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Contents

Abstract

This paper provides the evidence of a fall of markups of price over marginal costs in Poland over the last 15 years. Markups were calculated using a census of firms and the methodology proposed by De Loecker and Warzynski (2012). The fall of markups, by 18.6% for median and by 13.1% for weighted mean and experienced by 70% of firms, is robust to several empirical identification strategies. Moreover, the decline of markups is not related to changes in a sectoral composition and firms demography and is most severe in exporting firms. Our empirical results relate the fall of markups to globalization and emergence of the Global Value Chains. We show that the increasing reliance on imported components in production, together with rising concentration of domestic firms on export markets are the main factors behind the observed compression of markups. We also document a hump-shaped (U-shaped) relationship between foreign value added in exports (distance from final demand) and markups.

Keywords: markup, globalization, GVC, competition
JEL Classification Numbers: C23, D22, D4, F61, L11

1 Motivation and literature overview

Using firm-level data ranging from 2002 to 2016 we broadly document that markups in Poland have been falling during the last 15 years. This decline is in strong contrast with the recent literature documenting the secular rise in markups, mostly in advanced economies. We relate this fall to the globalization and integration with the Global Value Chains, affecting differently various countries, and the effects of ”superstar” firms.

During the last few years there has been an ongoing debate and a series of papers documenting a substantial increase of markups of price over marginal costs in the US economy. The discussion concerns secular trends in the US economy, i.e., declines in labor and capital shares or a fall of the real rate of interest. Barkai (2016), Eggertsson, Robbins, and Wold (2018), Caballero, Farhi, and Gourinchas (2017) or Farhi and Gourio (2018) use various approaches to measure markups, either from macroeconomic data or from relations implied by economic models, and find a significant rise in markups as an important factor affecting these trends. Hall (2018) develops a new method of measurement time-varying markups on a sectoral level and also finds that markups increased in the US economy.

Firm-level analysis also confirms long-term movements of markups in the US economy. De Loecker and Eeckhout (2017) showed a significant rise of markups using data on publicly traded firms. However, Traina (2018) challenges these results using similar methodology (based on the work of De Loecker and Warzynski, 2012) but different measurement and utilizing more representative Compustat data. She concludes that market power has either remained flat or declined.

The empirical evidence on markups outside the US economy is more scarce and more heterogeneous. Although De Loecker and Eeckhout (2018), using the Worldscope dataset (consisting mainly of publicly traded, but also privately held firms), report a rise of average markups on a global scale, they simultaneously conclude that the rise occurs mostly in North America and Europe while empirical evidence on long-run trends in emerging economics is less clear. Similar conclusions stem from Diez, Leigh, and Tambunlertchai (2018), who also use the Worldscope dataset. They report the rise of markups in advanced economies, with a relatively stable markup profile in developing countries.

Diez, Leigh, and Tambunlertchai (2018) suggest that the rise of markups in advanced economies can be driven by a relatively small number of ”superstar” firms in the upper tail of the distribution. It is also supported by Autor, Dorn, Katz, Patterson, and Van Reenen (2017) in the case of the fall of labor share. There are much less ”superstar” firms in developing economies and our analysis suggest that it could be a part of the reasons of the differences in markup behavior across advanced and developing economies, but it is hard to assume that this is the only reason behind different markup trends across the globe. Hence, we primary focus on globalization as a possible reason of a fall of markups in Poland – an example of a less advanced country and simultaneously a supplier in the European Global Value Chains.

Since the 1990s there has been a gradual removal of trade barriers in many countries. Together with the wide-spreading usage of IT technologies in enterprise sector, it led to important changes in the way many firms operate. The result was a rising degree of vertical specialization observed in the past two decades – the production of goods have been divided into highly specialized small stages, leading to the fragmentation of production process (as shown e.g. by Baldwin, 2012). Additionally, international integration of firms increased, and the fragments of the production process were spread across many countries, leading to the development of Global Value Chains. The resulting lengthening of production chain meant for many firms that their production became more dependent on inputs and components, but also that the average distance from final use rose.

Although for the whole production process the fragmentation and outsourcing or offshoring implies the improvement of efficiency, it does not mean that the gains are evenly distributed across the chain. Timmer, Erumban, Los, Stehrer, and de Vries (2014) or Ye, Meng, and Wei (2015), among others, showed that the gains from the GVC participation are the highest for firms that are either at the beginning of the production process (e.g. R&D, design) or very close to the final use (e.g. marketing, advertising, post-sale services). On the contrary, for manufacturing firms engaged in standardized stages (e.g. production of intermediates, positioned in the middle of the production chain) the benefits from the participation in GVC are the lowest.

Poland and the rest of Central and Eastern Europe countries (CEEC) entered the production chains of Western European countries in the 2000s, focusing on the production of intermediates[1], but still benefited from the globalization trends. At the micro level, this refers mainly to the productivity spillovers. The associated literature provides evidence on both vertical and horizontal spillovers from globalization (Hagemejer and Kolasa, 2011).[2] At the aggregate level, Hagemejer and Mućk (2018), among others, showed that entering GVC resulted in these countries in a rapid capital deepening and a rise of trade within the chain, which was an important factor contributing to their value added growth. Given the recent interest in aggregate markups the above evidence raises a natural question how the globalization has affected markups.

De Loecker and Warzynski (2012) document a statistically significant relationship between exporting and markups (for Slovenian manufacturing firms in the 1990s). However, the participation in the GVC implies that globalization affects firms not only via exports but also through imports. In this vein, Békés, Hornok, and Muraközy (2016) find that at the center of the European GVC, i.e., in France, Germany, Italy and Spain, not only exporting, but also importing intermediates and outsourcing are

[1] In Appendix A we illustrate how the globalization affected some structural features of Polish economy. Like in other countries the production became more upstream, i.e., the average distance from final demand increased. Moreover, exports became more dependent on imported intermediates, i.e., there was a substantial rise in foreign value added in exports. Although these changes were common for European economies their scale in Poland was higher than in the advanced economies.

[2] In a broader context this can be related to the inflow of FDI. The existing literature documents that there were productivity gains from the FDI influx (Hagemejer and Tyrowicz, 2012).

positively related to markups. Moreover, and the size of the importer markup premium is comparable to the premium estimated for exporters. Our results suggest, that for a less advanced country both these channels of globalization affect markups differently. In fact, the markups of the exporters at the beginning of our analysis, when the Polish firms stared to operate in GVC, were much higher than of the non-exporters. But the tightening integration of Polish firms in the GVC implied a rising dependence on foreign suppliers which pushed down the markups for export-oriented enterprises. This has been amplified by a fiercer competition between Polish firms on export markets.

The additional insights on the effect of globalization on markups can be derived from the recent debate on the sources of a secular decline in the labor share (equation (4 shows that the labor share is inversely related to the markup). In this vein, Elsby, Hobijn, and Sahin (2013) show that offshoring can account for a bulk of the fall of the labor share in the US. The mechanism is simple – offshoring the more labor-intensive part of the US production means that the remaining production would be more capital intensive. If factors of production are gross substitutes, i.e., an elasticity of substitution between labor and capital is above unity, it implies a fall in labor share. With constant labor elasticity of production there is a room for the markups to rise. But the recent empirical evidence is puzzling. In particular, Gutiérrez (2017) and Autor, Dorn, Katz, Patterson, and Van Reenen (2017) found no empirical support for the direct impact of offshoring on labor share in the US. In a broader context the related literature documents that the elasticity of substitution between labor and capital in developed economies is rather below than above unity (see Klump, McAdam, and Willman, 2012; Mućk, 2017). However, it should be noted that the effect of offshoring for the recipient country's labor share could be heterogeneous, as the offshored production need not to be labor-intensive in the hosting economy standards Elsby, Hobijn, and Sahin (2013).

Our contribution to the literature is three-fold. Firstly, using a rich and representative firm-level data from Poland we document that markups have been falling during the recent 15 years. This fall occurred in contrast to developed economies, but Poland is an example of a less advanced economy and simultaneously a destination country for the offshoring of production. The decline in markups that we find is robust to a number of possible empirical strategies, both for measurement and estimation.

Secondly, we argue that the fall of markups in Poland can, to a large extent, be explained by globalization trends and its position in the Global Value Chains. We found that although the average markups are higher for exporters, they also experienced a greater decline in markups. Moreover, the fall is related to the increasing dependence of exporters on foreign suppliers of inputs (with the largest effect in manufacturing), but it can also be explained by rising concentration and fiercer competition of domestic firms on foreign markets. The distance to final demand is important for many industries but its effects cancel out in aggregation and the average impact is almost neutral.

Thirdly, we extend the literature on the non-linear effects of a country's position in GVC. Ye, Meng, and Wei (2015), among others, show the so called smile curve illustrating the relationship between a position in GVC and value added creation. We extend these results into a different dimension and argue that the relationship between markups of price over marginal costs and GVC position is also non-linear. Moreover, we find a smile curve not only in industry-level data (like Input-Output tables), but also in firm-level data.

The rest of this paper is organized as follows. In section 2 we discusses empirical strategy employed to identify markups and describes the sources of data. Section 3 formulates a broad range of stylized facts on markups in Poland. Then, in section 4 we investigate the empirical link between markups and globalization. Section 5 concludes.

2 Empirical strategy

Disentangling the movements of price markups from productivity changes requires imposing some assumptions on the nature of production process. The first attempt to identify markups was Hall (1988), who used instruments (usually a proxy for the demand shocks) on the Solow residual to identify variation in output unrelated to productivity movement and use this information to extract markups. Roeger (1995) combined information from the revenues and costs to get estimates of primal and dual productivity measures and to infer the information on markups from the difference between them. On the contrary, Klette (1999) used the first order condition of profit maximization under iso-elastic demand to get estimates of both price markups and economies of scale. Those approaches however do not allow markups to vary simultaneously over time and industries/firms. We used instead the method of De Loecker and Warzynski (2012), which allows to estimate firm-level and time-varying markups, assuming cost-minimization.

2.1 Identification of markups

Let's assume that production function of the firm i in period t is:

$$Q(\Omega_{it}, V_{it}, K_{it}) = \Omega_{it} F_t(V_{it}, K_{it}), \tag{1}$$

where Ω_{it} is a Hicks-neutral productivity, K_{it} is capital stock and V_{it} is a set of variable inputs (e.g. labor). The Lagrangian associated with the cost minimization problem is:

$$\mathcal{L}(V_{it}, K_{it}, \Lambda_{it}) = P_{it}^V V_{it} + r_{it} K_{it} - \Lambda_{it}(Q(\Omega_{it}, V_{it}, K_{it}) - Q_{it}), \tag{2}$$

where Q_{it} is a scalar and Ω_{it} is a Lagrange multiplier associated with output – a measure of marginal cost. The FOC with respect to a variable input can be rearranged as:

$$\frac{\partial Q(\cdot)}{\partial V_{it}} \frac{V_{it}}{Q_{it}} = \frac{1}{\Lambda_{it}} \frac{P_{it}^V V_{it}}{Q_{it}}. \tag{3}$$

Let us define $\theta_{it}^V \equiv \frac{\partial Q(\cdot)}{\partial V_{it}} \frac{V_{it}}{Q_{it}}$ as a production function elasticity with respect to a variable production factor V_{it} and the markup μ_{it} as a price over marginal cost $\mu_{it} \equiv \frac{P_{it}}{\Lambda_{it}}$. Rearranging (3) we can get:

$$\mu_{it} = \theta_{it}^V \left(\frac{P_{it}^V V_{it}}{P_{it} Q_{it}} \right)^{-1}. \tag{4}$$

It follows that the markup μ_{it} of price over marginal cost can be measured by the distance of elasticity of production to a given factor θ_{it} (revenues generated by this production factor) to a share of costs associated with this production factor in total costs of production.

Note that the set of assumptions needed to identify the markup is cost minimization by the firm and the existence of a production factor that the firm can freely adjust.

There are various possible production factors which may serve as the base for calculations of equation (4), but in some cases they are subject to external variation, possibly influencing markup calculation. Firm's energy consumption for example is subject to changing domestic and EU regulations, leading to significant energy savings. Moreover, during the period of our analysis Polish enterprises outsourced their activities to other firms. Some of them also entered the international value chains, which might change their demand function for materials. Given these considerations, we decided to use labor (which should not be subject to significant changes in our period of interest) to identify markup in the baseline case. The identification of markup also assumes that changes in the demand for factors does not influence its price and there are no adjustment costs. In the Appendix D we discuss the possible biases of the markup estimates due to firms' monopsony power or adjustment costs and present a robustness analysis.

We also do not need to make assumptions on the source of firm's market power – whether it originates in the low elasticity of demand or in the market structure and the way how firms compete. It is both a pro and a con of the approach – it makes identification easier but does not tell us much about the nature of changes in firm's ability to set markups. Moreover, it is not even always the case that higher markups imply higher market power and increased ability to extract profits from economic activity. If, for example, the structure of firms' costs change – their variable costs are declining and fixed costs are rising (for example, Chen and Koebel (2017) estimated that fixed costs constitute a significant share of overall costs for many US industries), it implies a rising markup of price over marginal cost, but not necessarily leads to higher profits.

The approach of De Loecker and Warzynski (2012) requires an explicit treatment of the production function in order to get the estimates of θ_{it}, implying additional assumptions, which we will describe below. Consider a translog production function (with small letters denoting variable in logs):

$$\tilde{q}_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{lk} l_{it} k_{it} + \omega_{it} + \epsilon_{it}, \tag{5}$$

where $\tilde{q}_{it}$ is a firm's value added q_{it} deflated by an industry-specific price deflator. A direct estimation of (5), as noted by Marschak and Andrews (1944), yields biased estimates, as productivity ω_{it} is a part of the error term and simultaneously affects factor quantities. We follow the identification of the parameters of equation (5) proposed by Ackerberg, Caves, and Frazer (2015). The method, building on Olley and Pakes (1996) and Levinsohn and Petrin (2003), uses a nonparametric representation of an inverse demand function for intermediates (assuming that this demand function is monotone in productivity and thus invertible), which together with an assumption on autoregressive nature of log-productivity ω_{it} allows to identify the estimates of both the production function parameters and productivity. Like in Levinsohn and Petrin (2003) the method uses demand for intermediates (instead of investments, as in Olley and Pakes (1996)), but it corrects for the possible functional dependence problem associated with the fact that production function, after plugging in the factor demand, ceases to be informative on the production elasticity to a variable factor like labor (see the discussion in Ackerberg, Caves, and Frazer (2015)).

