well, as trade can increase firm-level markups, via a concentration effect, and the aggregate markup, as a consequence of reallocations of market shares toward more productive (high markup) firms. To the best of our knowledge we provide the first empirical test of the concentration and reallocation effects of trade on markups.[6]

The theoretical channels we highlight using our model are not new. 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 competitive models with endogenous markups obtained departing from CES preferences, the horse race between those two channels crucially depends on the choice of preferences.[7] 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, Venables (1985) shows that in this class of models free entry generates the concentration effect of

ing 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.

[5]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 the profitability of private firms but not on that of state-owned enterprises.

[6]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 do not provide a direct empirical test of the sources of this reallocation.

[7]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.

trade in the case of unilateral liberalisation. As in our model, Impullitti et al. (2021) find that the concentration effect attains also with multilateral liberalisation. The scope of our model is then not to uncover a new transmission channel of trade to markups but rather to provide a tractable unified framework that includes many existing channels and use it as a theoretical guide for our empirical investigation.

2 Theory

We present a simple theoretical framework that embeds the key channels through which trade can affect 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). To keep the model tractable we assume symmetric countries.

Environment. Households are endowed with one L units of labor and consume an homogenous good and a composite good deriving utility $U = \ln X + \beta \ln Y$, where is Y, homogeneous good, and X composite good is a CES aggregate of a continuum of varieties,

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

The homogeneous good is produced under perfect competition using one unit of labor and it is the numeraire of the economy. It follows that the equilibrium wage is equal to one.[8] 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, $q = z(\ell - \lambda)$, 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 $\tau > 1$.

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

Equilibrium price and markup. In this class of oligopoly models, the symmetric Cournot equilibrium leads to the standard markup pricing. The unique price in both domestic and foreign markets is, $p(z) = 1/(z\theta_d) = \tau/(z\theta_f)$, where θ_d is the inverse of the markup on domestic sales,

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

and $\theta_f = \tau\theta_d$ is the inverse of the markup on export sales. Another, perhaps more common, way to write the markup is $\theta_d = (n - (1-\alpha)s_d)\,/n$, where s_d is the share of sales of each firm on the domestic market. The inverse of a firm average markup can be written as

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

a weighted average of the domestic and export markups, using market shares as weights. 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, $\bar{\tau}$.

To keep the model tractable and derive the impact of trade on the markup in closed form, we have assumed symmetric countries and we now derive the effect of multilateral trade liberalisation. The transparency of the results that this assumption permits facilitates the discussion of the impact of unilateral liberalisation which we tackle later.

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

- 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 on 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 markup. 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,

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

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 can potentially 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.

This result suggests that the anti-competitive effect of trade liberalisation via concentration is stronger for firms operating in less competitive markets. Sunk entry costs and technological barriers to entry, which can be embedded in fixed costs, are considered primary barriers to entry in the IO literature (see e.g. Demsetz, 1982; McAfee et al., 2004). This insight will be particularly useful in guiding the empirical specification of our test of the concentration effect.

Firm heterogeneity. Our model can be easily extended to incorporate heterogeneous productivity across firms generating size and markup heterogeneity. The can be done assuming that each oligopolistic firm competing within each variety produces an imperfectly substitutable version of that good with its own specific productivity, as in Atkeson and Burstein (2008) and Edmond et al. (2015). This extended model loses analytical tractability and the impact of trade on markups cannot be characterised in closed form. It can be easily shown though that firms with higher market shares face lower demand elasticity and charge higher markups.[12] Consequently, any reallocation of market shares toward large firms, originating from trade or other shocks, would increase the aggregate markup.[13] 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 of the aggregate markup response to globalisation alongside the firm-level channels described above.

Unilateral liberalisation. In our empirical analysis we study the impact of a reduction in Spanish import tariffs on Spanish firms' markups. To keep the theoretical model tractable we have focused on symmetric countries and multilateral liberalisation. It is fair to wonder which of the results above depend specifically on the simplifying assumption of multilateral liberalisation. The pro-competitive effect on firm-level domestic markup holds through, as it measures the impact on the domestic market of the liberalising country. Firms from the liberalising country instead will not see any change in their export markup with unilateral liberalisation, so the incomplete pass-through would not

[12] As we showed above, markups can be written as a function of the share of sales going to each firm. With heterogeneous firms, those with higher productivity have higher sales shares and charge higher markups. See Edmond et al. (2015) for the detailed derivation.

[13] 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.

be operative.[14]

Finally, similar to the pro-competitive effect, the concentration effect is a direct result of higher competition on the domestic market. Hence, it holds even in the case of unilateral liberalisation. For this class of models, oligopoly with free entry, this is shown in Venables (1985). Although the impact on the number of firms cannot be characterised, it is shown that with free entry markups in the liberalising country increase.[15] A similar result can be obtained in monopolistic competition models with variable markups, such as Melitz and Ottaviano (2008). In this class of models, a reduction in trade costs in one country pushes firms to 'relocate' to the non-liberalising country where there is less competition. More firms enter the latter while the number of entrants in the liberalising country shrinks leading to a higher markup. It is easy to show that, in line with our findings, this anti-competitive effect of trade is stronger for firms facing higher entry barriers.[16]

Taking stock, the relationship between trade and markups that emerges from economic theory is complex. Trade liberalisation reduces domestic firm-level markups via the standard pro-competitive effect. Increases domestic firm-level markups via a concentration effect which is stronger the higher the domestic barriers to entry. Finally, it increases the aggregate markup via a reallocation effect. 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 used in the analysis that follows.

[14]The incomplete pass-through channel can also be obtained with unilateral liberalisation if along with final goods tariffs we consider also intermediate goods tariffs, as in De Loecker et al. (2016). A reduction in input tariffs leads to cost reductions a part of which will go into higher markups. Extending the model to include intermediate inputs would compromise its tractability without adding new insights. Due to data limitation we are not able to fully explore this channel, but we will test a version of it in our robustness analysis.

[15]See also Helpman and Krugman (1989) chapter 7.

[16]We do not use Melitz and Ottaviano (2008) as our theoretical guidance because it makes the impact of trade on markups strictly dependent on entry thereby excluding any direct impact of changes in trade costs on markups. In that framework, when entry is not active, the so-called short-run scenario, trade liberalisation has no effect on firm-level markups. Instead, in our model lower barriers in the home country give foreign firms cheaper access to the home market thereby putting higher competitive pressure on the domestic markups of home firms, as shown in proposition 1. Thus, our framework captures a richer set of features of the relationship between trade and markups.

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 conditions 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,

$$\mu_{it} = \theta_{ivt} \frac{P_{it} Q_{it}}{P_{vit} V_{it}}, \tag{2}$$

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 relevant variable input as it is the most flexible and least adjustment cost intensive - compared to capital and labour. We also choose 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. Robustness of the key results to using a Cobb-Douglas specification and other inputs is also presented. 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, the Encuesta Sobre Estrategias Empresariales (ESEE). 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 31,595 observations from 1990 to 2010, belonging to 20 different industries.[17]

The dataset contains information on firm's inputs and outputs. Firms report price changes from their main products and inputs, and ESEE uses this information to create annual estimation of firm specific input and output price changes. For our empirical

[17] Data for more recent years, up to 2015, are also available but not relevant for our question, as trade liberalisation takes place mainly in the 1990s and peters out after the mid-2000s, as we show later.

analysis, we will clump these price changes together to build firm-specific price indices[18], 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 as 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.[19] 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 barriers is tariffs that Spain imposes on imports from 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 (WITS) pulled directly at the 3-digit SIC industry level, so no form of aggregation was required from our end. We match these with our dataset at the 3-digit industry level, the finest sectoral aggregation level available in ESEE. We compute *input tariffs*, the tariffs on intermediate goods using Spanish input-output tables from the WIOD (World Input-Output Database)[20]. These tariffs are computed as as a weighted average of the output tariffs using intermediate inputs cost shares as weights.

3.3 Trade liberalisation in Spain

In the 1980's Spain was in the process of political transition, with its previous state-controlled economic system being done away with in favour of a more globalised trading environment for firms.[21] By 1985, Spain had signed an agreement to join the European Union, and became a full member in 1986. In conjunction with these events,

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

[19]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

[20]Input tariffs have only been calculated from 1995 onwards due to lack of data availability for earlier years from WIOD

[21]Under Franco, Spain used a large variety of policy instruments that hindered international trade. Using bilateral trade flows and a structural gravity model, Campos et al. (2022) measure the thickness of Spanish boarder and find that in the period 1948-75 Spain's barriers to international trade were the highest in Western Europe.

the European Union was also in the process of implementing one of the largest market liberalisation reform since the late 1960's, called the Single Market Programme.[22]

Our measure of trade liberalisation is the change in Spanish import tariffs. Spain's trade integration into the EU took over a transition period of about ten years. Spanish customs tariffs were phased out over a period of seven years for most products originating from the EU and the European Free Trade Association (EFTA) countries, and over a ten-year period for some agricultural products. For products imported from other countries, the difference in duty rates between Spain and the EU common external tariffs were phased out during a seven-year period. By 1997 the integration process was completed, although a reduction in EU tariffs based on the commitments undertaken during the Uruguay Round would continue till 2001 (OECD (2000)).