It follows that $\theta_{it}^{L} = \beta_l + 2\beta_{ll}l_{it} + \beta_{lk}k_{it}$. We do not observe individual firms' physical production and associated prices[3], instead we get real values by deflating a firm's nominal value added by a sectoral value added deflator: $\tilde{Q}_{it} = P_{it}Q_{it}/P_j$. The residual from (5) contains the error associated with the lack of a proper deflator and, following De Loecker and Warzynski (2012), we correct the observed labor share for the regression residual: $L\tilde{S}_{it} = \frac{P_{it}^{L}L_{it}}{P_j \frac{\tilde{Q}_{it}}{exp(\epsilon_{it})}}$. It follows that

$$\mu_{it} = \theta_{it}^{L}\left(L\tilde{S}_{it}\right)^{-1}. \tag{6}$$

Olley and Pakes (1996) noticed that firms exiting the sample usually have lower productivity and not accounting for firm demography can result in a bias of the estimates of equation (5). We use exit dummy to control for this source of possible bias.

2.2 Measurement

Our data cover the 15-years period (2002-2016) and come from annual financial reports and balance sheets of all Polish enterprises (excluding firms from agriculture, financial sector and some specific non-market services) employing at least 10 employees (in full time equivalent)[4]. The data are collected by the Central Statistical Office and comprise non-financial enterprises from mining, manufacturing, construction, market and non-market services (the latter covers only the enterprise sector).

There are some variables necessary for the estimation of production function, which are not directly observed in the data. Our definition of value added follows closely the national accounts counterpart – it is defined as global output (sales of products, together with change in inventories and value of production for internal purposes and profits realized on reselling goods and other operating revenues) less intermediate consumption (costs of materials, outsourcing and other operational costs). Employment is measured in full time equivalent. Capital is measured as the beginning of period book value of fixed assets: buildings, machinery and vehicles (the relatively short time period and firm demography makes Perpetual Inventory Method to construct capital unreliable).

We used prices from the Eurostat databases to construct real variables. Capital prices are measured at 1-digit NACE sector and vary by asset type (so effective capital price deflator vary on firm-level) and are constructed from data on valuation of fixed asset in current and previous year prices. Prices of value added, intermediate consumption and global output are measured for 2-digit NACE sector separately. In some cases price data contain missing values for the last period of the sample – in such cases

[3] As we do not observe p_{it}, the procedure identifies the markup up to a constant.

[4] Although filling the forms is compulsory and is subject to a fine some firms, especially smaller ones, employing 10-49 FTE, decide not to send it to the CSO.

we used prices predicted by simple AR models for annual price growth with automatic lag specification.

The original data are an unbalanced panel of almost 770 thousand observations – about 120 thousand firms were observed for on average 6.4 years, while also containing missing observations. We trimmed the original data to be usable for further analysis due to two reasons. First, our initial database contains both missing or non-positive observations (we need to take logs of variables in the production function specification). Second, some observations are missing due to a lack of information on a NACE sector, which is required to deflate nominal variables by sectoral prices. Our sample covers the period in which the available industry classification system had changed from NACE rev. 1.1 to NACE rev. 2 [5]. In case of firms observed both before and after the change we imputed NACE rev. 2 code from the last observation, which solved the issue in most cases. For the rest of cases (firms present only before 2008) we imputed NACE rev. 2 code using official conversion tables, but it was possible only in the case of 1:1 mappings. For the remaining observations (their share declines from 14.4% in 2002 to 7.3% in 2004 and 2.7% in 2007) we could not merge the NACE rev. 2 code and, consequently, calculate real variables, so we excluded these observations from further analysis.

In particular, 10.3% and 20% of observations of fixed assets and value added respectively are zeros or missing.[6] Similar problems were present in 3.4% of observations on either labor or intermediates. Jointly, almost 25% of all observations available were unusable for the production function estimation and the markup calculation. Moreover, we excluded 0.2% of observations from sectors with a very small number of firms because, as a robustness check, we will consider a case in which the markups are calculated using production function estimates at the industry level. The final data contains 576.4 thousand observations on 82.1 thousand firms observed for 7.02 years on average.[7]

Table 1 shows basic data properties. The first three columns present information from the beginning, middle and last period of the final sample (a trimmed sample, serving as a basis for the further analysis). Next column presents analogous information calculated using the initial sample (before filtering the data) for the last period. The last two columns present data properties for subsamples of exporters and non-exporters

[5] Namely, the transition period was from 2005 to 2007

[6] See Table E.2 for the definitions of variables.

[7] Trimming of the sample induces removing all observations from small or specific sectors, like agriculture of financial enterprises (a limited number of firms from these sectors are present in the data), but apart from these cases the sectoral structure of the final sample is very similar to the sectoral structure of the initial sample. Moreover, the dispersion measures of differences in sectoral shares either of firm number or sales are stable after 2004, indicating that if the possible selection bias due to trimming is problematic, it is stable over time (in previous periods measure of dispersion were higher, due to missing information on NACE rev.2 code.). Comparison of columns 3 and 4 in Table 1 shows that although the removed observations concerns firms bigger in terms of labor and more capital-intensive (and hence with lower labor share), but still their productivity and the role of export is comparable.

Table 1: Data properties

year	2002	2008	2016	2016	2016	2016
sample		final		initial	non-exporter	exporter
no. firms	28846	38022	43132	56629	26771	16361
L coverage	0.62	0.76	0.75	0.90	–	–
VA coverage	0.70	0.81	0.75	0.85	–	–
average L	104.5	108.2	99.4	102.4	63.2	158.7
average K/L	308.77	346.71	381.93	413.46	331.38	403.49
avegare VA/L	150.06	159.57	215.96	214.71	154.73	242.08
av. labor share	0.52	0.47	0.57	0.53	0.56	0.58
share of exporters	0.29	0.32	0.38	0.38	0.00	1.00
av. export share	0.13	0.17	0.23	0.23	0.00	0.33

Note: In the initial sample column averages of variables and exporter share are calculated on smaller sample of firms with non-zero employment and value added. The last two columns refer to final sample split info exporters and non-exporters. All calculated means are weighted by sales.

using our final sample. The number of firms in the sample clearly rises, inducing a fall of average employment. The capital deepening of the Polish enterprise sector increased within the period under consideration, together with labor productivity (measured as real value added per employee), which increased on average by over 44% in real terms. Mean labor share was falling till 2007 and then it started to climb to a level slightly higher than in the first period of our sample. The growing openness of the economy is reflected both in the growing share of exporting firms and the growing share of export in total sales.

The employment and value added coverage of our final sample (the ratio of both variables to their counterparts from total enterprise sector, taken from the Eurostat databases) rises and stabilizes in both cases at 75% at the end of the sample. The 'initial' column of Table 1 shows that the coverage of the initial sample (before trimming) was 90% and 85% in 2016 in terms of labor and VA, respectively (the difference is similar in the other years). Trimming of the sample results in lower average employment, lower average K/L, higher average labor share and comparable average productivity and exporting characteristics. Exporting firms in the final sample are on average larger, more capital intensive and more productive. Exporters also exhibit slightly higher labor share.

3 Stylized facts on markups in Poland

In this section we provide a broad set of stylized facts related to markups in Poland.

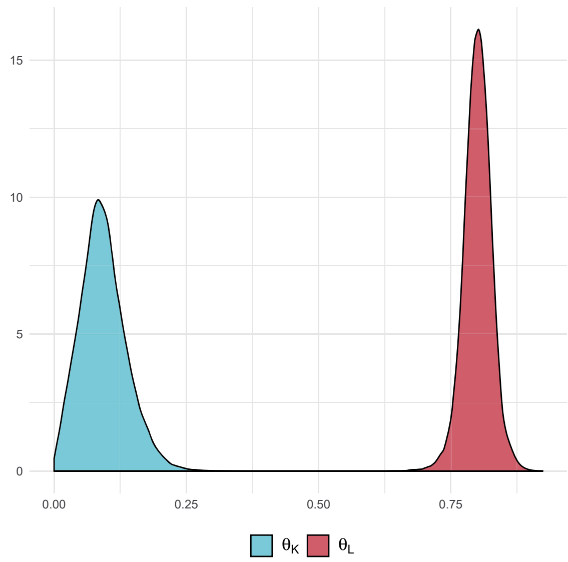
Let us start with the estimation results of the output elasticities. Table 3 summarizes the estimates of the underlying parameters of the translog production function (5). The estimates of β_l, β_k, β_{ll}, β_{kk} and β_{lk} do not have direct interpretation. Figure 1 shows the distribution of implied labor and capital elasticities, averaged over time. The average implied labor elasticity equals 0.8 while mean capital elasticity is about 0.1. These elasticities are quite far from commonly assumed 2/3 and 1/3 in the macro literature[8] but are in line with estimates from micro data, see. e.g. Pavcnik (2002) or Foster, Grim, Haltiwanger, and Wolf (2017). The estimated elasticities imply that the returns to scale, i.e., $\bar{\theta}^L + \bar{\theta}^K$, are on average diminishing.[9]

Table 3: Baseline estimation results

variable	coeff
β_l	0.832^{***}
	(0.000168)
β_k	-0.0348^{***}
	(0.000281)
β_{ll}	0.0168^{***}
	(0.000147)
β_{lk}	0.0356^{***}
	(0.000195)
β_{kk}	-0.00323^{***}
	(0.000116)
Observations	576407
Number of firms	82142

Note: *** denotes the rejection of null about parameters' insignificance at 1% significance level. The expressions in round brackets stand for standard errors.

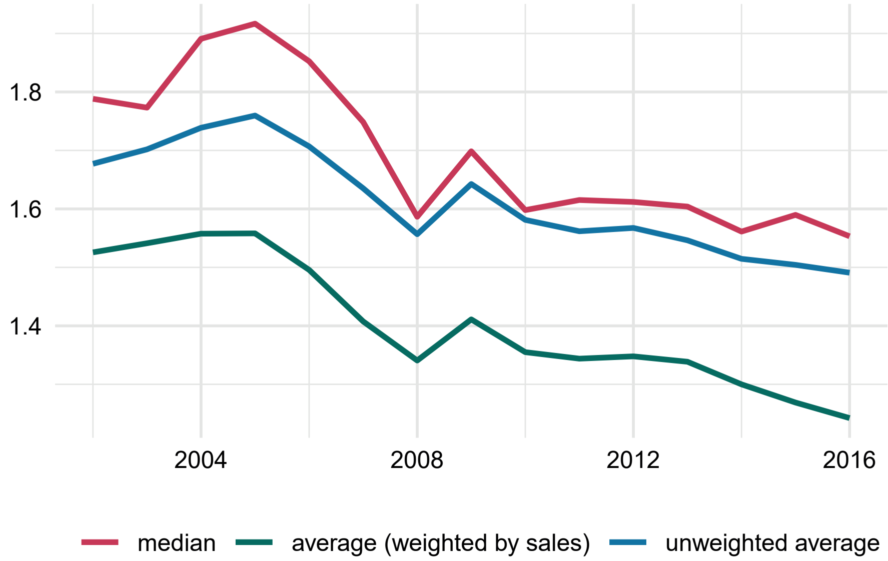
Figure 1: The distribution of estimated elasticities



Our baseline aggregate series of the markups are presented on the figure 2. It is straightforward to see that the aggregate markups in Poland have fallen between 2002 and 2016 and the total decline ranged from 11% for an unweighted average to almost 19% for the median. It implies that the markups have been falling by 1-1.5 % per annum. In comparison with the peak, which can be dated around 2005, this fall has been more pronounced and exceeded 30%, irrespectively of the statistics considered. Importantly, the observed tendency was rather long-run than driven by business cycles fluctuations. Although the most pronounced decline in markups was observed between 2005 and 2008 the systematic downward tendency can be observed in 2010s.

[8]Note that in the macro literature the labor and capital elasticities are usually calibrated to match the long-run properties of factor shares. For instance, the typical labor elasticity is calculated as average labor share. For the US the long-run averages of different measures of the labor share vary

Figure 2: Aggregate markups in Poland



To check the robustness of the long-run decline in markups we consider several alternative empirical strategies. Firstly, we use the standard Cobb-Douglas production function instead of the translog specification. Secondly, the underlying parameters of the production function are estimated at various aggregation level. This refers to industry-level estimation of production function parameters for (i) WIOD industries (see Table E.2 for definitions), (ii) two-digits NACE industries, and (iii) three-digits NACE industries. Thirdly, we relax the assumption that the elasticity between intermediate inputs and value added conglomerate is zero and we estimate the production function for global output instead of value added. Fourthly, we use materials instead of intermediate consumption as a proxy variable. Fifthly, we consider a scenario with time invariant NACE code at the firm level. Our motivation stems out from a fact that almost 15% of enterprises in our sample have changed their NACE code. It is possible that these firms have changed the nature of their economic activity. But technically it can lead to unwarranted variation in real variables due to using sectoral deflators. Therefore, we consider the case in which we keep NACE code constant at the most recent value.

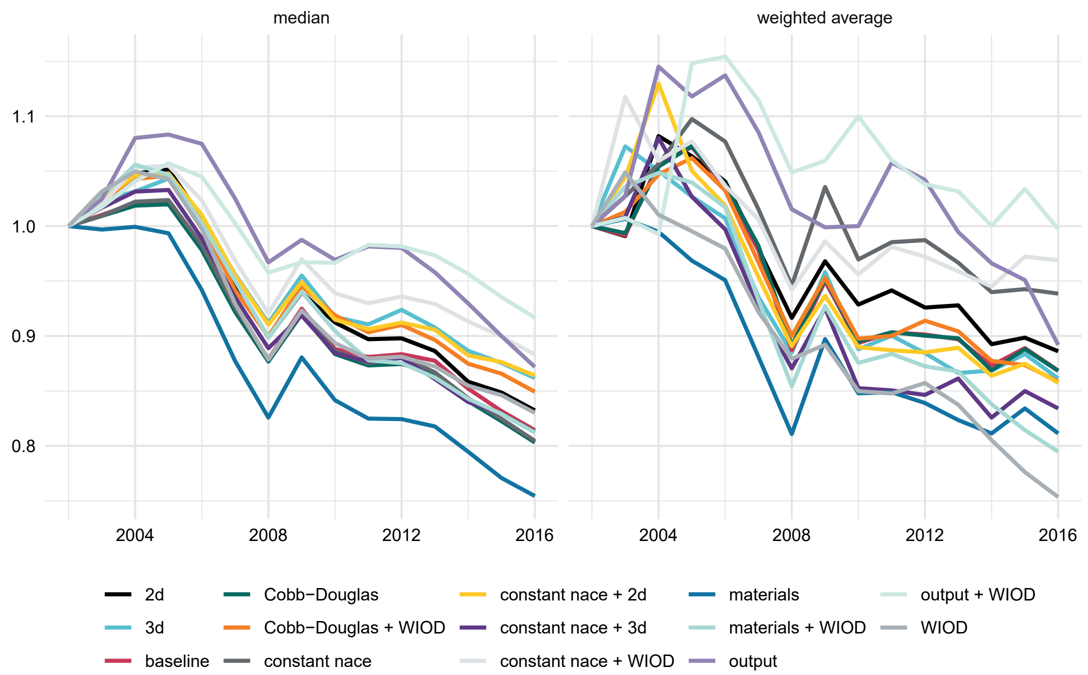
A broad set of aggregate markups obtained under various empirical strategies is depicted on figure 3. Eyeballing the series and comparing with the baseline results one might conclude that decline in markups is quite robust to the choice of empirical

from 0.61 to 0.67 (see Mućk, McAdam, and Growiec, 2018, for a general discussion of measurement strategy).

[9]Given a time-variable nature of the output elasticities, we have also investigated the evolution of returns to scales. It turns out that there is no pronounced trend in the returns to scale over the analyzed period. Between 2002 and 2016 both the weighted and unweighted sum of the $\bar{\theta}_t^L$ and $\bar{\theta}_t^K$ rose by 1%.

measurement. In all cases the median markups have been systematically decreasing over the considered period and the overall fall in this period ranges from 8% to 25%. The dynamics of the weighted average is slightly more heterogeneous across different measures of the markups and in one case there is no change. [10] However, if we compare the peak of markups around 2005 with the last value the decline in markups can be unquestionably observed, irrespectively of the empirical strategy.

Figure 3: Aggregate markups in Poland: alternative empirical measurement strategies (2002=1)



Note: Cobb-Douglas – the Cobb-Douglas production function; **output** – the estimates for the global output as the outcome variable; **WIOD** – separate estimation for the WIOD industries; **2d** – separate estimation for the two-digits NACE industries; **3d** – separate estimation for the three-digits NACE industries; **materials** – materials instead of intermediate consumption as a proxy variable; **constant nace** – constant NACE classification based on the last observation.

In the next step, we quantify the role of changes in the sectoral composition of the economic activity in the markup change. One might suppose that the fall in markups has been driven by a rising role of industries, in which the markups are substantially smaller. This effect can be quantified by using the shift-share analysis. In general, the change in the (weighted) average markups within any time period can be decomposed

[10] This refers to the case when the underlying parameters of the translog production function for output were estimated at the WIOD industry level. However, these results should be interpreted with caution due to large number of observations with negative implied output elasticities. Around 48.3% of observation from the final sample were dropped because at least one estimated elasticity was below zero. It is an extremely larger fraction of observations than in our baseline setting ($< 1\%$) or other alternative strategies (ca. $0.5\% - 7.5\%$).

into three components:

$$\Delta\mu_t = \sum_j s_{j,t-1}\Delta\mu_{j,t} + \sum_j \mu_{j,t-1}\Delta s_{j,t} + \sum_j \Delta\mu_{j,t}\Delta s_{j,t}, \tag{7}$$

where $s_{j,t}$ is the share in sales (weighting variable) of a sector j in period t. The first component (*within*) captures the effects of changes in average markups at the industry level while the second term (*between*) arises when there is a substantial shift in composition. The remaining component measures the joint effect of simultaneous changes in markups and industry composition and can be seen as a reallocation effect. The results of the shift-share analysis are depicted on figure 4. We present the cumulated (log) changes to illustrate the anatomy of the observed tendency. It follows that the fall of markups has been driven mainly by changes within industries. At the same time, the contribution of the between effect is positive but its overall role is negligible. Moreover, the reallocation term is slightly negative, i.e., there are larger falls of markups in industries that have been growing faster over the considered period.

Figure 4: Decomposition of the cumulated log changes in markups

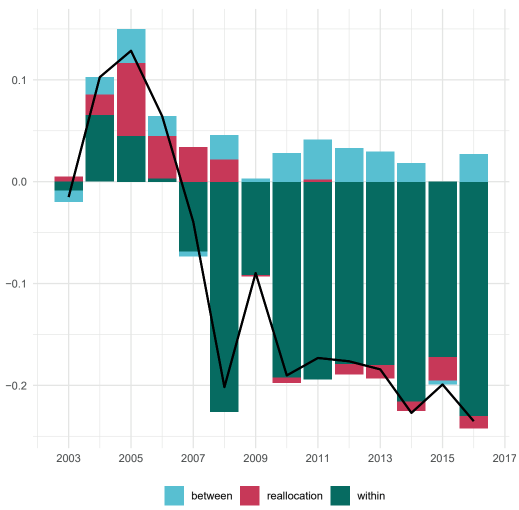
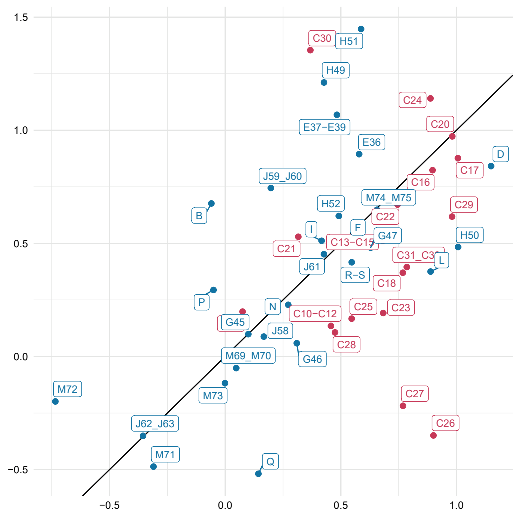


Figure 5: The logged markups at the industry level in 2002 (horizontal axis) and 2016 (vertical axis)



Note: the black solid line in figure 5 stands for the 45 degree line which represents no change in markups at the industry level between 2002 and 2016. The detailed description of the industry codes is delegated to table E.2.

Interestingly, the changes in markups at the industry level between 2002 and 2016 were very heterogeneous. The most pronounced falls can be observed in manufacturing industries, i.e., manufacture of computer, electronic and optical products (C26), electrical equipment (C27) and other non-metallic mineral products (C23). It is worth to notice that these industries are recognized as the most spectacular examples of international fragmentation of production process (Wang, Wei, and Zhu, 2013). However, there are some industries in which the markups have boosted, i.e., selected transport industries and mining and quarrying (B). Despite the above heterogeneity it is clear to observe that in majority of industries the markups have fallen. Therefore, the magnitude of the within component is dominating and it corroborates with negligible role of the between component in total markups change.

Importantly, the above features are highly robust to a choice of measurement strategy. The shift-share analysis performed for the alternative estimates of markups implies that the role of the between component is not dominant (see figure B.1). In particular, the magnitude of this component varies among the considered empirical strategies. In some cases the contribution of this effect is negative while in other the between effect mitigates the fall at the industry level. All in all, the within effect seems to predominant, which means that the falls were driven by changes at the sectoral level.

In the next step we assess whether the decline in the markups has been driven by changes at the firm level. However, one might suppose that the aggregate fall has been caused by new enterprises that enter our sample and exhibit a lower markup or exiting firms that have higher markups. In fact, non-negligible dynamics of entries and exits can be observed in our sample (see figure 6).[11] The average annual share of entrants and exiters is about 10% and 7.3%, respectively. In addition, the demography of firms seems to be more complex, i.e., the share of exiters have been rising while new firms have become less important in our sample. To scrutinize the potential non-trivial impact of entrants (denoted as E) and exiters (X) on markups we apply a dynamic decomposition proposed by Melitz and Polanec (2015). In general, the change in markups ($\Delta\mu_t$) can be decomposed as follows:

$$\Delta\mu_t = \Delta\bar{\mu}_{S,t} + \Delta\text{cov}_{S,t} + S_{E,t}\left(\mu_{E,t} - \mu_{S,t}\right) + S_{X,t-1}\left(\mu_{S1,t-1} - \mu_{X,t-1}\right), \qquad (8)$$

where $\Delta\mu_{S,t}$ is the aggregate markup change, while $\Delta\bar{\mu}_{S,t}$ denotes the average markups change observed for the surviving firms (S). The remaining components measure: (i) the change in reallocation $\Delta\text{cov}_{S,t}$), (ii) effect of entrants ($S_{E,t}\left(\mu_{E,t} - \mu_{S,t}\right)$), and (iii) effect of exiters ($S_{X,t-1}\left(\mu_{S1,t-1} - \mu_{X,t-1}\right)$).

Figure 7 portrays the results of the dynamic decomposition for the cumulative changes of markups. Clearly, the decline in markups has been predominantly driven by changes at the level of surviving firms. In general, looking at disaggregated data, it can be found that around 70% of enterprises have experienced fall of markup. Moreover, the average fall has been stronger than decline in the aggregate (weighted) markups and this effect has outweighed the contribution of remaining components. Positive contribution of reallocation implies that the firms with larger (gross) sales have faced lower fall in the markups. Interesting pattern can be found for the entrants. It turns out that the importance of new firms in the dynamics of aggregate markups was substantial between 2002 and 2008. In fact, the peak of the average markup around 2005 can be

[11] It should be noted that entrants are firms which enter a sample while exiters refer to enterprises that withdraw from a sample. This mostly refers to existing or entering the market due to bankruptcy or firm creation. But in our case this can be related to a fact that firms pass the 10 employees threshold. In addition, these groups could consist of firms that are dropped from sample due to negative output elasticities. However, in the baseline strategy the share of such firms is small since we drop around 1% observations.

mostly explained by entrants. However, the effect of new firms has been dying out over the sample and the cumulative contribution is quite small. Similarly, the overall role of exiting firms is also limited.

Figure 6: Demographics of firms and the OP gap for markups

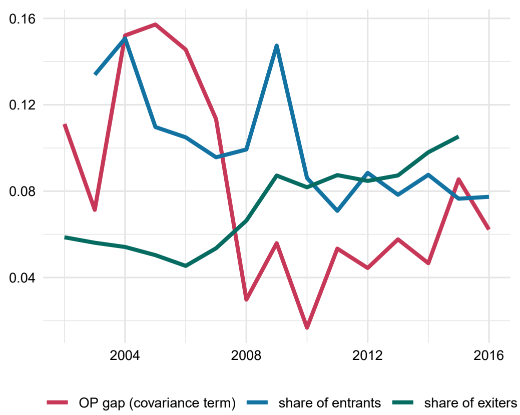


Figure 7: Decomposition of the cumulated log changes in markups

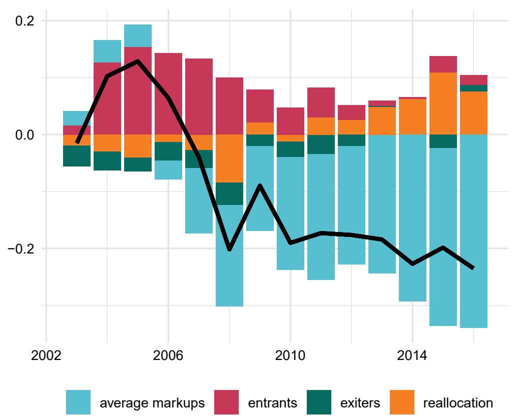


Figure B.2 confirms our previous findings. Independently of the empirical strategy chosen, the decline in the aggregate markups can be predominantly explained by falls at the firm level. In virtually all cases, this effect has mitigated a counterfactual increase in markups due to a positive contribution of reallocation and entrants. But the role of exiting firms is ambiguous.

Apart from the mean, the other characteristics of the markups distribution have also changed between 2002 and 2016 (see figure 8). Firstly, the overall dispersion of markups has systematically risen in this period. The standard deviation of log markups has increased by around 30%. Secondly, the distribution of markups became more skew. This is confirmed by rising skewness as well as interquartile range. All above patterns are in line with empirical regularities documented for other economies (De Loecker and Eeckhout, 2018).

The downward tendency in the markups varies with firms' efficiency. Taking the TFP as a proxy of the economic efficiency, it can be illustrated by a fact that the larger drops in markups are observed for the relativity least efficient firms (figure 9)[12]. At the same time, the most efficient enterprises, i.e., characterized with the highest TFP, have experienced only very small din their markups. Autor, Dorn, Katz, Patterson, and Van Reenen (2017) argue that 'superstar' firms (defined as firms with the highest TFP levels) capture a higher share of industry output, exhibit lower labor share and tend to have larger price-cost markups (as predicted by e.g. a homogeneous product Cournot model). Diez, Leigh, and Tambunlertchai (2018) find that a relatively small number of 'superstar' firms that are able to extract increasingly large markups are an important driver of rising markups. It suggests one of the reason why we observe a fall of markups

[12]We have also experimented with alternative groupings on the top of the distribution, with similar results. Details are available upon request.