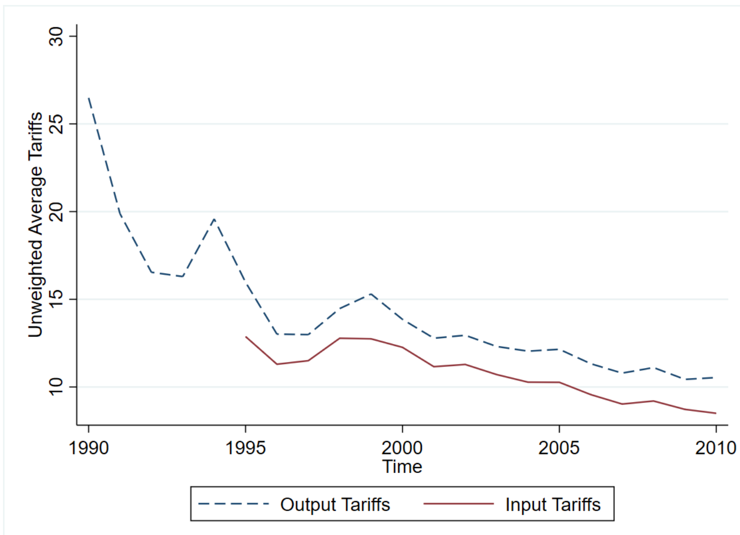


Figure 1: Unweighted average industry output and input tariffs

Notes. The figure above illustrates unweighted averages of output and input tariffs across all 3-digit SIC industries. Input tariffs have only been calculated from 1995 onwards due to lack of data availability for earlier years from WIOD (World Input-Output Database).

Figure 1 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.[23] The trend is common to the wide majority of sectors, as shown in Figure A.1. The average input tariff also exhibits a similar reduction across the sample period. After

[22]Among other things, this program involved the removal of roughly 300 non-tariff barriers (NTBs) that still existed in the EU. See Buigues et al. (1990) for more information on the latter.

[23]The 3-digit aggregation from WITS gives higher average tariff levels than finer aggregations but there is no substantial difference in the trend. For example, aggregating at the eight-digit level gives an average tariff of 8.5 percent in 1990, monotonically declining to 4 percent in 2020.

2010 the tariff decline is essentially completed and we do not observe any substantial change. Thus, although we have a few more years (up to 2015) in the ESSE dataset, we focus on the period up to 2010, as after that there is not much variation in tariffs.

Along with a reduction in tariff barriers came a substantial increase 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, which triples between 1990 and 2010. As for the tariffs the biggest change takes place in the 1990s.

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, for instance, 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 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 more effectively). From the scatterplots shown in figure 2 above we can see that there is little to no statistical correlation between output tariffs and the majority of the industry characteristics, with the exception of the capital-labour ratio.

While these checks cannot entirely rule out the possibility of endogeniety in using

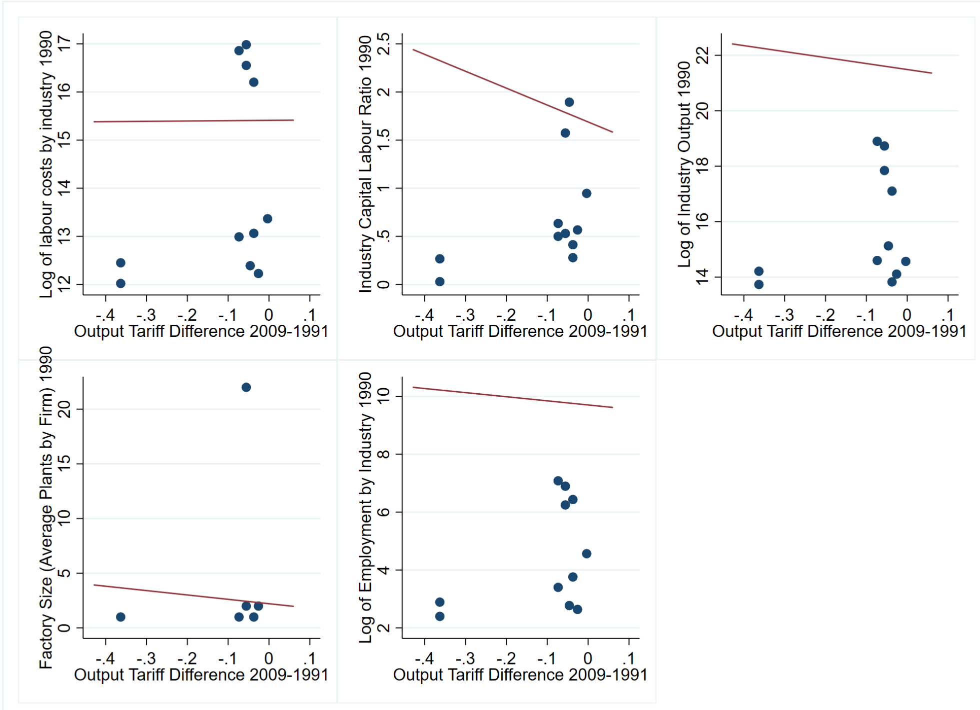


Figure 2: Scatter plot of industry characteristics (1990) and output tariff differences (2009-1991)

Notes The figure above illustrates a scatterplot with overlaid linear prediction plot between politically important industry characterics in 1990 and the difference between output tariffs in 2009 and 1991.

the variation in tariffs to test our intended hypothesis, this evidence is suggestive of some degree of exogeniety in our explanatory measures of choice.

4 Markups dynamics 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 and then decompose the aggregate trend between sectors and between firms within sectors. Summary statistics of the estimated markups are presented in the appendix, where we show the statistics of the inputs used in the production function estimation, table A.1 and the average sectoral markups obtained with the translog and Cobb-Douglas specifications, table A.2. For the majority of the sectors the two estimates are fairly consistent. We also report the estimated output elasticities for each input (from the translog specification of the production function) and their corresponding returns to scale.

4.1 Aggregate markup

Figure 3 shows the unweighted average firm markup across Spain's manufacturing sector, reporting both our baseline specification using the translog production function and the 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 charging a price 42 percent (translog) and 29 percent (Cobb-Douglas) above the 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 3, 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.

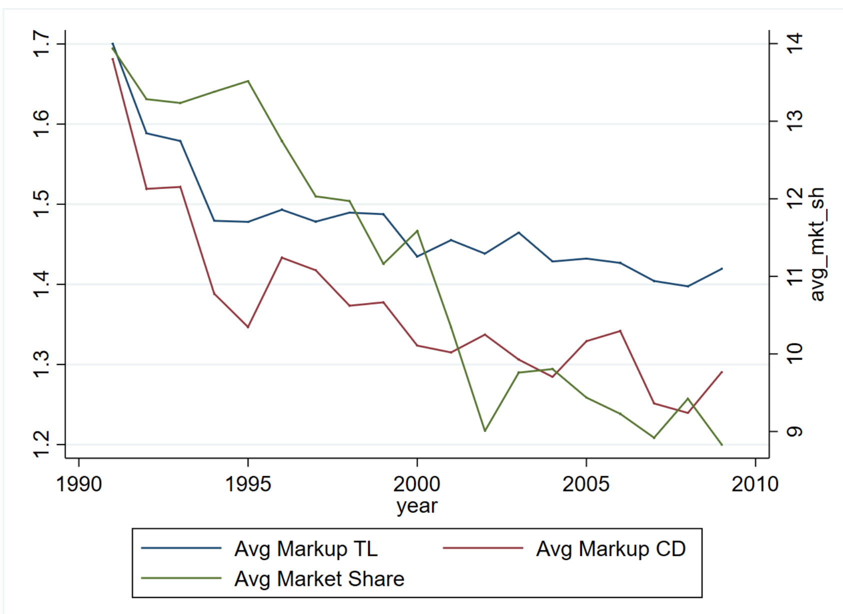
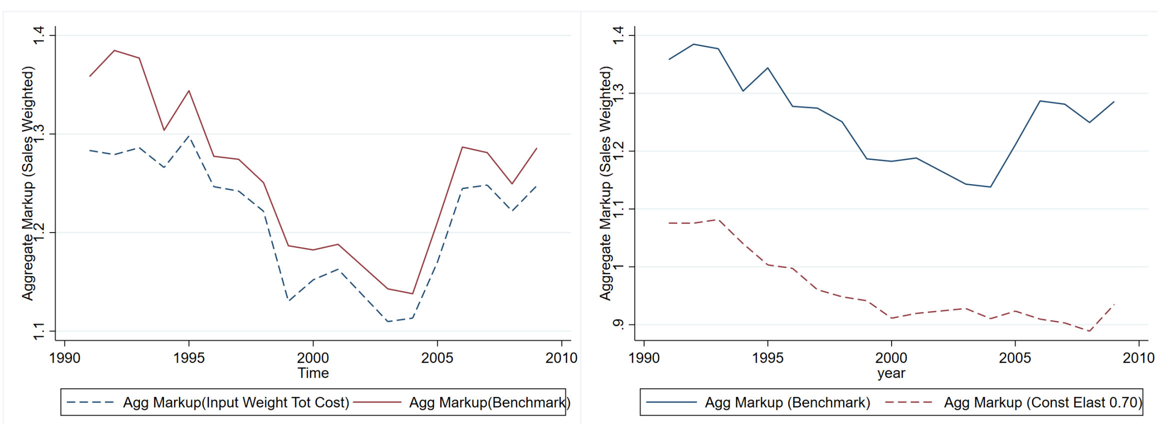