Figure 8: Dispersion and skewness of markups (2002=1)

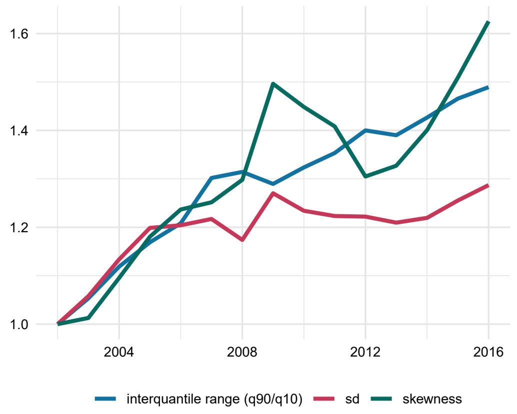
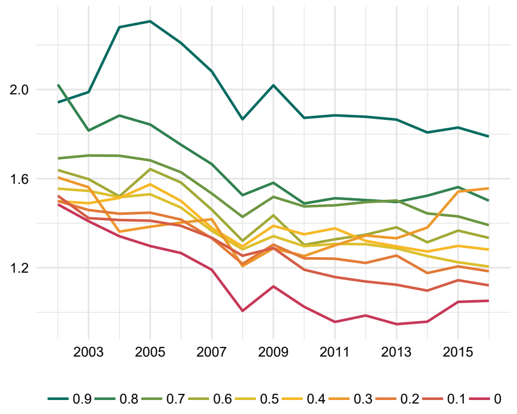


Figure 9: Evolution of weighted mean markups in TFP classes



Note: in the figure 9 firms are grouped based on deciles of average level of the log TFP, accounting for industry differences. Lines represent weighted means of firms within these deciles, where the numbers in the legend correspond to the lower bound of the interval.

in Poland and a rise of markups in high-income countries. Although the most efficient firms in Poland indeed exhibit higher markups they are hardly 'superstar' firms in global terms. This can be supported by a fact that, contrary to 'superstar' firms in developed countries (De Loecker and Eeckhout, 2018; Diez, Leigh, and Tambunlertchai, 2018), their ability to extract high markups has not been increasing over the time.

We subsequently look at the markups for exporters and non-exporting firms. In the early 2000s the exporters exhibited systematically and substantially higher markups than other enterprises (see figure 10). This fact is consistent with the literature investigating markups for developing economies. For instance, De Loecker and Warzynski (2012) focus on Slovenian manufacturing firms between 1994 and 2002 and document that the average export premium for markups is about 15%. As it can be seen from figure 10, this difference is not stable over the time. Moreover, after 2005 the fall in markups was more pronounced for the exporting enterprises and differences between these group has become less systematic. In addition, the stronger fall in markups for exporters can be unambiguously confirmed for alternative measures of the markups (see B.3 and B.4).

Having in mind that firms from Poland have benefited from the trade liberalization and international integration we also look at the markups in groups with different international linkages. Given the data constrains[13], our population is additionally splited into four groups: (i) firms exporting and importing, (ii) enterprises reporting only exports, (iii) firms with imports only, and (iv) enterprises without international trade linkages. Intuitively, the most internationally integrated firms belong to the first group. A visual inspection of the markups dynamics (see figure 11) suggests that firms exporting or/and importing faced a larger drop than enterprises without

[13]Our database provides data on imports since 2005 and distinguishes only the imports of intermediates.

Figure 10: The average markups for exporters and non-exporting firms (weighted mean)

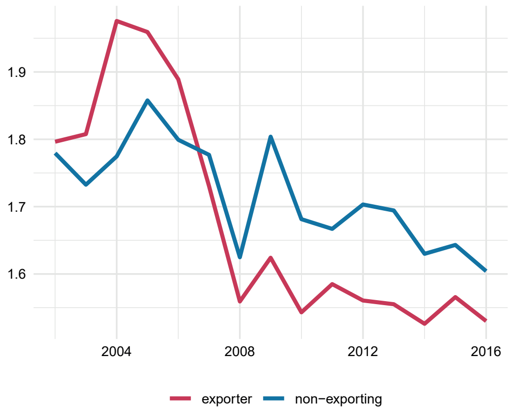
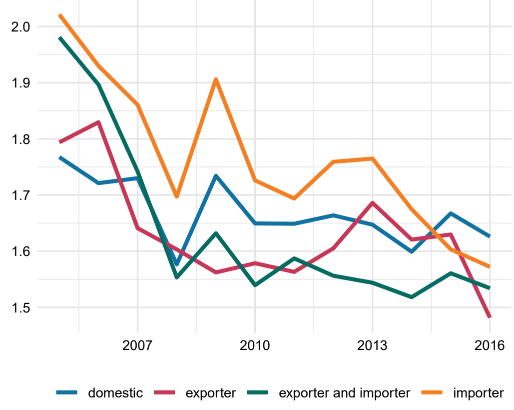


Figure 11: The average markups for exporters, importers and domestic firms (weighted mean)



international trade flows. This suggests that rising openness of the economy might be a good candidate for a possible explanation of the observed (aggregate) declining tendency.

4 The role of globalization in the decline of markups

In this section, we investigate the link between markups and globalization in the Polish economy.

To scrutinize the impact of globalization we use the World Input-Output database (WIOD, Timmer, Dietzenbacher, Los, Stehrer, and de Vries, 2015) to calculate two structural characteristics measuring intersectoral linkages at the industry level. Firstly, we use the upstreamness index (denoted as $\mathcal{UPS}$) which quantifies an average distance of a given industry from final demand (Antras, Chor, Fally, and Hillberry, 2012). The $\mathcal{UPS}$ takes the value of one if firms in a given industry produce only final goods. The $\mathcal{UPS}$ will be higher if produced goods are mostly intermediates and will be even higher when this intermediate production is used by other intermediate producers. In other words, the upstreamness measures the average number of production stages required to reach the final demand.

Globalization via fragmentation should also mean that firms use more imported intermediates in their production. One of the possible measures of this phenomenon is the foreign value added in exports ($\mathcal{FVAX}$ or import content of exports), proposed by Wang, Wei, and Zhu (2013). It allows to estimate the import content of gross exports at the industry level. Since the process of production have been divided into smaller stages which have been reallocated between countries one might expect that at the country level the gross exports is often highly dependent on very specific intermediates that are imported. Consequently, there will be a high share of foreign value added in exports in industries that are more intensively engaged in Global Value Chains.

In the econometric analysis we also consider the market structure. This can be captured by the standard Herfindahl-Hirschman indices (denoted as $\mathcal{HHI}$). In particular, we use the inverted $\mathcal{HHI}$ indices as they can be interpreted as a number of symmetric competitors. If the $\mathcal{HHI}^{-1}$ is higher than the market concentration is lower. The indices are subsequently calculated for total sales ($\mathcal{HHI}^{-1}_{total}$), domestic sales ($\mathcal{HHI}^{-1}_{domestic}$) and exports ($\mathcal{HHI}^{-1}_{export}$), measuring the extent of competition at various markets. [14]

4.1 Dynamic panel data at the industry level

Since virtually all globalization measures are observed at the industry level we start our regression analysis using sectoral data. Taking possible persistence into account we will consider the following dynamic model:

$$\log \mu_{jt} = \rho \log \mu_{jt-1} + x'_{jt}\beta + \varepsilon_{jt}, \tag{9}$$

where μ_{jt-1} is the lagged markup, x_{jt} is a set of explanatory variables, β is the vector of coefficients and industries are indexed with the j.

[14] In particular, the measure $\mathcal{HHI}^{-1}_{export}$ assumes that firms from Poland compete for export orders only with domestic firms, so it proxies concentration of local firms on export markets.

The error term ε_{jt} can potentially consist of both the idiosyncratic component and industry specific one, constant over time. Given the well-known bias of the OLS and FE estimates in a dynamic panel setting, we employ a system-GMM approach, along the line of Arellano and Bover (1995) and Blundell and Bond (1998). In particular, we use two-step estimator with robust standard errors. Since the time dimension of the panel is not extremely low, the number of lags of dependent variable used as instruments is truncated to five.[15] In all regressions time dummies are included.

Table 5 presents our baseline estimation results for sectoral models. We start with the specification that includes only the upstreamness measure and subsequently extend our regression. The estimates in the first column suggest that there is a nonlinear relationship between the distance to final demand and the markups. The signs of these estimates imply the so called smile curve (see figure 12; right panel) – the highest markups are in industries that are (i) very close to final demand or (ii) at the begging of the supply chain. It should be noted that this shape of relationship, as well as the minimum of the smile curve is robust among all considered specifications.

In the next step, we extend our regression by the import content of exports ($\mathcal{FVAX}$). Since the upstreamness index measures changes in distance to final consumer, which can be related to both international and domestic vertical specialization, the $\mathcal{FVAX}$ can potentially better scrutinize the effects of globalization. In fact, our estimates imply that the relationship between the markups and the import content of export is hump-shaped (see table 5 and left panel of figure 12). Importantly, the inverted U-shaped relationship can be found even if the additional explanatory variables are included. In industries with low $\mathcal{FVAX}$ the impact of changes in import content of export could be positive due to two reasons. Firstly, firms decide to import more high-tech intermediates which are not available at domestic market. This could lead to the improvement in the quality of produced goods and hence to a markup increase. Secondly, the $\mathcal{FVAX}$ might illustrate the degree of integration with supply chains. In this vein, the integration with foreign suppliers and final producers facilitate both adoption of advanced technologies aimed at overall increase in efficiency and access to foreign consumers. In contrast, in sectors with moderate and high $\mathcal{FVAX}$ these positive effects might be outweighed by a large degree of vertical specialization that might be associated with relatively small market power. Since these firms are tightly integrated with foreign suppliers of intermediates as well as with producers of finals goods it is intuitive that they are rather price takers than price setters. This effect could be additionally amplified by the fact that these firms face a fierce competition driven by a larger number of firms that want to operate in the global supply chains.

We also control for the productivity gains in the estimation. The estimated coefficients for the log total factor productivity (tfp) are in line with economic intuition and with the results of recent empirical studies (Békés, Hornok, and Muraközy, 2016). The positive relationship between tfp and markups reflects the downward pressure on

[15] We have experimented with the robustness of this choice – increasing the number of lags does not change qualitatively our estimation results.

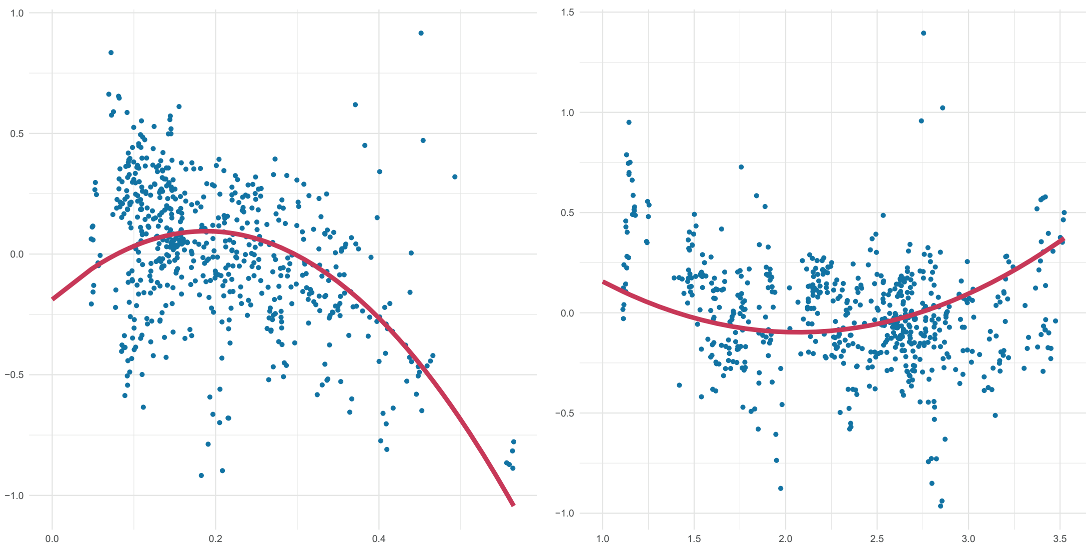
Table 5: Estimates of dynamic panel data models describing markups at the industry level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\log \mu_{it-1}$	0.871***	0.780***	0.697***	0.686***	0.691***	0.678***	0.737***
	(0.014)	(0.028)	(0.031)	(0.031)	(0.033)	(0.032)	(0.041)
$\mathcal{UPS}$	−0.391***	−0.711***	−1.128***	−1.074***	−1.072***	−1.219***	−0.917***
	(0.079)	(0.166)	(0.270)	(0.270)	(0.318)	(0.316)	(0.323)
$\mathcal{UPS}^2$	0.095***	0.145***	0.276***	0.260***	0.259***	0.294***	0.222***
	(0.016)	(0.031)	(0.059)	(0.060)	(0.069)	(0.070)	(0.072)
$\mathcal{FVAX}$		3.777***	3.147***	3.217***	3.032***	3.231***	3.013***
		(0.415)	(0.609)	(0.577)	(0.601)	(0.609)	(0.640)
$\mathcal{FVAX}^2$		−7.814***	−8.088***	−8.291***	−7.756***	−8.173***	−8.014***
		(0.743)	(0.963)	(0.918)	(0.969)	(0.998)	(1.058)
tfp			0.697***	0.682***	0.659***	0.709***	0.627***
			(0.075)	(0.078)	(0.080)	(0.096)	(0.087)
$\mathcal{HHI}^{-1}_{total}$				−0.000		−0.000	
				(0.000)		(0.000)	
$\mathcal{HHI}^{-1}_{domestic}$					−0.000		−0.000*
					(0.000)		(0.000)
$\mathcal{HHI}^{-1}_{export}$					−0.000		−0.000
					(0.000)		(0.000)
entry						0.210**	0.323***
						(0.104)	(0.092)
exit						0.144***	0.302***
						(0.053)	(0.075)
Constant	0.461***	0.588***	−2.182***	−2.130***	−2.025***	−2.156***	−2.083***
	(0.094)	(0.187)	(0.290)	(0.256)	(0.281)	(0.263)	(0.329)
Observations	552	552	552	552	552	552	552
Number of sectors	47	47	47	47	47	47	47
Time dummies	✓	✓	✓	✓	✓	✓	✓
Sargan	[0.929]	[0.875]	[0.950]	[0.974]	[0.970]	[0.973]	[0.982]
AR(2)	[0.537]	[0.606]	[0.868]	[0.897]	[0.861]	[0.970]	[0.980]

Note: the superscripts ***, ** and * denote the rejection of null about parameters' insignificance at 1%, 5% and 10% significance level, respectively. The expressions in round and squared brackets stand for standard errors and probabilities values corresponding to respective hypothesis, respectively. AR(2) it the test for serial correlation developed by Arellano and Bond (1991) and the null hypothesis in this case is about the error term time independence (of order two). The Sargan statistics are used to test over-identifying restrictions and the null postulates validity of instruments.

costs induced by increasing efficiency, allowing firms to gain higher markups. The relationship between the markups and market structure is less clear. Although the signs of the coefficient for $\mathcal{HHI}^{-1}_{total}$, $\mathcal{HHI}^{-1}_{domestic}$ and $\mathcal{HHI}^{-1}_{export}$ are negative they are not statistically significant. Moreover, there are significant effects of firms' demography, i.e., there is a positive relationship between markups and both entry and exit ratios. This suggests two empirical regularities. Firstly, after accounting for other factors the new firms have on average higher markups which might be due to the uniqueness or innovativeness of their production. Secondly, exiting firms try to set relatively high markups probably in order to survive.