Figure 3: Unweighted average firm markup and market share

Notes. Output elasticities θ_{st} for the translog measure of markups (estimated from the production function) are time-varying and industry-specific (3-digit SIC). For the Cobb-Douglas measure, output elasticities θ_s (estimated from the production function) are time-invariant and industry specific (3-digit SIC). The figure illustrates unweighted averages of firm translog and Cobb-Douglas markups for all industries from 1991 to 2009.

Next, we report the sales-weighted average markup. From Figure 4 we can clearly see that similar to our unweighted average firm markup, the sales-weighted average markup declines fairly sharply between 1991 to 2004. Interestingly, differently from our unweighted markups, sales-weighted average markups start increasing from 2005 onwards and continue rising up till the end of the sample period 2010.

Changes in the average sales-weighted markup can originate from three possible sources: (i) the weights (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 weights. 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 suggests that the levels of average markups calculated using input weights should be lower than those of their revenue-weighted counterparts. Figure 4 validates this intuition. For inputs, we use firm total costs from the income statement. We can see that the level of inpu-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 the variation of the average markup observed in the sample. It also suggests that changing the weight to inputs (total cost) instead of revenue does not alter its trend.



A) Aggregate sales-weighted and cost-weighted markups

B) Constant elasticity comparison

Figure 4: Evolution of weighted markups

Notes. The figure above uses the translog specification of firm markups. Benchmark markups are revenue (sales) weighted.

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). Figure 4 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 a role in driving the increase in our benchmark measure from 2005 onwards.[24] The precise reasons for how and why we observe the latter are something we 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, especially in the period of intense trade liberalisation, the bulk of the downward trend can be attributed to the decline in the wedge of sales to material expenditure. Figure A.6 in the Appendix, showing the dynamics of the material share, confirms this insight.

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. Figure 5 presents the kernel density of unweighted markups for years 1991 and 2008 to understand their respective distributional differences. We can clearly see that the distribution in 2008 has shifted to left, compared to 1991, indicating that average markups have been lowered by changes to all segments of the distribution.

4.2 Decomposition Analysis

To better understand the nature of the decrease in the weighted-average markup, we can decompose its changes into the component that is assigned to the changes in the markup itself at the firm-level, and the component that is attributable to the reallocation of economic activity across firms with different markup. We also decompose the aggregate changes into a within and an across sectors component.

Following De Loecker et al. (2020), we decompose the change in the average markup at the firm-level as follows[25]:

[24] Extending the sample to 2014 we find that the increasing trend in the average markup stops and actually shows some regression toward the 2010 level.

[25] This decomposition method was first outlined in Olley and Pakes (1996), Melitz and Polanec (2015)

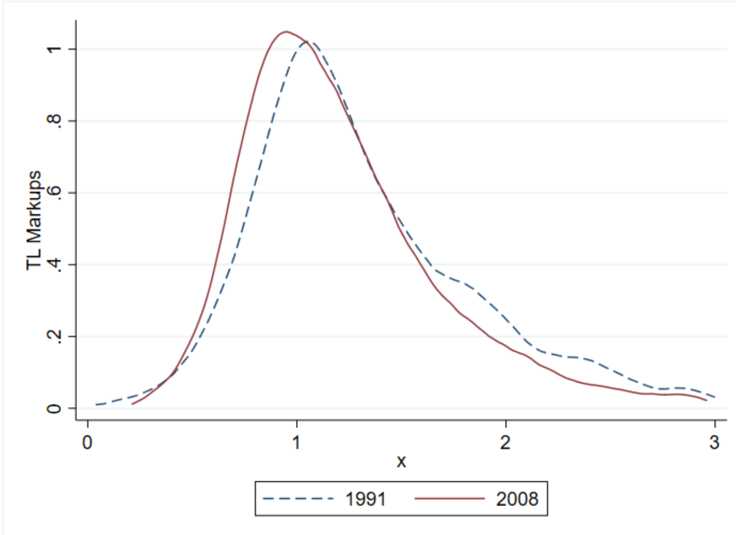


Figure 5: Distribution of unweighted markups: kernel density

Notes. The figure above uses the translog specification of firm markups estimated from the production function approach.

$$\Delta\mu_t = \underbrace{\sum_i m_{it-1}\Delta\mu_{it}}_{\Delta within} + \underbrace{\underbrace{\sum_i \mu_{it-1}\Delta m_{it}}_{\Delta marketshare} + \underbrace{\sum_i \Delta\mu_{it}\Delta m_{it}}_{\Delta cross}}_{\Delta reallocation}, \qquad (3)$$

where m_{it} is the market share of firm i and μ_{it} its markup. The $\Delta within$ term measures the change in the markup attributable 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 shares while keeping firm's markup fixed. If this term is decreasing, it means that lower markup firms are capturing a greater share of the economy. The $\Delta cross$ term measures the joint changes in markups and market share.

In Figure 6, we show an illustrative plot for this decomposition calculated for adjacent one-year periods, for the period 1992-2010. From our one-year decomposition we find that both the within and the between component play a role in the observed changes in the average markup. The 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 a role as well, although

generalize it to account for exit and entry – something which we cannot account for given the limitations of the dataset. Our data does not allow us to track firm entry and exit.

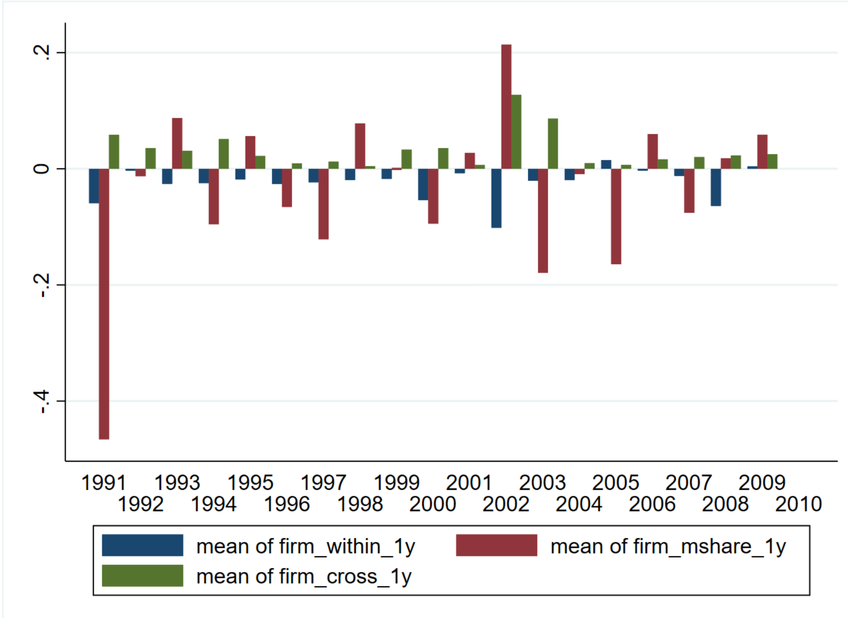


Figure 6: Decomposition: Firms

Notes. The blue bars represent the within component, the red bars the between component and the green the cross component.

it contributes to both negative and positive markup variation.