Figure 12: Relationship between markups (vertical axis) and FVAX (left panel, horizontal axis) and Upstreamness (right panel, horizontal axis)



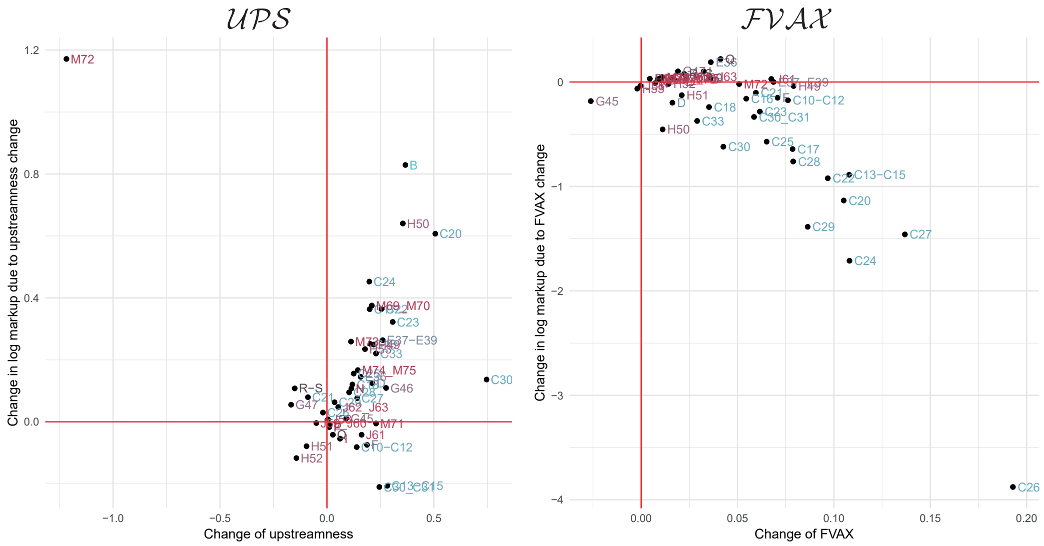
Note: the markups are corrected for the impact of the explanatory variables as well as fixed effects estimates. This recalculation bases on the estimates from the specification (7) in table 5.

Given the documented nonlinear relationship between markups and both the upstreamness and the import content of export, the aggregate effects of these factors could be ambiguous. Therefore, we look at their contribution to the observed change of markups at the industry level, see Figure 13. It follows that the on-going changes in upstreamness have rather positive impact on markups. Only for some manufacturing and transportation industries there is a negative contribution of $\mathcal{UPS}$ to the change of markup. This suggests that the fragmentation of production is a good explanation for a decline in markups only in selected industries.

Importantly, the overall effect of the international vertical specialization is intuitively negative. The rise in $\mathcal{FVAX}$ was more pronounced in sectors producing tradable goods, i.e. in manufacturing. The highest contribution of international fragmentation of production can be observed for manufacturing of computers, electronic and optical products (C26) which is recognized as the most spectacular example of vertical specialization (Wang, Wei, and Zhu, 2013). Besides, the rising import content in exports contributes negatively to the markups dynamics also in selected services sectors, i..e, transportation, wholesale and retail trade.

As a robustness check, we consider modified explanatory variable measuring the role of import in exports. Namely, we corrected $\mathcal{FVAX}$ with the share of exports in sales, allowing the coefficient associated with $\mathcal{FVAX}$ to vary with export intensity of the sector. The detailed results of these regressions are presented in table C.1 and figure C.1. Clearly, these numbers are in line with our baseline estimates. In general, there is a quite convincing evidence on the smile curve, i.e., the implied relationship between upstreamness (foreign value added in exports related to total sales) and markups is U-shaped.

Figure 13: Long-run contribution of changes in $\mathcal{FVAX}$ and $\mathcal{UPS}$ to the markup change at the industry level



Note: all above calculations based on the estimates of the model (7) in table 5. The long-run estimated contribution is calculated in line with nature of the autoregressive model, e.g. for a given initial level of explanatory variable x_0 it equals $\Delta x\hat{\beta}(x_0)/(1-\hat{\rho})$, where Δx is the cumulated change in x, $\hat{\beta}(x_0)$ is the estimated parameter at point x_0 and $\hat{\rho}$ is the estimated persistence parameter. In these figures the blue colored labels refer to sectors in industry. This group consists of the following economic areas: mining and quarrying (code B in NACE Rev. 2), manufacturing (C), electricity, gas, steam and air conditioning supply (D) and water supply, sewerage, waste management and remediation activities (E).

4.2 Between estimates

Having documented the most important forces that pushed down markups in Poland at the industry level we check whether these factors have been also crucial at the firm level. To challenge this issue we employ the between regression of the form:

$$\log \bar{\mu}_i = \bar{x}_i'\beta + \epsilon_i, \tag{10}$$

where $\log \bar{\mu}_i$ stands for the average markups for the firm i and $\bar{x}_i$ denotes a set of time-averages of explanatory variables. The underlying parameters β are estimated with weighed least squares where the weights correspond to a number of observations per firm. In other words, we account for a different number of observations for each unit to better explain the cross-sectional variation in the markups. The standard errors ϵ_i are clustered at the industry level.

Contrary to the previous industry level regression analysis we focus on the between variation in markups. This choice stems from two reasons. Firstly, we want to assess to what extent changes of the firms' characteristics moved down the aggregated markups. In addition, it allows to cross-check the robustness of the documented role of the globalization processes in the markup decline. Secondly, due to a large role of unobserved heterogeneity, as well as non-negligible demography of firms, it is not possible to obtain reliable estimates from a firm level dynamic panel data model in this case.

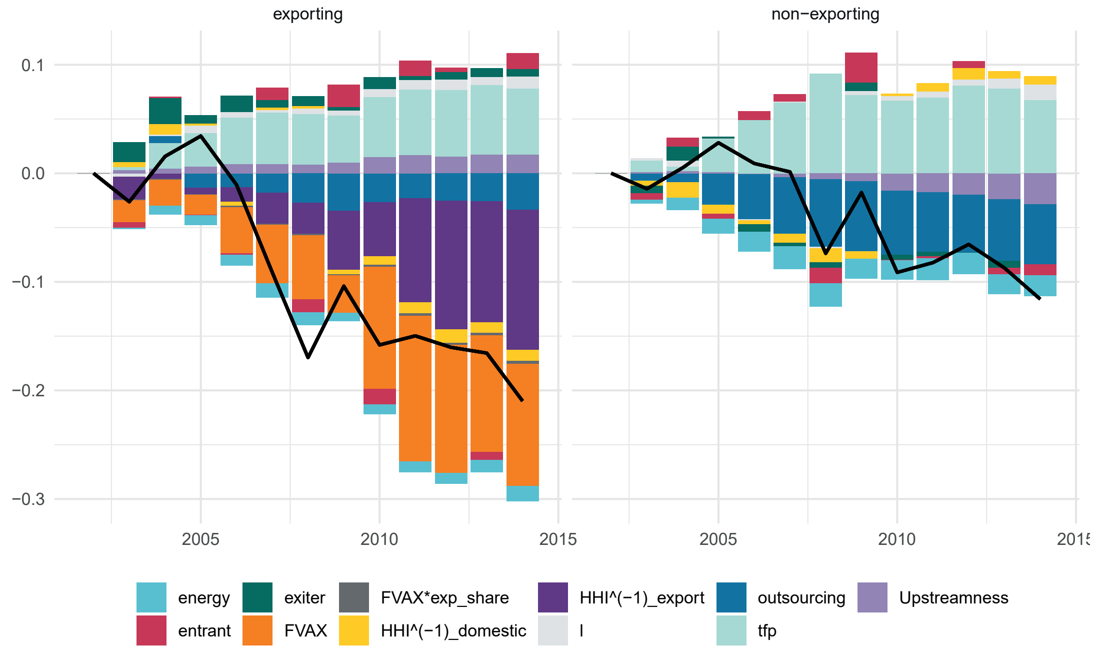
Since the globalization process has affected mostly exporting firms we split our sample into exporters and non-exporters and we exclude measures of international integration in the former case. Detailed estimation results are summarized in tables C.2 and C.3 and the regression results confirm our previous finding. The lower statistical significance of the globalization measures can be explained by a substantial role of unobserved heterogeneity, since the standard errors are clustered at the industry level. However, the estimated coefficient on squared $\mathcal{FVAX}$ are significant in all specifications. Moreover, in contrast to the dynamic panel regression the concentration on foreign market plays now an important role and is statistically significant. The sign of the relationship is in line with economic intuition, i.e., larger concentration in exporting market translates into lower markups.

Furthermore, the estimated coefficients on outsourcing share also illustrate complex effects of specialization. The implied relationship between the markup and *outsourcing* is hump-shaped. This suggests that the rise of outsourcing in firms not contracting many activities positively affects markups as firms can focus on processes in which they have comparative advantage. However, the effect of outsourcing on markups becomes negative for enterprises which are highly specialized. It could reflect the possible problems faced by these firms with taking control over the production costs.

The results for non-exporting firms are less clear. In comparison with the results for exporting enterprises, the estimates for the upstreamness and the outsourcing share have opposite signs. The further investigation shows that the above inconsistency is mostly due to firms from service sectors while estimation results for industrial enterprises are coherent with the regression results for exports.

Figure 14 presents the sources of markups decline, identified by the between regressions, for both exporters and non-exporters, but we will concentrate on the former. It clearly shows that among the factors considered there are two main forces behind a fall of markups for exporters: foreign value added in exports $\mathcal{FVAX}$ and the inverse of Herhindahl-Hirschmann index based on export revenues $\mathcal{HHI}^{-1}_{export}$, measuring the number of symmetrical firms present on export markets in a given industry. If follows that the increasing reliance on imported components in production, although is inevitably related to the participation in the Global Value Chains, simultaneously leads to a fall of markups. In other words, firms find it harder and harder to pass rising costs of imported components into prices of their products and therefore the markups are becoming compressed. The second factor – $\mathcal{HHI}^{-1}_{export}$ explains why it is the case. Namely, concentration of domestic firms on export markets rises (both on average and in case of most industries) – there are more and more firms competing for exporting orders, which limits their ability to rise prices. These two factors are moderated by rising cost efficiency, measured by productivity (tfp), putting an upward pressure on markups, but its scale is much less than the effects stemming from both globalization and export competition. The other factors considered proved to be of much smaller im-

Figure 14: Sources of markup declines in exporting and non-exporting firms



Note: The left panel is based on specification (7) in table C.2, the right panel – on specification (5) in table C.3. The figures show contributions of factors considered in the estimation, measured as $\beta_x \Delta x$, where Δx measure the cumulated change of a given variable from the first year on.

portance. For instance, although the effect of upstreamness is usually important at the industry level it is canceled out in the final aggregation. In case of non-exporting firms, the fall of markups is shallower and is mainly driven by the negative effect of rising firms' reliance on outsourcing, with a counteracting effect of increasing productivity.

5 Concluding remarks

We use financial data for the period 2002-2016 from a census of Polish enterprises employing more than 9 employees and construct the estimates of a time-varying and firm-specific markups of price over marginal costs using a methodology proposed by De Loecker and Warzynski (2012). The identification of markups is based on a measure of a distance of a production elasticity of labor, estimated using a translog production function and utilizing Ackerberg, Caves, and Frazer (2015) GMM estimator, to properly corrected labor share.

We document that during the recent 15 years markups were falling in Poland. The fall occurred not only for measures of central tendencies (like median, weighted or unweighted means), but also for the most of quantiles of the distribution of markups, excluding the highest quantiles, for which a slight rise was observed. Importantly, at the firm level, around 70% of enterprises experienced a decline in markups. We also document that the fall is robust to a choice of empirical strategy – to different ways of measuring output, to assumptions on production function shape and estimation and to fixing the firms' NACE code.

The fall of markups in Poland, an example of less developed country, is in line with the results for developed countries, e.g. in De Loecker and Eeckhout (2017). We showed that the decline in markups is more severe for exporting enterprises. Our econometric analysis indicates that the fall of markups for exporters can, to a large extent, be explained by factors related to globalization. The increasing reliance on imported components in production, inevitably related to the participation in the Global Value Chains, is one of important factors behind a fall of markups. Moreover, concentration of domestic firms on export markets (both on average and in case of most industries) rises, having a negative impact on markups. It implies that there is an increasing number of firms competing for exporting orders and the firm's ability to rise prices (also due to rising costs of imported components) is therefore declining. The other factor related to joining the Global Value Chains – the distance to final demand – has almost neutral effect on markups due to larger heterogeneity of individual effects across industries.

These globalization forces are possibly an important reason why we observe a fall of markups in Poland and a simultaneous rise of markups in high-income countries. In fact, firms located in Western Europe, importing intermediate inputs and outsourcing their production, exhibit higher markups – see Békés, Hornok, and Muraközy (2016). The possible explanation of the above divergence could be additionally related to the effect of 'superstar' firms. They tend to have higher markups, both in high income countries and in Poland. However, firms from Poland are hardly 'superstar' firms in global terms and the ability of Polish firms to extract high markups is not increasing. Moreover, our analysis suggests that the fall of markups is mainly driven by the firm- or industry-level changes. On the contrary, the rise of markups in the US (see Baqaee and Farhi, 2017) seems to be mainly due to the increasing market share of high-markup firms (the between component in the context of our analysis). The divergence could also be partly due to representatives issue – our analysis is done on a population of all firms employing at least 10 employees, whereas the most of the firm level markup estimates are from listed (and possibly more efficent) companies. Traina (2018) also rises this issue.

Moreover, we contribute to the literature on the non-linear effects of a country's position in the GVC. The results of Ye, Meng, and Wei (2015) indicated that the relation between the position in the GVC and the creation of value added is convex and quadratic. We extend these results into different dimension and document the similar relationship between the position in the GVC and the markups of price over marginal costs. We also show that a smile curve occurs not only in industry-level data (like Input-Output tables), but also in firm-level data.

There are various interesting extensions and avenues for further research that we consider in the future. First, given the sluggish evolution of inflation in recent years, an important question is related to the transmission of markups into producer prices and the contribution of a fall of markup to the fall of producer prices (Andrews, Gal, and Witheridge, 2018, show that greater participation in global value chains has placed downward pressure on inflation). Second, the methodology of De Loecker and Warzynski (2012) is silent on the nature of changes in markups – whether it originates from changes in the structure of the market or from changes in demand elasticities. Moreover, the change of markups does not necessarily imply the shift of the firm's market power and the ability to extract profits. Investigating the nature of a decline of markups in Poland is an important next step of the analysis.

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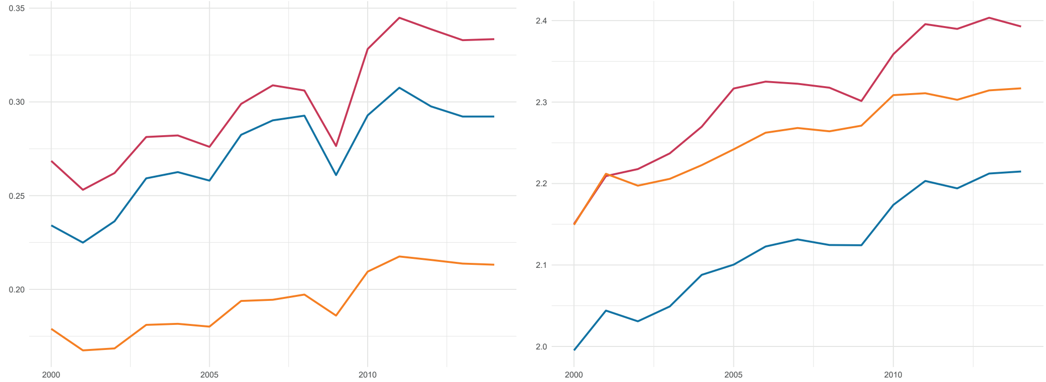
A Poland and Globalisation

Figure A.1: Foreign value added in exports ($\mathcal{FVAX}$; left panel) and the Upstreamness in Poland ($\mathcal{UPS}$; right panel)



Note: the blue lines stands for the aggregate measures, the orange line denotes the averages (from industry level measures) while the red line represents these measures adjusted by structure of German exports.

Figure A.2: Foreign value added in exports (left panel) and $\mathcal{FVAX}$ adjusted by structure of German export (right panel) in 2000 (horizontal axis) and 2014 (vertical axis)

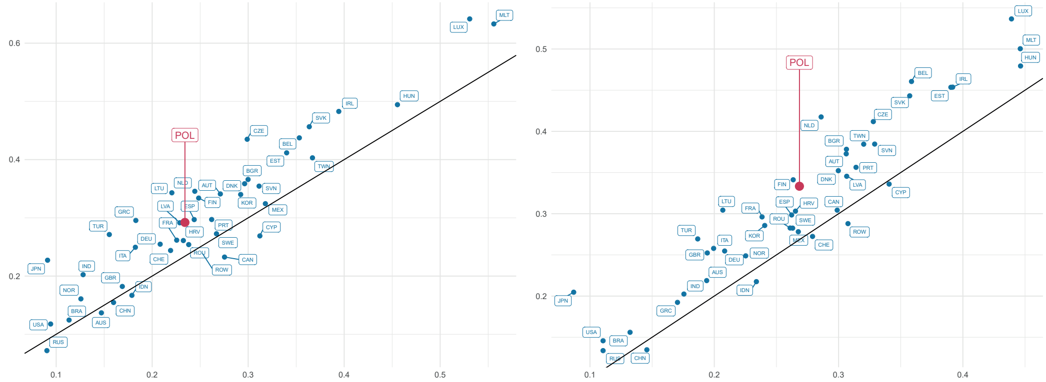
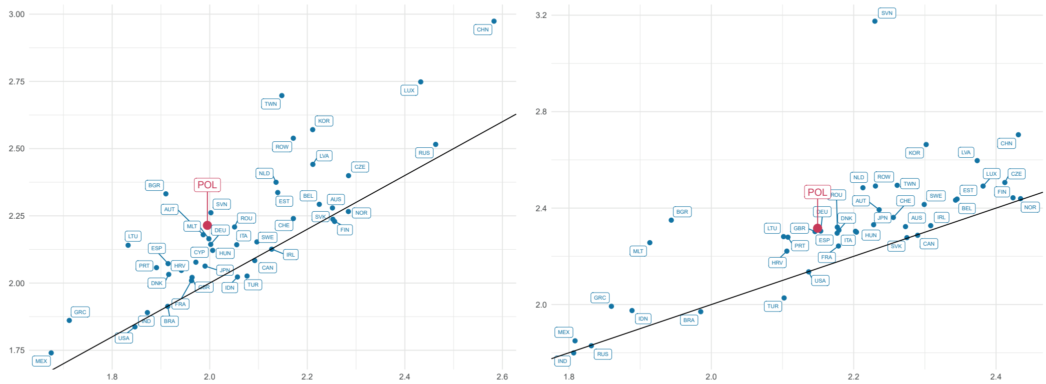


Figure A.3: The output-weighted upstreamness (left panel) and average upstreamness (right panel) in 2000 (horizontal axis) and 2014 (vertical axis)



B Additional graphs and tables

Figure B.1: Shift-share analysis (in log changes; cumulated 2002-2016)

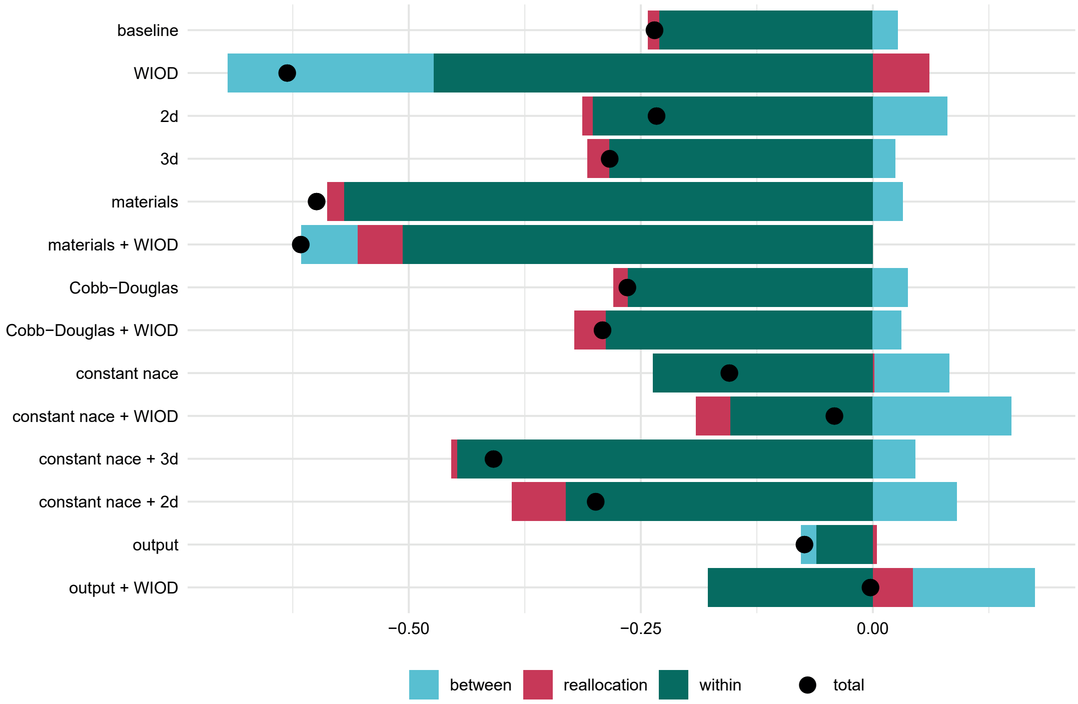


Figure B.2: Dynamic decomposition of the markups (in log changes; cumulated 2002-2016)

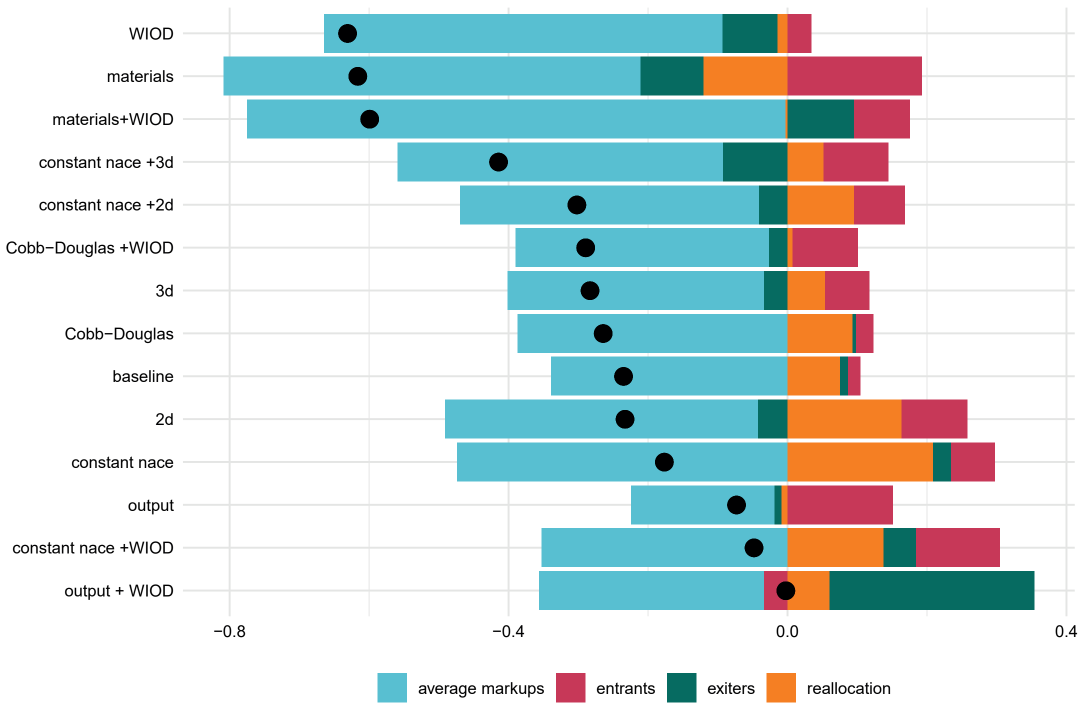


Figure B.3: The median (top panel) and mean (bottom panel) markups for exporters and non-exporting firms (2002=1)

Figure B.4: The average (weighted mean) markups for exporters and non-exporting firms (2002=1)

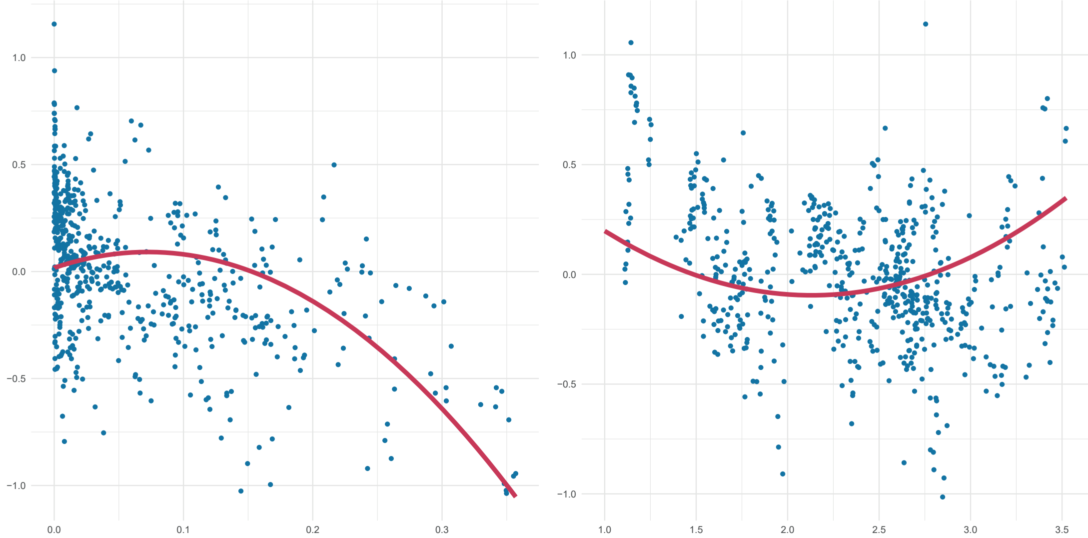
C Additional estimation results

Table C.1: Estimates of dynamic panel data models describing markups at the industry level – adjusted FVAX