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,

$$\Delta\mu_t = \underbrace{\sum_i m_{st-1}\Delta\mu_{st}}_{\Delta within} + \underbrace{\sum_i \mu_{st-1}\Delta m_{st}}_{\Delta between} + \underbrace{\sum_i \Delta\mu_{st}\Delta m_{st}}_{\Delta cross}, \quad (4)$$

where m_{st-1} is the market share of sector S at time $t-1$ and μ_{st} is the sectorial markup. The first expression on the right-hand side, the $\Delta within$ component, expresses the contribution of changes in sectorial markups, for a give share of each sector in our economy. This tells us the extent to which markups are changing at the industry level. The second expression, the $\Delta between$ component, computes the change in markups due to changes in the market shares of the sectors. The third and final expression is the $\Delta cross$ component which describes the decline of markups as a joint change in markup and the sectoral shares.

We consider two-year changes in weighted markups starting from 1992. The decomposition presented in Table 1, shows that the bulk of the changes in the average markup is driven by the within-industry component. The changes in the between-industry component is substantially smaller in magnitude for almost every successive year. There is also no correlation in the direction of the components. The change in markups due to cross component, the joint effect of the previous two components, is also substantially smaller in magnitude compared to the within component.[26] Note also that the mean change in output elasticity, shown in the last column of Table 1 is not responsible for the decline markups, corroborating our results in Figure 4.

Table 1: Sectoral decomposition of the sales-weighted markup

2yr Period	Δ Markup	Δ Within	Δ Between	Δ Realloc.	Mean ($\Delta\theta$)
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

Notes. Table reports sectoral decomposition with 2-year time differences

This finding from the time series decomposition shows that most of the decrease in markups occurs within all industries. As in De Loecker et al. (2020), who perform a similar decomposition for the US and find that the rise in markups is mostly a within-sector phenomenon, we find that the decline in Spanish markups takes place primarily within sectors. While we find that within sectors both the within and between firm component drive markup variation, their results show that only the latter is the driving force in US data.

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:

[26] Similar results are obtained using a one-year and 4-year decomposition. See tables A.6 and A.7.

$$ln\mu_{ijt} = \alpha_j + \alpha_t + \lambda\tau_{jt} + \zeta Z_{j1991} + \epsilon_{jt}, \quad (5)$$

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 shock, 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 2. 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 firms' markups. 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 this results 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 implies that the average decline in output tariffs resulted in a 4.37 percent ($= 17 \times 0.257$) decline in average markups.

These results support our theoretical insight that increases in the competitive pressure brought about by lower tariffs led to a reduction in firm markups. Thus our analysis finds support for the the pro-competitive effect highlighted in the theory.

5.1 The concentration effect

One of the theoretical predictions from our model is that, via free entry, trade liberalisation reduces the number of firms competing in each product line which, in turn, puts upward pressure on surviving firms' markups. Hence, the impact of trade on markups

Table 2: 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 1991		-0.000	-0.000	0.000	−0.000***
		(0.000)	(0.000)	(0.000)	(0.000)
Average percentage foreign holding by Industry 1991			0.000	0.000	0.000
			(.)	(.)	(.)
Export Intensity 1991				−1.513***	1.945
				(0.304)	(1.595)
Firm TFP TL 1991	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	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. The table above uses the log of the translog specification of firm markups. We use 1991 as a base year for industry controls instead of 1990 due to a significantly higher observation count.

can be less pro-competitive or even anti-competitive.

To evaluate whether or not this prediction holds in our data, we follow the theoretical insights and explore the interaction of tariff variation with measures of barriers to entry. To measure these barriers, in our baseline specification, we use intangible fixed assets which include the value of goodwill, copyrights, trademarks, and intellectual property for each firm and are directly available in our ESEE dataset. In the robustness analysis, we also look at firm size and R&D. Since our 3-digit sectoral aggregation is very coarse we explore entry barriers both at the sectoral level and at the firm level. Within each sector the presence of firms with high intangible assets can restrict the extent of competition, as any technological barrier would do.

We begin with sectoral barriers. Based on our theoretical predictions we would expect that sectors with higher barriers to entry experience a weaker pro-competitive effect or even an anti-competitive effect of trade. To test this hypothesis, we use the following specification,

$$ln\mu_{ijt} = \alpha_j + \alpha_t + \lambda\tau_{jt} + \beta Intan_{j1991} \times \tau_{jt} + \kappa Intan_{j1991} + \zeta Z_{j1991} + \epsilon_{jt}, \qquad (6)$$

where $Intan_{j1991}$ is a dummy that equals one if sector j has below median intangibles fixed assets in 1991 and zero otherwise. Our results in Table 3 show that sectors with below median intangible fixed assets undergo a higher pro-competitive effect compared to their above median counterparts, although the interaction term is not statistically significant. This is in line with our theoretical predictions highlighted in Proposition 3.

Table 3: The concentration effect: sector dummy

	Fixed Effects
	(1)
Output Tariff	0.332***
	(0.089)
$\text{Intant}_{1991} \times$ Output Tariff	0.256
	(0.193)
Intan_{1991}	0.086
	(0.296)
Avg. pctg. foreign holding by Industry	-0.000*
	(0.000)
Export Intensity	4.124*
	(2.208)
Firm Effects	X
Year Effects	X
Industry Effects	X
N	29,166
R^2	0.020

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

Notes: Standard errors clustered at the 3-digit industry level.

Although the model is very simple, the basic insights of the concentration effect it produces should carry over to more granular scenarios as well. Ideally we would want to test proposition 3 at a higher level of sectoral disaggregation to gain more statistical significance, but our firm-level data do not allow us to do so. In order to circumvent this problem, we test whether firms with better technologies (higher fixed intangibles assets) are more shielded from competition and therefore experience a weaker pro-competitive effect of trade. One way to think about this is that a firm with a better technology - in the model can simply be higher economies of scale due to a higher fixed operating cost - operates in a less competitive 10-digit or even more granular sector which is likely to be more shielded from increases in foreign competition.[27]

To test this mechanism, we compute the distribution of intangible fixed assets across firms and study whether firms in lower quartiles in a given sector experience a lower concentration effect compared to those in higher quartiles. As suggested by the discussion above, this in turn should manifest in a stronger pro-competitive effect of trade at

[27]This channel is also typical of standard Schumpeterian growth models where technological leadership allows firms to obtain monopoly on their sector. In a step-by-step version of this class of models, Akcigit et al. (2021) show that firms with larger technological lead with respect to their followers experience a weaker competitive pressure from trade liberalisation.

lower quartiles. To test the latter, we interact the firms' position in the intangibles distribution (their percentile) in 1991 with the import tariff, running the following regression specification:

$$ln\mu_{ijt} = \alpha_j + \alpha_t + \lambda\tau_{jt} + \beta Inquart_{ij1991} \times \tau_{jt} + \kappa Intquart_{it} + \zeta Z_{j1991} + \epsilon_{jt}, \tag{7}$$

where $Inquart_{ij1991} = 1$ if firm i in a sector j has intangible fixed assets below a given quartile and zero otherwise. Table 4 below reports the results.

Table 4: The concentration effect: firm dummy

	Fixed Effects			
	(1)	(2)	(3)	(4)
Output Tariff	0.251***	0.234***	0.196***	0.138**
	(0.060)	(0.063)	(0.066)	(0.068)
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	4.756**	4.710**	4.504**	4.485**
	(1.851)	(1.868)	(1.854)	(1.851)
Firm TFP TL	0.033*	0.035$^{\hat{*}}$	0.037**	0.039**
	(0.018)	(0.018)	(0.018)	(0.018)
$\text{Inquart}_{1991,50} \times$ Output Tariff		0.050		
		(0.079)		
$\text{Inquart}_{1991,75} \times$ Output Tariff			0.079	
			(0.075)	
$\text{Inquart}_{1991,90} \times$ Output Tariff				0.143*
				(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. Standard errors clustered at the 3-digit industry level.

Our results suggest that within a 3-digit sector, all firms below the 90th percentile of the intangible fixed assets distribution undergo a higher pro-competitive effect, with a statistically significant interaction. Firms below the 75th and 50th percentile also show stronger competition effects but the results are not statistically significant. These findings, along with those with the interaction at the sectoral level presented in table 3, provide support to the theoretical hypothesis that trade liberalisation has a weaker impact on markups for firms and sectors with higher pre-liberalisation market power.

This is an indirect test of the concentration effect in the theory. A more direct approach analysing whether the weaker impact of trade on markups is due to the trade-induced increases in concentration is difficult in a reduced-form empirical analysis. To provide additional support to our theoretical insight we can though study the direct impact of trade on market concentration. This is what we do next, acknowledging that any measure of market concentration computed with our dataset is imperfect because it does not include foreign firms operating in Spain.