	(1)	(2)	(3)	(4)	(5)	(6)
$\log \mu_{it-1}$	0.840***	0.751***	0.782***	0.679***	0.689***	0.668***
	(0.022)	(0.042)	(0.040)	(0.050)	(0.052)	(0.057)
$\mathcal{UPS}$	−0.286	−0.925***	−0.677***	−0.958***	−0.913***	−0.976***
	(0.184)	(0.259)	(0.244)	(0.339)	(0.316)	(0.357)
$\mathcal{UPS}^2$	0.045	0.223***	0.163***	0.225***	0.211***	0.229***
	(0.035)	(0.056)	(0.054)	(0.073)	(0.070)	(0.079)
$\mathcal{FVAX} \times \frac{export}{sales}$	2.505***	1.479**	1.609**	1.836**	2.218***	2.045***
	(0.430)	(0.739)	(0.702)	(0.719)	(0.710)	(0.739)
$\left(\mathcal{FVAX} \times \frac{export}{sales}\right)^2$	−11.422***	−11.189***	−12.101***	−13.343***	−14.914***	−14.131***
	(1.606)	(2.381)	(2.287)	(2.326)	(2.415)	(2.318)
tfp		0.710***	0.649***	0.810***	0.768***	0.833***
		(0.083)	(0.079)	(0.092)	(0.095)	(0.113)
$\mathcal{HHI}^{-1}_{total}$			−0.000*		−0.000	
			(0.000)		(0.000)	
$\mathcal{HHI}^{-1}_{domestic}$				−0.000		−0.000
				(0.000)		(0.000)
$\mathcal{HHI}^{-1}_{export}$				−0.000		−0.000
				(0.000)		(0.000)
entry					0.287***	0.319***
					(0.068)	(0.070)
exit					0.108	0.119
					(0.102)	(0.098)
Constant	0.451**	−2.193***	−2.133***	−2.513***	−2.420***	−2.655***
	(0.228)	(0.307)	(0.300)	(0.385)	(0.362)	(0.442)
Observations	552	552	552	552	552	552
Number of sectors	47	47	47	47	47	47
Time dummies	✓	✓	✓	✓	✓	✓
Sargan	[0.955]	[0.964]	[0.972]	[0.989]	[0.995]	[0.996]
AR(2)	[0.480]	[0.695]	[0.664]	[0.829]	[0.848]	[0.946]

Note: the superscripts ***, ** and * denote the rejection of null about parameters' insignificance at 1%, 5% and 10% significance level, respectively. The expressions in round and squared brackets stand for standard errors and probabilities values corresponding to respective hypothesis, respectively. AR(2) it the test for serial correlation developed by Arellano and Bond (1991) and the null hypothesis in this case is about the error term time independence (of order two). The Sargan statistics are used to test over-identifying restrictions and the null postulates validity of instruments.

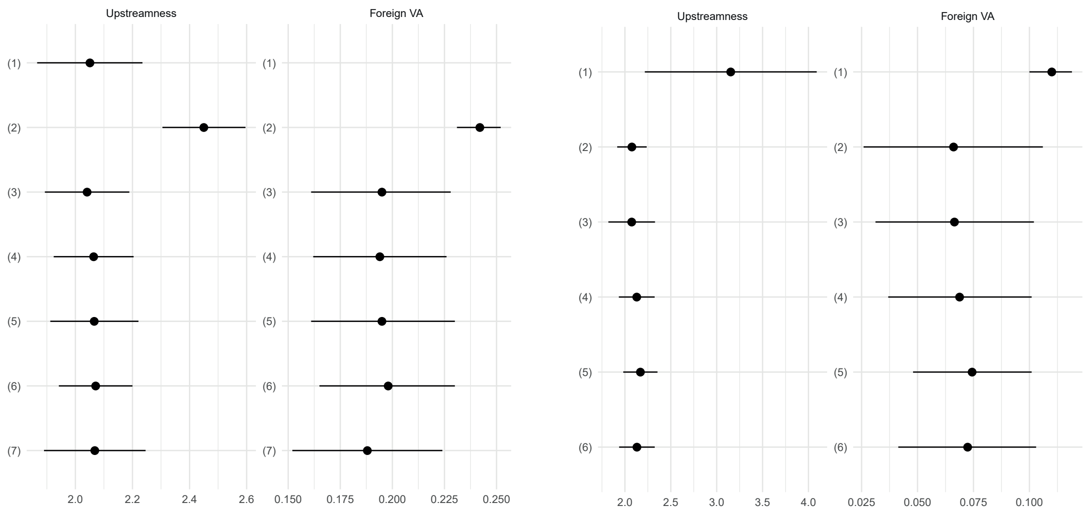
Figure C.1: Relationship between markups (vertical axis) and adjusted FVAX (left panel, horizontal axis) and Upstreamness (right panel, horizontal axis)



Note: the markups are corrected for the impact of the explanatory variables as well as fixed effects estimates. This recalculation bases on the estimates from the specification (6) in table C.1.

Figure C.2: Extreme values of $\mathcal{FVAX}$ and $\mathcal{UPS}$ in baseline model (left panel) and in regression including adjusted $\mathcal{FVAX}$ (right panel)

baseline **adjusted FVAX**



Note: the extreme values of $\mathcal{FVAX}$ and $\mathcal{UPS}$ stand up for turning points at which the direction of impact of these factor changes. The vertical solid lines denote the 95% interval estimates calculated with the delta method. The estimated turning point for baseline and regression with adjusted $\mathcal{FVAX}$ refer to the specification (7) in table 5 and the specification (6) in table C.1, respectively.

Table C.2: Estimates of between models describing markups for exporting firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
tfp	0.393***	0.369***	0.350***	0.370***	0.408***	0.491***	0.538***
	(0.0677)	(0.0726)	(0.0786)	(0.0796)	(0.0819)	(0.0929)	(0.090)
$\mathcal{UPS}$	−0.614	−0.614	−0.386	−0.427	−0.150	0.0286	−0.226
	(0.683)	(0.707)	(0.803)	(0.735)	(0.702)	(0.726)	(0.424)
$\mathcal{UPS}^2$	0.145	0.151	0.0971	0.107	0.0571	0.0124	0.067
	(0.148)	(0.155)	(0.176)	(0.162)	(0.151)	(0.155)	(0.090)
$\mathcal{FVAX}$		4.396	4.816*	5.690**	2.728	2.690	0.846
		(2.855)	(2.562)	(2.483)	(2.393)	(2.351)	(1.137)
$\mathcal{FVAX}^2$		−9.722*	−10.66*	−12.24**	−8.795*	−8.594*	−4.468**
		(5.696)	(5.320)	(5.187)	(4.979)	(4.807)	(2.098)
$\mathcal{FVAX} \times \frac{export}{sales}$			−0.314	−0.153	−0.132	−0.0301	−0.427
			(0.568)	(0.510)	(0.543)	(0.508)	(0.329)
$\left(\mathcal{FVAX} \times \frac{export}{sales}\right)^2$			−0.0383	−0.421	−0.0344	−0.0674	0.511
			(1.592)	(1.475)	(1.518)	(1.399)	(0.963)
$\mathcal{HHI}^{-1}_{total}$			−0.0005				
			(0.0004)				
$\mathcal{HHI}^{-1}_{domestic}$				0.000	0.001	0.000	0.000
				(0.001)	(0.001)	(0.001)	(0.000)
$\mathcal{HHI}^{-1}_{export}$				−0.003***	−0.004***	−0.004***	−0.001***
				(0.001)	(0.001)	(0.001)	(0.001)
$outsourcing$					−0.607	−0.565	−0.894***
					(0.388)	(0.376)	(0.222)
$outsourcing^2$					−0.218	−0.256	0.169
					(0.401)	(0.377)	(0.196)
$energy$						2.166	0.262
						(1.925)	(0.337)
l						−0.292***	−0.271***
						(0.029)	(0.0246)
l^2						0.024***	0.021***
						(0.004)	(0.003)
Constant	−0.791	−1.142	−1.236	−1.361	−1.210	−1.002	−0.396
	(0.859)	(0.910)	(0.917)	(0.881)	(0.921)	(0.978)	(0.485)
Entrants and exiters dummies	✓	✓	✓	✓	✓	✓	✓
Sectoral dummies							✓
Observations	32519	32519	32519	32519	32519	32519	32519
R^2	0.069	0.090	0.099	0.114	0.213	0.248	0.470

Note: the superscripts ***, ** and * denote the rejection of null about parameters' insignificance at 1%, 5% and 10% significance level, respectively. The expressions in round brackets stand for clustered standard errors.

Table C.3: Estimates of between models describing markups for the non-exporting firms

	(1) domestic	(2) industry	(3) services	(4) manufacturing	(5) domestic	(6) industry	(7) services	(8) manufacturing
tfp	0.563***	0.540***	0.632***	0.640***	0.593***	0.668***	0.572***	0.700***
	(0.111)	(0.0945)	(0.114)	(0.0546)	(0.0740)	(0.0409)	(0.0862)	(0.0347)
$\mathcal{UPS}$	1.323**	−1.009	1.631**	−1.278**	−0.188	−0.875*	0.405	−0.118
	(0.612)	(0.776)	(0.591)	(0.561)	(0.653)	(0.455)	(0.792)	(0.475)
$\mathcal{UPS}^2$	−0.310**	0.243	−0.393**	0.288**	0.0190	0.189*	−0.112	0.009
	(0.148)	(0.165)	(0.150)	(0.117)	(0.152)	(0.100)	(0.189)	(0.112)
$outsourcing$	0.398	−0.922***	−0.135	−1.078***	−0.344	−1.029***	−0.143	−1.086***
	(0.312)	(0.323)	(0.296)	(0.241)	(0.243)	(0.203)	(0.260)	(0.185)
$outsourcing^2$	−0.981***	0.786**	−0.657**	0.759***	−0.216	0.645***	−0.414*	0.701***
	(0.286)	(0.322)	(0.279)	(0.243)	(0.218)	(0.202)	(0.226)	(0.196)
l	−0.151**	−0.159*	−0.111	0.074	−0.176***	−0.133	−0.179***	0.0909
	(0.068)	(0.086)	(0.070)	(0.136)	(0.053)	(0.091)	(0.057)	(0.142)
l^2	0.002	0.008	−0.004	−0.032*	0.005	0.001	0.005	−0.035*
	(0.009)	(0.013)	(0.009)	(0.018)	(0.007)	(0.013)	(0.008)	(0.019)
$energy$	0.762	5.501*	0.537	4.779*	−0.259	−2.933**	0.156	−2.154
	(0.554)	(2.659)	(0.538)	(2.586)	(0.494)	(1.147)	(0.512)	(1.913)
$\mathcal{HHI}^{-1}_{domestic}$	−0.000	−0.001	−0.001	0.000	0.000	−0.000	0.000	−0.000
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.005)	(0.000)	(0.005)
Constant	−2.518***	−0.327	−2.897***	−0.795	−0.096	0.142	−1.391	−2.151***
	(0.734)	(0.782)	(0.741)	(0.541)	(0.700)	(0.613)	(0.952)	(0.603)
Entrants and exiters dummies	✓	✓	✓	✓	✓	✓	✓	✓
Sectoral dummies					✓	✓	✓	✓
Observations	41314	8111	33203	6067	41314	8111	33203	6067
R-squared	0.220	0.261	0.288	0.341	0.429	0.456	0.431	0.446

Note: the superscripts ***, ** and * denote the rejection of null about parameters' insignificance at 1%, 5% and 10% significance level, respectively. The expressions in round brackets stand for clustered standard errors.