For each industry, we measure industry concentration as the share of the largest firms in sales[28]. We mainly focus on the sales share of the 8 largest firms (CR8), but also perform robustness analysis using the 4 largest firms (CR4). To understand the response of industry concentration to the tariff cut, we run the following regression,

$$lnCR8_{jt} = \alpha_j + \alpha_t + \lambda\tau_{jt} + \zeta Z_{j1991} + \epsilon_{jt}, \tag{8}$$

where $lnCR8_{jt}$ refers to the concentration index by industry, top-8 firms (in logs), α_j and α_t are the industry and time fixed effects, τ_{jt} are industry-level output tariffs. We use the same industry controls as in our baseline regression.

Table 5: Regressions of output tariffs on industry concentration (CR8)

	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
Output Tariff	-0.129^{***}	-0.143^{***}	-0.156^{***}	-0.156^{***}	-0.197^{***}
	(0.020)	(0.020)	(0.017)	(0.010)	(0.008)
Average tangible fixed assets (excluding land and buildings) by Industry 1991		0.000^{***}	0.000^{***}	0.000^{***}	0.000^{***}
		(0.000)	(0.000)	(0.000)	(0.000)
Average percentage foreign holding by Industry 1991			-0.001^{**}	-0.004^{***}	-0.003^{***}
			(0.000)	(0.000)	(0.000)
Export Intensity 1991			-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	0.002	0.047	0.048	0.048	0.72

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

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 results from our regression confirm the hypothesis that trade liberalization has a positive effect on industry concentration levels. Column (1) shows that a 10 percent reduction in import tariffs leads to 1 percent increase in industry concentration. When we introduce industry controls and corresponding industry and year fixed effects, the

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

coefficient of output tariffs slightly increases in magnitude keeping the same sign and the same strong statistical significance. Similar results are obtained for CR4 (table A.8).

Taking stock. Our empirical analysis of the impact of trade liberalisation on firm-level markups leads to the following conclusions. First, we find a robust pro-competitive effect of import tariffs cuts on markups. Second, this effect is weaker for sectors and firms with higher intangible assets. Since intangibles are typical barriers to entry, our findings support the theoretical insights of an anti-competitive channel operating via entry/exit, to which we refer as the concentration effect of trade. We also provide direct evidence of a positive impact of trade liberalisation on market concentration.

6 Trade and the aggregate markup

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 increase market shares of large/more productive firms (e.g. Melitz, 2003). If these firms charge a higher markups, trade should put upward pressure on aggregate markups via this reallocation channel.[29] 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.

The reallocation channel. We explore the reallocation channel by running a reduced-form equation between the change in output tariffs and each component of the firm Olley-Pakes decomposition performed in Section 4.2 as follows:

$$\sum_i s_{ijt-1}\Delta m_{ijt} = \alpha_t + \lambda \Delta \overset{o}{\tau}_{jt} + \epsilon_{jt}, \tag{9}$$

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 are reported in Table 6 .

[29] This is the *superstar hypothesis* popularised by Autor et al. (2020) although in their case not directly related to trade.

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

	(1)	(2)
	$\Delta Within - Firm$	$\Delta Realloc - Firm$
$\Delta\tau^{o}_{jt}$	0.014***	-0.023
	(0.002)	(0.015)
Year Effects	X	X
Industry Effects	X	X
N	355	355
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.

There is a strong correlation between falling industry output tariffs and the within component of the change in markups. The positive and statistically significant coefficient of the change in 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 reallocation channel. Moreover, consistent with the reallocation channel, figure A.3, shows that firms with larger sales charge higher markups. The same size/markup correlation is confirmed using other measures of size, as shown in Figure A.4 and A.5. Although both the within and the reallocation components have the signs predicted by the theoretical insights, only the first channel is statistically significant.

Table 7: Trade liberalisation and sales weighted sectoral markups

	OLS
	(1)
$\Delta\tau^{o}_{jt}$	0.228***
	(0.022)
Year Effects	X
Industry Effects	X
N	355
R^2	0.096

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

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

Having established that the impact of trade liberalisation on the aggregate markup operates primarily via the within component, which produces a pro-competitive effect, it is worth performing a direct analysis of the link between trade and the aggregate markup. As the reduction of aggregate markups is occurring via changes at the firm-level, we would expect trade liberalization to be negatively related to aggregate markups. Thus, we run the following specification: $\Delta ln\mu_{jt} = \alpha_t + \lambda\Delta\overset{o}{\tau}_{jt} + \epsilon_{jt}$, where μ_{jt} is the sales-weighted markup of in industry j at time t. We report the results in table 7 which shows a positive and statistically significant relationship between import tariffs and markups.

This results, along with those in the decomposition analysis in Table 6 and our finding at the firm level in section 5, lead to the conclusion that the liberalisation episode that we study is overall pro-competitive and operates primarily via the intensive margin, that is, via changes in markups at the firm level.

7 Robustness

We perform extensive robustness analysis. We first check whether using a simpler measure of markups that does not require the several assumptions we need to make with our estimation procedure yields a similar aggregate trend. Second, we use generally available data and check whether the sector-level material shares show the same pattern as our firm-level data. Then we dig deeper into the relationship between markups and market power constructing a measure of average profitability. We also test the robustness of our markup trends using cost share estimates. We then move on to perform a set of robustness checks of our findings on the impact of import tariffs on firm-level markups. We re-run our baseline specification replacing markups estimated with material shares with those estimated with labor shares and also replace the translog production function with the Cobb-Douglas. Finally, we use different measures of barriers to entry to test the concentration effect and construct a measure of import tariffs to test the incomplete pass-through channel.

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: $\mu_{ijt} = (Va_{ijt} - Pay_{ijt})/(Va_{ijt} + Matc_{ijt})$, where Va_{ijt} is value added of firm i, sector j, Pay_{ijt} is its payroll and $Matc_{ijt}$ is its material cost. 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 ESEE. When plotting the average values of this measure, we find that the trend roughly matches the ones from our baseline analysis estimates (A.9).

Material shares with sectoral data. We perform a sanity check to corroborate our firm-level markup estimate trends by using publicly available sector-level data for the whole economy 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 ESEE. 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.7 and A.8 shows that the intermediate consumption to output ratio is increasing across time (between 1995-2010), similar to what we observe in our 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 Spanish manufacturing, it is 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 compute a complete measure of profits, properly accounting for all cost types, including overhead (or fixed) costs and the expenditure on capital. Let $\Pi_{it} = S_{it} - \overset{V}{P}_t V_{it} - r_t K_{it} - \overset{X}{P}_t X_{it}$ be the net profits, where $\overset{X}{P}_t X_{it}$ is the value of the fixed overhead costs. The net profit rate, Π_{it}/S_{it} is then,

$$\pi_{it} = 1 - \frac{\theta_{st}}{\mu_{it}} - \frac{r_{it} K_{it}}{S_{it}} - \frac{\overset{X}{P}_t X_{it}}{S_{it}}.$$

Figure A.10 reports a sales-weighted average of this profitability measure and shows a declining trend in our period of interest. We corroborate this finding looking at the distributional differences of unweighted profits between 1991 and 2009, and find 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 maring change across the entire sample.

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 $\overset{V}{\alpha}_{it} = \frac{\overset{V}{P_t} V_{it}}{P_t V_{it} + r_{it} K_{it}}$, as the total material cost over total cost (which includes financial expenditures). For each industry we compute the median of the cost shares at a given point in time as a measure for the output elasticity $\theta_{st} = median(\overset{V}{\alpha}_{it})$. The results are reported in Figure A.11, where 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 our baseline markup measure in figure 4. Note also that in both measures the bulk of the decline in markups takes place in the 1990s, the period of most intense trade liberalisation.

7.2 Trade liberalisation and markups

Baseline firm-level analysis with Cobb-Douglas markups. We run our baseline regression between industry tariffs and firm-level markups, as specified in (5), 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 A.10. 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 demostrated in Figure 4, that time-varying elasticity coefficients do not play a role in driving down aggregate markups. Table A.11 shows that the coefficient on the import tariff for Cobb-Douglas markups is higher in magnitude, compared to their translog counterparts shown in Table 2 and remains positive and significant. This result supports our baseline findings.

Running baseline regression with labour markups. We test the robustness of our key finding replacing materials with labor in the computation of the markups. We run our baseline regression between industry tariffs and firm-level markups, as specified in (5), but instead of using markups estimated with the elasticity co-efficient of materials from the production function, we use the elasticity coefficient of labour. The results are reported in Table A.12 which shows that the coefficient of output tariff while not statistically significant, is still positive and the magnitude is roughly similar to the materials-elasticity baseline markup estimates in Table 2.