D The potential effects of monopsony power and adjustment costs

We decided to use labor as variable production factor for the basis of calculation of markups. As we argue in the main text it is motivated by long-run trends that may affect the demand for other production factors, like outsourcing. Still, it is possible that firm's monopsony power or labor adjustment costs may affect markup estimates. To see how are it affects markup estimates, consider a Lagrangian associated with a firm's cost minimization problem under monopsony:

$$\mathcal{L}(V_{it}, K_{it}, \Lambda_{it}) = P^V_{it}(V_{it})V_{it} + r_{it}K_{it} - \Lambda_{it}(Q(\cdot) - Q_{it}), \tag{D.11}$$

with a f.o.c. with respect to a factor V:

$$\frac{\partial P^V_{it}(V_{it})}{\partial V_{it}} V_{it} + P^V_{it} = \Lambda_{it} \frac{\partial Q(\cdot)}{\partial V_{it}}. \tag{D.12}$$

When you define $\frac{\partial P^V_{it}(V_{it})}{\partial V_{it}} \frac{V_{it}}{P^V_{it}} \equiv \eta_{it}$ as an elasticity of input price w.r.t. quantity demanded (the measure of monopsony power) then using the same definition of markup as before: $\mu_{it} = P_{it}/\Lambda_{it}$ the equation (D.12) can be rearranged as:

$$\mu_{it} = \theta^V_{it} \left(\frac{P^V_{it} V_{it}}{P_{it} Q_{it}} \right)^{-1} (1 + \eta_{it})^{-1}. \tag{D.13}$$

If we, instead, assume that firms face some adjustments costs $\Phi(V_{it})$ in the production factor of interest and we define $\phi_{it} \equiv \frac{\partial \Phi(V_{it})}{\partial V_{it}} \frac{V_{it}}{Q_{it}}$ as an adjustment costs elasticity, then the resulting equation for μ_{it} becomes:

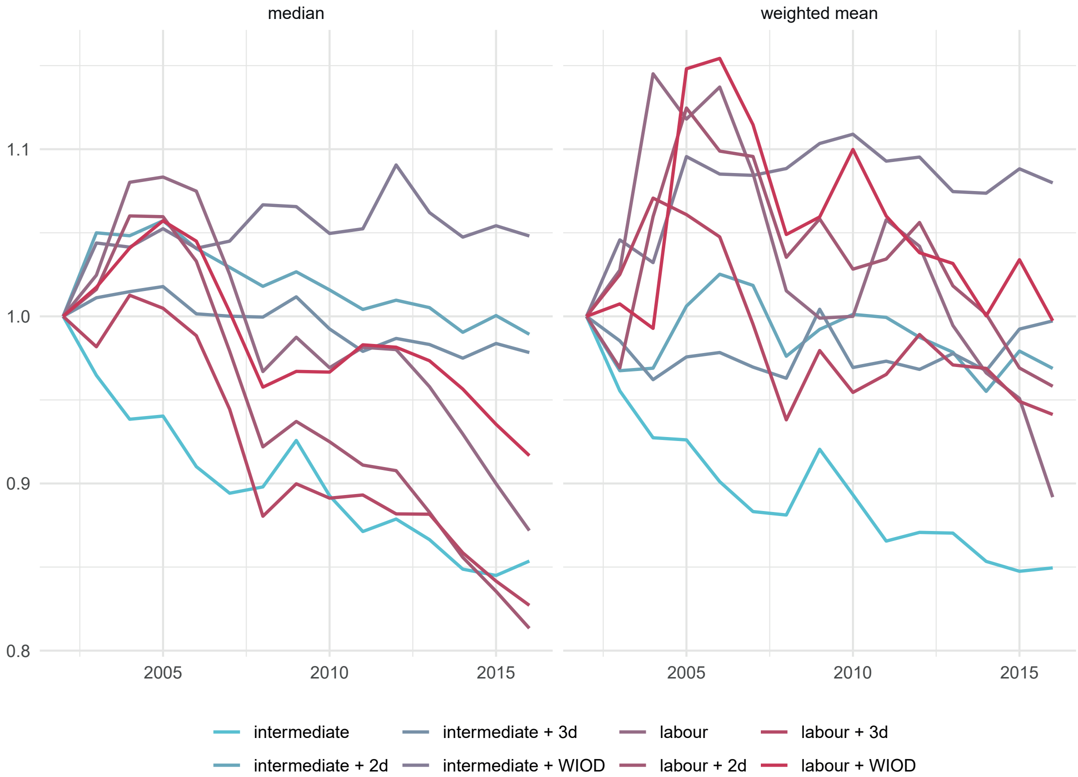
$$\mu_{it} = \theta^V_{it} \left(\frac{P^V_{it} V_{it}}{P_{it} Q_{it}} + \phi_{it} \frac{\Phi(V_{it})}{P_{it} Q_{it}} \right)^{-1}. \tag{D.14}$$

It follows that by ignoring potential monopsony power of the presence of adjustment costs we are overestimating the markup. Simultaneously, if our results on the fall of markups are to be governed by frictions in the labor market, frictions need to increase during our sample period. However, during this time demography was deteriorating, the number of firms rising and employment was on a long-run increasing tendency, which exerted rather an upward pressure on markups. We are not aware of any literature measuring changes in labor market frictions in Poland.

Even if it is indeed the case that the fall of markups is due to increasing labor market frictions, it is highly implausible that changes in labor market frictions are related to changes in frictions in intermediates (both materials and outsourcing as the relative demand for outsourced serviced increased in the Polish enterprise sector). To check for this possibility we estimated production function for the global output and measured the markup using estimated elasticity and factor share either for intermediates or labor inputs. Figure (D.1) shows the resulting estimates of markups (normalized to 1 in 2002), calculated for four production function estimation strategies: with common translog parameters for whole sample, or estimated separately for two and three digits NACE and WIOD aggregation. It shows that the fall of markups, regardless if measure by median or weighted mean, is also present in the corresponding measure based on intermediates elasticity and factor share, although the magnitude of the fall is smaller.

In case of measures based on production function estimated for WIOD aggregations separately both the median and the weighted means of markups based on intermediates actually rise, but in this case the sample used is significantly smaller, due to reasons discussed in the main text.

Figure D.1: Median markups based on labor and intermediate input elasticities



E The WIOD industry classification & definition of variables

Figure E.2: Description of variables used in the study

Variable	Description
	MEASURED AT THE FIRM LEVEL
global output	Sales of products with change in inventories and value of production for internal purposes and profits realized on reselling goods and other operating revenues, deflated by corresponding national accounts deflator measured at 2-digit NACE sector.
intermediate consumption	Costs of materials, outsourcing and other operational costs, deflated by corresponding national accounts deflator measured at 2-digit NACE sector.
value added	Global output less intermediate consumption.
employment	The number of employees in full time equivalent.
capital	The beginning of period book value of fixed assets: buildings, machinery and vehicles. Deflated by capital prices measured at 1-digit NACE sector and at asset type, constructed from fixed asset valuation for current and previous year prices.
outsourcing	The share of nominal outsourcing costs in nominal intermediate consumption.
energy	The share of nominal energy costs in nominal intermediate consumption.
	MEASURED AT THE INDUSTRY LEVEL
$\mathcal{UPS}$	the upstreamness index measuring the average distance of a given sector to final demand; calculated with the method proposed by (Antras, Chor, Fally, and Hillberry, 2012)
$\mathcal{FVAX}$	the foreign value added in exports/ import content of export; calculated with the method proposed by (Wang, Wei, and Zhu, 2013)
$\mathcal{HHI}^{-1}_{total}$	Inverted Herfindahl-Hirschman index for total sales – the number of symmetric firms present on both domestic and export market.
$\mathcal{HHI}^{-1}_{domestic}$	Inverted Herfindahl-Hirschman index for domestic sales – the number of symmetric firms present on domestic market.
$\mathcal{HHI}^{-1}_{export}$	Inverted Herfindahl-Hirschman index for exports – the number of symmetric firms present on export market.
exit	the ratio of firms existing in preceding year and exiting from the sample to a total number of firms.
entry	the fraction of firms non-existing in preceding year and entering the sample to a total number of firms.

Table E.2: Industry classification based on the WIOD database

Industry	Description
A01	Crop and animal production, hunting and related service activities
A02	Forestry and logging
A03	Fishing and aquaculture
B	Mining and quarrying
C10-C12	Manufacture of food products, beverages and tobacco products
C13-C15	Manufacture of textiles, wearing apparel and leather products
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
C17	Manufacture of paper and paper products
C18	Printing and reproduction of recorded media
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C23	Manufacture of other non-metallic mineral products
C24	Manufacture of basic metals
C25	Manufacture of fabricated metal products, except machinery and equipment
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
C29	Manufacture of motor vehicles, trailers and semi-trailers
C30	Manufacture of other transport equipment
C31_C32	Manufacture of furniture; other manufacturing
C33	Repair and installation of machinery and equipment
D35	Electricity, gas, steam and air conditioning supply
E36	Water collection, treatment and supply
E37-E39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services
F	Construction
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
G46	Wholesale trade, except of motor vehicles and motorcycles
G47	Retail trade, except of motor vehicles and motorcycles
H49	Land transport and transport via pipelines
H50	Water transport
H51	Air transport
H52	Warehousing and support activities for transportation
H53	Postal and courier activities
I	Accommodation and food service activities
J58	Publishing activities
J59_J60	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities
J61	Telecommunications
J62_J63	Computer programming, consultancy and related activities; information service activities
K64	Financial service activities, except insurance and pension funding
K65	Insurance, reinsurance and pension funding, except compulsory social security
K66	Activities auxiliary to financial services and insurance activities
L68	Real estate activities
M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities
M71	Architectural and engineering activities; technical testing and analysis
M72	Scientific research and development
M73	Advertising and market research
M74_M75	Other professional, scientific and technical activities; veterinary activities
N	Administrative and support service activities
O84	Public administration and defence; compulsory social security
P85	Education
Q	Human health and social work activities
R_S	Other service activities
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	Activities of extraterritorial organizations and bodies

Note: based on the 2016 release of the World Input Output Database (WIOD, Timmer, Dietzenbacher, Los, Stehrer, and de Vries, 2015).

Table E.3: Aggregate markups and markups at the industry level – detailed data

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Aggregate series															
median	1.526	1.541	1.558	1.558	1.496	1.408	1.341	1.411	1.355	1.344	1.348	1.339	1.300	1.269	1.242
mean	1.677	1.702	1.739	1.760	1.707	1.635	1.557	1.643	1.581	1.562	1.567	1.546	1.515	1.504	1.491
weighted mean	1.788	1.773	1.891	1.917	1.852	1.749	1.587	1.698	1.598	1.615	1.612	1.604	1.561	1.590	1.553
The one-digit NACE industries (weighted mean)															
B	0.942	1.000	1.011	1.094	1.187	1.252	1.208	1.341	1.721	1.835	1.928	1.750	1.748	1.719	1.967
C	1.974	2.072	2.225	2.176	2.091	1.921	1.657	1.786	1.605	1.682	1.657	1.612	1.609	1.666	1.627
D	3.157	2.976	3.207	2.871	2.728	2.905	2.050	2.300	1.846	1.617	1.701	1.872	1.925	2.411	2.320
E	1.680	1.904	1.951	1.898	1.925	2.027	2.129	2.187	2.265	2.379	2.436	2.542	2.580	2.570	2.804
F	1.688	1.682	1.885	1.936	1.891	1.830	1.920	2.020	1.940	1.875	1.852	1.852	1.847	1.790	1.692
G	1.475	1.403	1.427	1.489	1.444	1.362	1.281	1.370	1.390	1.414	1.418	1.446	1.327	1.271	1.219
H	1.635	1.678	1.856	1.965	1.993	2.011	2.110	2.546	2.360	2.311	2.414	2.382	2.539	2.728	2.822
I	1.517	1.652	1.620	1.741	1.689	1.636	1.733	1.868	1.898	1.941	1.855	1.805	1.705	1.695	1.668
J	1.071	1.085	1.085	2.354	2.292	2.187	2.080	2.046	1.959	1.787	1.641	1.466	1.339	1.381	1.350
L	2.430	2.416	2.451	2.601	2.426	2.469	2.715	2.257	2.120	2.150	2.198	1.908	1.673	1.516	1.456
M	1.018	0.984	1.007	1.026	0.981	0.913	0.956	0.865	0.815	0.858	0.914	0.994	1.106	1.017	0.910
N	1.314	1.381	1.261	1.278	1.331	1.293	1.319	1.300	1.387	1.271	1.327	1.325	1.242	1.243	1.257
P	0.951	0.804	0.799	0.757	0.830	0.842	0.879	1.081	0.921	1.014	1.144	1.167	1.182	1.227	1.342
Q	1.154	0.937	0.951	0.901	0.832	0.744	0.724	0.674	0.680	0.667	0.644	0.651	0.645	0.617	0.596
R	2.230	2.211	4.026	1.697	2.753	2.592	3.120	4.108	3.181	3.370	2.172	2.725	2.317	2.986	3.462
S	1.715	2.149	1.778	2.079	1.659	1.615	1.743	1.521	1.601	1.850	1.640	1.407	1.500	1.455	1.301
Selected manufacturing industries (weighted mean)															
C10-C12	1.579	1.433	1.434	1.279	1.248	1.107	1.088	1.303	1.283	1.210	1.265	1.200	1.215	1.193	1.145
C13-C15	1.975	2.345	2.299	2.232	2.178	2.068	1.926	1.967	1.775	1.804	1.857	1.841	1.759	1.706	1.668
C16	2.451	2.581	2.793	2.649	2.560	2.523	2.021	2.283	2.310	2.125	2.229	2.310	2.351	2.317	2.279
C17	2.735	2.802	2.524	2.346	2.322	2.228	1.899	1.997	1.964	2.065	2.014	1.971	2.156	2.315	2.403
C18	2.156	2.291	2.362	2.599	2.431	2.038	1.912	1.895	1.645	1.687	1.653	1.579	1.542	1.492	1.448
C20	2.669	2.653	2.808	2.510	2.645	2.494	2.530	2.392	2.690	3.062	2.879	2.825	2.810	2.831	2.647
C21	1.372	1.342	1.405	1.355	1.349	1.277	1.346	1.226	1.314	1.448	1.559	1.600	1.570	1.707	1.698
C22	2.107	2.345	2.307	2.232	2.184	2.093	1.921	2.250	2.043	2.082	2.100	2.125	2.026	1.979	1.957
C23	1.981	2.366	2.276	2.132	2.040	2.196	2.021	1.953	1.560	1.469	1.433	1.370	1.307	1.255	1.212
C24	2.429	2.270	3.466	3.507	3.839	4.382	2.992	2.261	2.104	2.866	2.702	2.857	2.995	3.269	3.131
C25	1.728	1.905	1.836	1.846	1.574	1.403	1.330	1.580	1.415	1.329	1.359	1.315	1.263	1.228	1.182
C26	2.461	2.068	1.816	1.549	1.416	0.899	0.854	1.349	0.745	0.697	0.725	0.659	0.667	0.763	0.706
C27	2.157	2.348	2.133	2.183	2.004	1.686	1.407	1.540	1.152	0.990	0.937	0.872	0.844	0.835	0.804
C28	1.608	1.778	1.698	1.788	1.673	1.436	1.123	1.320	1.207	1.042	1.021	1.015	1.052	1.124	1.112
C29	2.667	2.896	3.508	3.572	2.993	2.358	1.927	2.316	1.807	1.983	1.941	1.736	1.666	1.828	1.856
C30	1.445	1.645	1.723	2.660	2.863	2.377	1.849	2.631	2.173	2.159	2.206	2.344	2.912	3.579	3.874
C31_C32	2.192	2.483	2.122	2.313	2.015	1.783	1.563	1.877	1.536	1.490	1.378	1.398	1.443	1.438	1.485
C33	1.078	1.315	1.333	1.374	1.229	1.145	1.181	1.063	1.122	1.130	1.262	1.165	1.231	1.198	1.220

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