The concentration effect. We re-run specifications (7) with different proxy measures for barriers to entry in addition to firm intangible assets. We first use firm-level R&D intensity, the R&D to sales ratio, to test for the concentration effect within industries. Similar to intangibles, R&D spending is a technological barrier to entry, thus we would expect that firms in the lower quartile of the R&D intensity distribution experience a lower concentration effect and therefore a higher pro-competitive effect. Results in table A.9 show that all firms below the 75th percentile of the R&D intensity distribution undergo a stronger pro-competitive effect compared to firms above the 75th percentile within an industry (sector). Although the sign of the effect is consistent with that in the baseline regression with intangibles the result is not statistically significant. Similar results are obtained using firm size as a proxy of barriers to entry (see A.10).

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,

$$\Delta ln\mu_{ijt} = \alpha_j + \alpha_t + \lambda\Delta\overset{o}{\tau}_{jt} + \beta\Delta\overset{i}{\tau}_{jt} + \epsilon_{jt}, \tag{10}$$

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 A.13, we report the results. In line with the results in De Loecker et al. (2016), the coefficient on the change in input tariffs 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 the effects of both the output and input tariffs are in line with the theoretical predictions, they are not statistically significant.

Unfortunately, our ESEE dataset does not contain information on firm-level prices and thus we cannot retrieve marginal costs. As a result we are not be able to study how the input and output tariffs interact with prices and marginal costs and perform a full analysis of the incomplete pass-through channel, as in De Loecker et al. (2016).

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.

The theory suggests a rich set of channels through which foreign competition affects markups and guides our empirical exploration. We find that a reduction of Spanish import tariffs reduces markups at the firm level, thereby confirming the received view that trade has a pro-competitive effect. This competition effect is stronger for industries and firms with lower entry barriers, measured by intangible assets, R&D investment and firm size. We also find that trade liberalisation increases market concentration. These last two results provide empirical support to the concentration effect highlighted in the theory: due to the competitive pressure induced by trade, the number of firms competing in each market declines and the more so the higher the barriers to entry. Although the concentration effect tames the pro-competitive effect, the overall impact of trade on firm-level markup is pro-competitive.

At the aggregate level we find that the observed changes in the markup are essentially driven by within-sector variation. Focusing on the variation within sectors we find that both within and between-firm changes contribute to the dynamics of the aggregate markup. Trade liberalisation reduces the aggregate markup via its within-firm component and increases it via its between-firm component. 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. Thus reconciling our firm-level and aggregate analysis and leading us to conclude that the impact of Spanish trade liberalization on markups operated mainly via its intensive margin, that is, via changes at the firm level rather than a composition effect via reallocation of market shares.

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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 (1) leads to $(x/X)^\alpha = 1$. Finally, use the definition of $\mathcal{A}$ to derive the equilibrium variable cost $qz^{-1} = \theta e$.

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,

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

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,

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{lk} l_{it} k_{it} + \beta_{lm} l_{it} m_{it} + \beta_{km} k_{it} m_{it} + \beta_{lkm} l_{it} k_{it} m_{it} + \omega_{it} + \epsilon_{it}. \tag{A.10}$$

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 (2). The material expenditure share of gross output is corrected for measurement error by dividing it by $exp(\epsilon_{it})$.

D Additional tables and figures

Table A.1: Summary statistics of production function

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

Notes. 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.

Table A.2: Average 3-digit SIC industry 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

Notes. The above table displays the mean translog and Cobb-Douglas markups (left and right column respectively) by industry for the sample 1990-2010.

Table A.3: Average output elasticities by 3-digit SIC industry, translog specification: 1990-2010

heightIndustry	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

Notes. Table reports mean output elasticities from the translog production function from year 1990-2010. Columns 2-4 report the mean output elasticity with respect to each factor of production from the translog production function for all firms. Column 5 reports the corresponding returns to scale, which is the sum of columns 2-4.

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

Notes. Table reports cross-correlations of output tariffs between each 3-digit SIC industry from year 1990-2010

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

Notes. Table reports cross-correlations of input tariffs between each 3-digit SIC industry from year 1990-2010

Table A.6: Sectoral decomposition of sales-weighted markup: one-year changes

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

Notes. Table reports sectoral decomposition with one-year time differences

Table A.7: Sectoral decomposition of sales-weighted markup: 4-year changes

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

Notes. Table reports sectoral decomposition with 4-year time differences

Table A.8: Regressions of output tariffs on industry concentration (CR4)

	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 1991		0.000^{***}	0.000^{***}	0.000^{***}	0.000^{***}
		(0.000)	(0.000)	(0.000)	(0.000)
Average percentage foreign holding by Industry 1991			-0.001^{**}	-0.004^{***}	-0.003^{***}
			(0.000)	(0.000)	(0.000)
Export Intensity 1991			-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.

Table A.9: Concentration effect with firm RD intensity

	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. $RDintensityfirmdummy = 1$ if firm i has RD intensity below a given quartile and is $RDintensityfirmdummy = 0$ above the same quartile.

Table A.10: Concentration effect with firm size

	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. $Firmsizedummy = 1$ if firm i has size below a given quartile and is $firmsizedummy = 0$ above the same quartile for a given sector (industry).

Table A.11: 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 1991		−0.000***	−0.000***	−0.000***	−0.000***
		(0.000)	(0.000)	(0.000)	(0.000)
Average percentage foreign holding by Industry 1991			0.001	0.001	-0.000
			(0.001)	(0.001)	(0.001)
Export Intensity 1991				−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.

Table A.12: 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 1991		-0.000*	-0.000*	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)
Average percentage foreign holding by Industry 1991			-0.001	-0.007	-0.010
			(0.008)	(0.009)	(0.008)
Export Intensity 1991				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.

Table A.13: 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.

E Additional figures

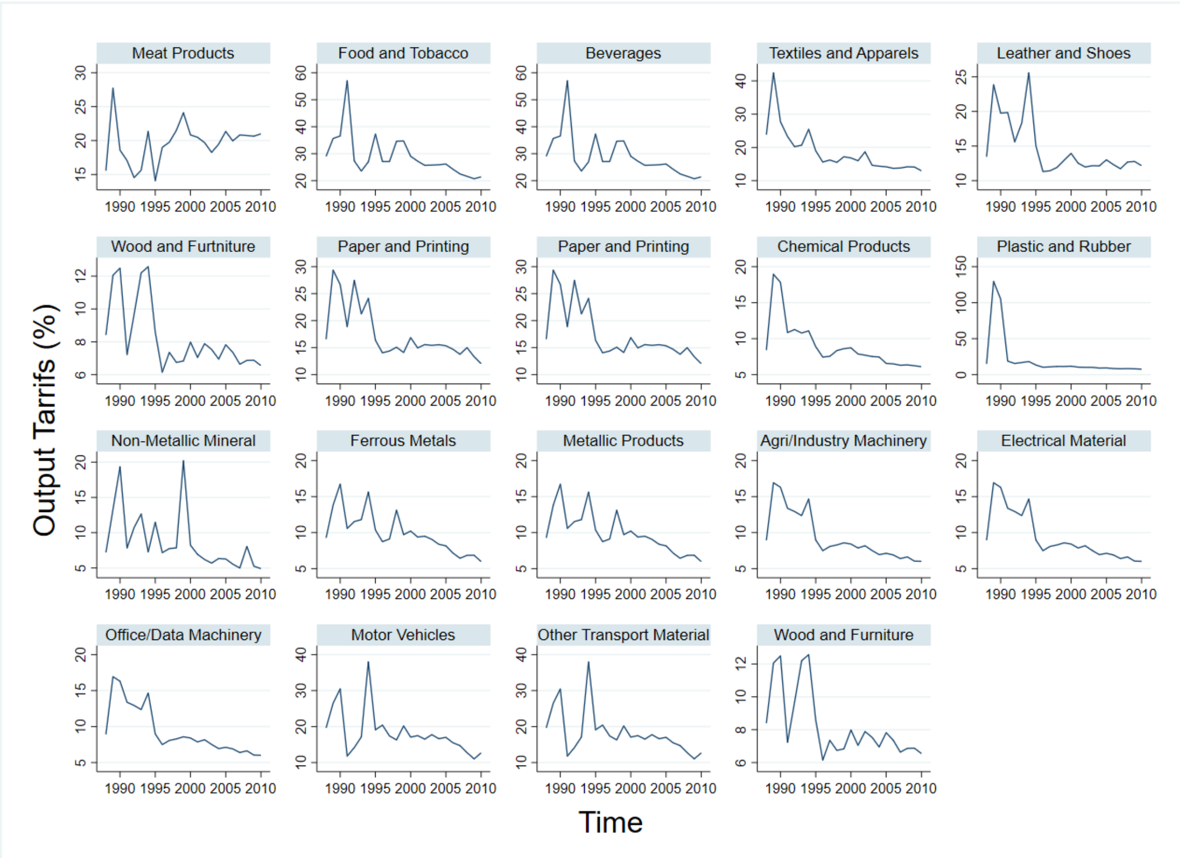


Figure A.1: Output Tariffs by 3-digit SIC industries

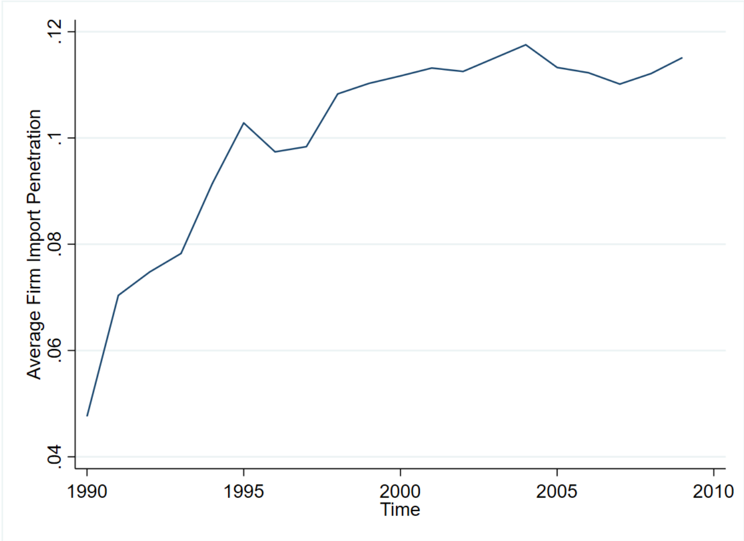


Figure A.2: Average Import Penetration

Notes. The figure above shows the unweighted average of firm import penetration. Firm import penetration is computed as the value of a firm import over the values of its sales plus its import minus its export.

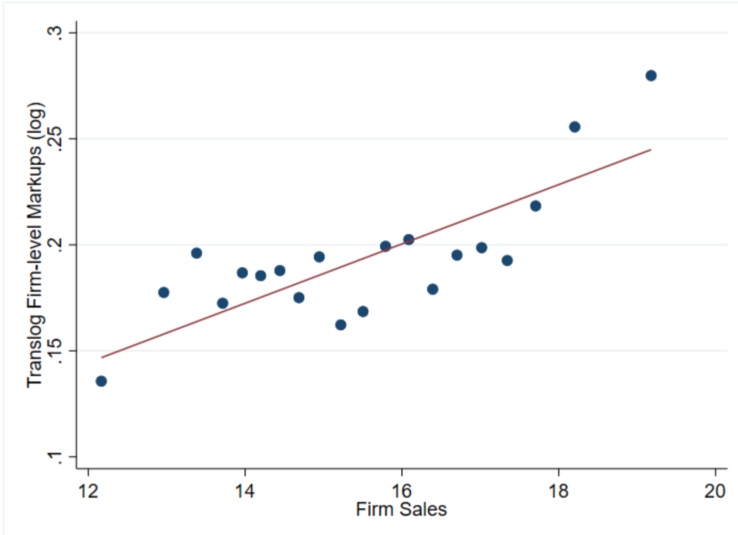


Figure A.3: Markups and Firm Size

Notes. The above figure is a binscatter plot between firm translog markups and firm sales (as a measure of firm size) with industry fixed effects. Each dot shows the average 'firm translog markup' for a given level of 'firm sales' holding industry effects constant.

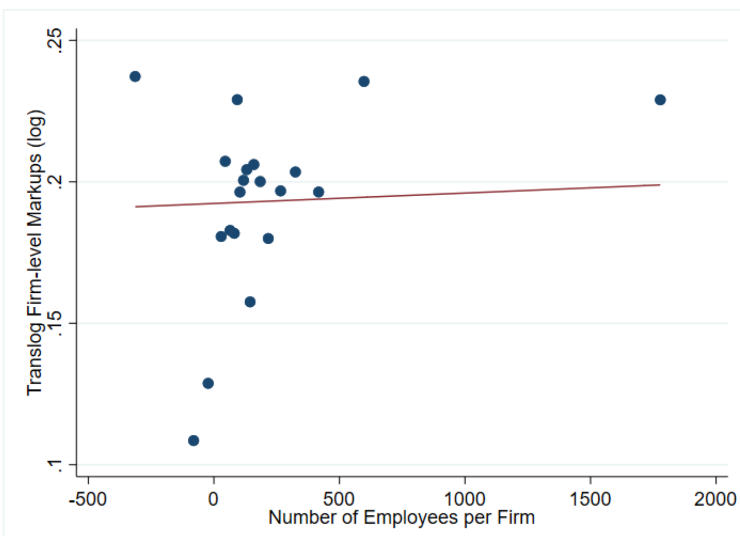


Figure A.4: Markups and Firm Size

The above figure is a binscatter plot between firm translog markups and firm number of employees (as a measure of firm size) with industry fixed effects. Each dot shows the average 'firm translog markup' for a given level of 'firm number of employees' holding industry effects constant.

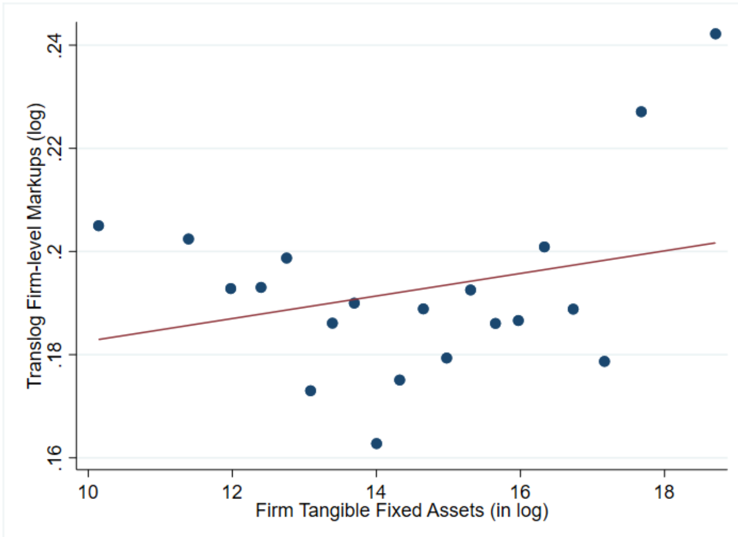


Figure A.5: Markups and Firm Size

The above figure is a binscatter plot between firm translog markups and firm tangible fixed assets (as a measure of firm size) with industry fixed effects. Each dot shows the average 'firm translog markup' for a given level of 'firm tangible fixed assets' holding industry effects constant.

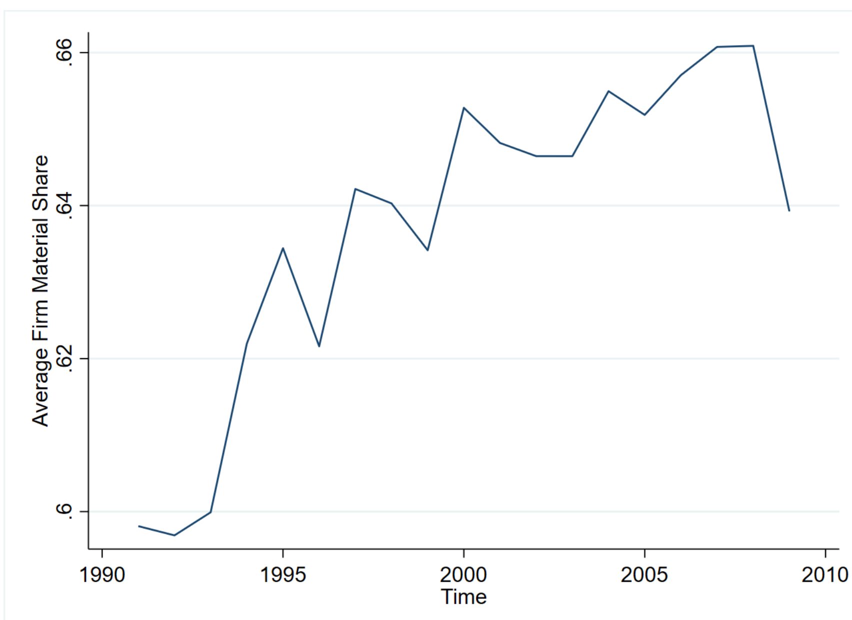


Figure A.6: Average firm material share.

The figure above shows the unweighted average of firm material share from year 1990-2010. Firm material share is calculated as $Materialshare_{ijt} = \frac{Valueof firmmaterialexpenditure_{ijt}}{Firmsales_{ijt}}$. The drop in year 2009 and 2010 is due to a reduction in survey responses from firms in the ESSE dataset.

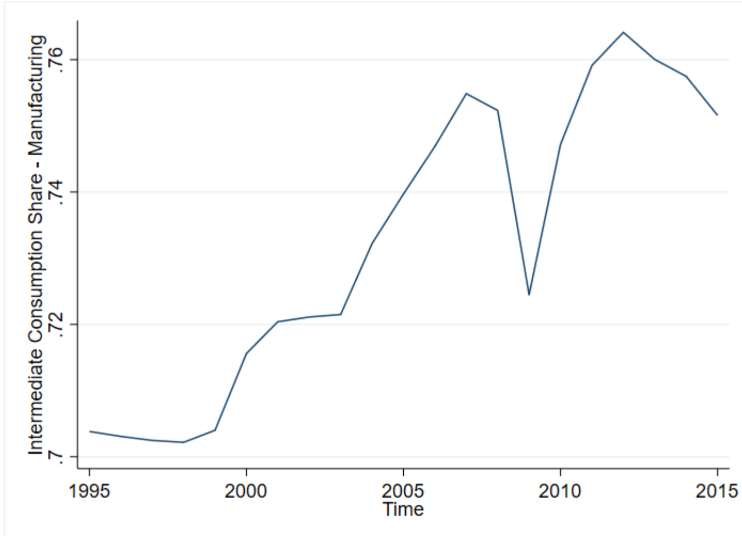


Figure A.7: Intermediate consumption share as a fraction of total output for Spanish Manufacturing

The figure above shows the intermediate consumption share as a fraction of total output for Spanish manufacturing from year 1995-2015. We use intermediate consumption in KLEMS as a proxy for material expenditure in our ESSE dataset. Intermediate consumption share (for Spanish manufacturing) is calculated as $Intermediateconsumptionshare_t = \frac{Valueofintermediateconsumption_t}{Totaloutput_t}$.

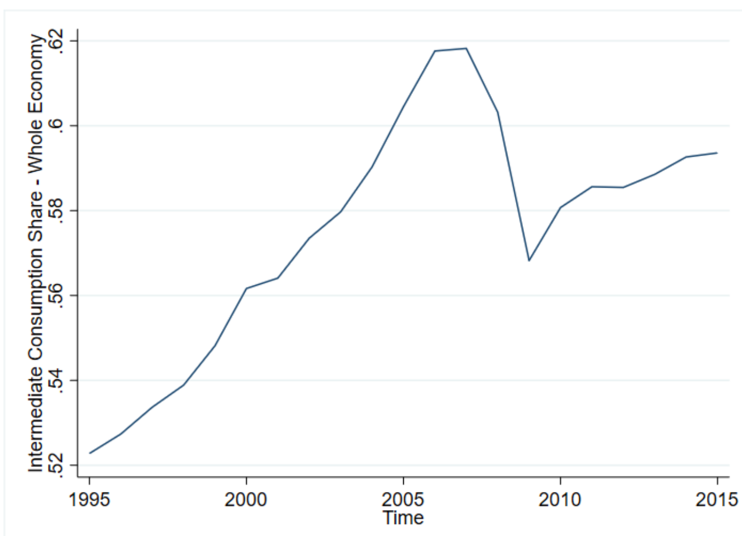


Figure A.8: Intermediate consumption share as a fraction of total output for the entire Spanish economy

The figure above shows the Intermediate consumption share as a fraction of total output for Spanish economy from year 1995-2015. We use intermediate consumption in KLEMS as a proxy for material expenditure in our ESSE dataset. Intermediate consumption share (for whole Spanish economy) is calculated as $IntermediateConsumptionShare_t = \frac{ValueofIntermediateConsumption_t}{TotalOutput_t}$.

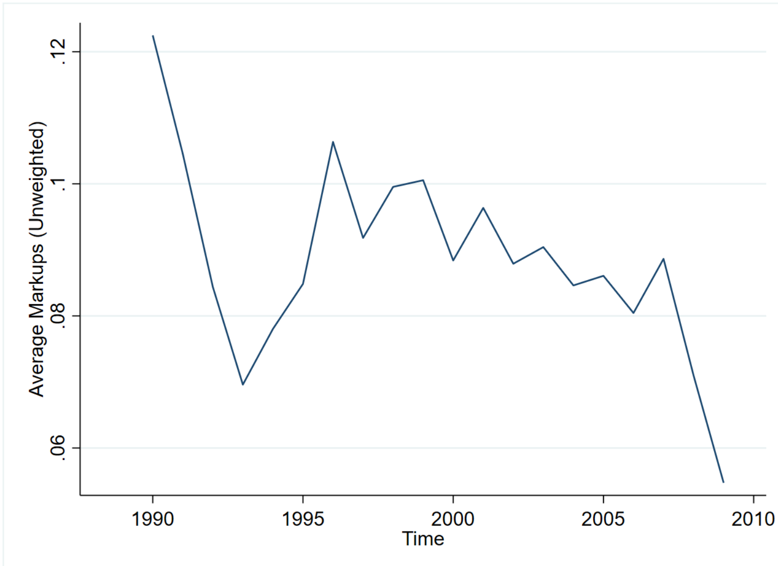
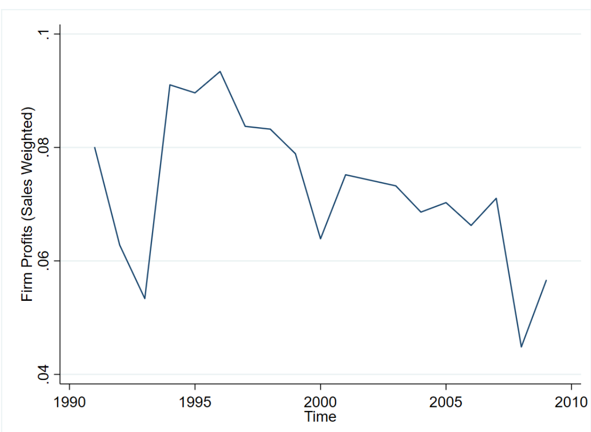
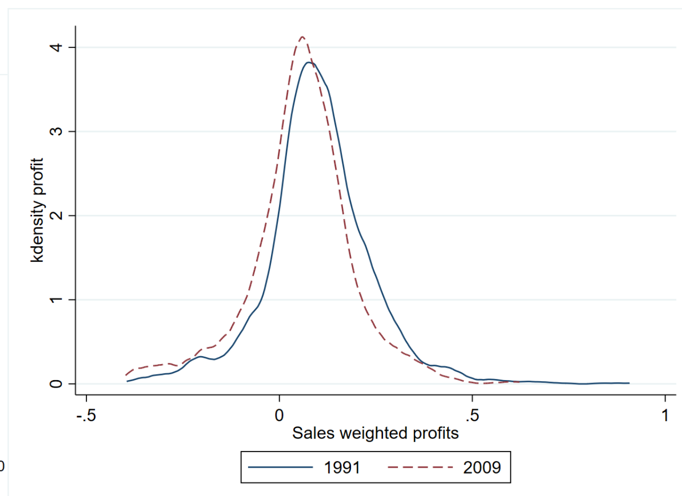


Figure A.9: Unweighted average markup (alternate measure)



A) Sales Weighted Firm Profits



B) Kernel Density Unweighted Firm Profits

Figure A.10: Evolution of firm profits

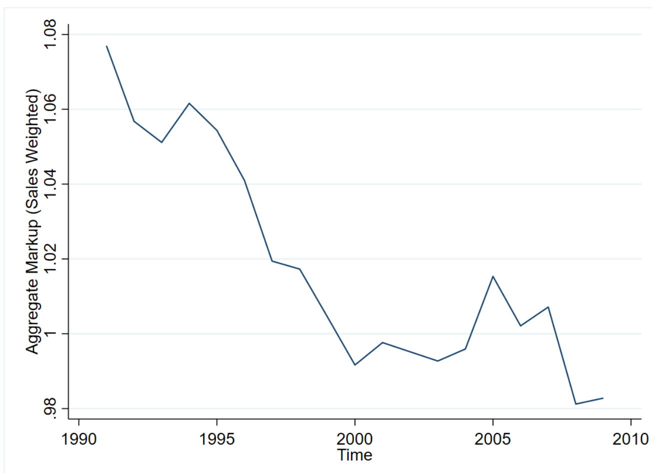


Figure A.11: Sales-Weighted Average Cost Share Markups