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Marktmacht – Aanvullingen

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Inhoudsopgave

KTO "Markmacht – Aanvullingen" – Samenvatting

Motivering

El Gallaa en Reynaerts (2017, STORE-17-015) brengen het verband tussen geografische locatie en de omvang van marktmacht in kaart en besluiten dat zodra de onderlinge verschillen in productiviteit in rekening worden gebracht, bedrijven gevestigd in Wallonië hogere markups kennen dan vergelijkbare bedrijven in het Brussels hoofdstedelijk gewest en dat het verschil met Vlaamse ondernemingen niet langer statistisch significant is. Dit rapport brengt als aanvulling op de eerdere studie verslag uit van de invloed van een reeks van robuustheidscontroles op de initiële bevindingen. Deze omvatten o.m. (*i*) het buiten beschouwing laten van afwijkende waarden in bepaalde verklarende variabelen, (*ii*) het gebruik van de translog productiefunctie die de geobserveerde heterogeniteit tussen bedrijven (in termen van omzet, gebruik van intermediaire goederen, etc.) vertaalt in bedrijfs- en tijdsspecifieke outputelasticiteiten, en (*iii*) de beperking van de steekproef tot enerzijds bedrijven actief in de maakindustrie en anderzijds bedrijven met één enkele vestiging.

Methodologie

De gehanteerde benadering gaat nog steeds uit van een individuele productiefunctie om bedrijfsspecifieke markups te schatten zoals voorgesteld door o.a. Hall (1986), De Loecker (2011) en De Loecker en Warzynski (2012). De bedrijfsspecifieke markup wordt m.a.w. In eerste instantie nog steeds berekend als

$$\mu_{it} = \theta_{it}^{X} \frac{P_{it}^{X} X_{it}}{P_{it} Q_{it}},$$

waarbij in dit rapport de nadruk ligt op de manier waarop θ_{it}^{X}, de elasticiteit van de productie ten opzichte van de input X_{it} (de percentsgewijze toename in de geproduceerde hoeveelheid naar aanleiding van een toename van de input met 1%) berekend wordt en welke gevolgen dit heeft voor de resultaten van de regressie-analyse. Voor een Cobb-Douglas productiefunctie[1] $Q_i = AL_i^{\beta_l} K_i^{\beta_k} M_i^{\beta_m}$ zijn de inputelasticiteiten per definitie immers gelijk aan de respectievelijke

[1] Dit is de gehanteerde functionele vorm voor productie in de voorgaande studie; de interpretatie is dat een onderneming i een welbepaalde productie Q_i genereert door de inzet van bepaalde hoeveelheden arbeid L_i, kapitaal K_i en materialen M_i,.

exponenten β_l, β_k en β_m en kunnen deze bekomen worden door de schatting van coëfficiënten van de volgende empirische specificatie, m.n.

$$q_{it} = \beta_0 + \beta_l\, l_{it} + \beta_k\, k_{it} + \beta_m m_{it} + \omega_{it} + \varepsilon_{it}.$$

Kenmerkend is dat de aldus geschatte outputelasticiteit van materialen, $\hat{\theta}_{it}^m = \hat{\beta}_m$, *dezelfde* is voor alle ondernemingen en bovendien constant in de tijd. Verschillen in de geschatte markup op ondernemingsniveau, $\hat{\mu}_{it}^m = \frac{\hat{\theta}_{it}^m}{\alpha_{it}^m}$, zijn daarom enkel toe te wijzen aan de verschillen tussen bedrijven in de noemer van de voorgaande uitdrukking: deze noemer, α_{it}^m, is het aandeel van de uitgaven aan materialen ten opzichte van de bedrijfsomzet die uit de boekhoudkundige gegevens wordt gepuurd.

Uitgaande van een translog (TL) productiefunctie, met empirische specificatie

$$q_{it} = \beta_0 + \beta_l\, l_{it} + \beta_k\, k_{it} + \beta_m m_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_m m_{it}^2 + \beta_{lk}\, l_{it} k_{it} + \beta_{km}\, k_{it} m_{it} + \beta_{lm} l_{it} m_{it} + \beta_{lkm} l_{it} k_{it}\, m_{it} + \omega_{it} + \varepsilon_{it},$$

is de geschatte outputelasticiteit van materialen daarentegen

$$\hat{\theta}_{it}^m = \hat{\beta}_m + 2\hat{\beta}_{mm} m_{it} + \hat{\beta}_{ml} l_{it} + \hat{\beta}_{km} k_{it} + \hat{\beta}_{lkm}\, l_{it} k_{it},$$

en deze is door het optreden van de ingezette hoeveelheden arbeid, kapitaal en materialen in de voorgaande vergelijking zowel bedrijfsspecifiek als tijdsafhankelijk. Meer algemeen is de TL specificatie (die CD omvat als bijzonder geval) beter in staat om de ongekende productietechnologieën van bedrijven te benaderen. De prijs die de onderzoeker betaalt voor dit meer flexibel uitgangspunt omvat o.m. een toegenomen computationele kost: TL modellen zijn moeilijker te schatten (o.a. door convergentieproblemen bij de minimalisatie van de objectieffunctie) en vergen een behoorlijke rekenkracht (o.m. om de correcte standaardfouten via bootstrapping te berekenen).

De TL-gebaseerde markups worden in tweede instantie in verband gebracht met de geografische locatie van de overeenkomstige ondernemingen volgens dezelfde regressiebenadering als het initiële rapport; deze methodologie wordt hier daarom niet verder besproken.

Beschrijving van de gegevens

De benodigde boekhoudkundige gegevens voor de uitvoering van deze studie werden conform de voorgaande studie gepuurd uit de Bel-first databank van Bureau van Dijk en vervolgens gekoppeld aan de gegevens van de Rijksdienst voor Sociale Zekerheid (RSZ) die informatie vervat over de tewerkstelling in de afzonderlijke vestigingen van de ondernemingen. Deze vestigingen, geïdentificeerd via het vestigingsnummer, werden aan de moederbedrijven gekoppeld via de informatie hernomen in de Kruispuntbank Ondernemingen (KBO), in het bijzonder via het KBO nummer. De resulterende niet-gebalanceerde longitudinale steekproef bevat 53.185 bedrijven over de periode 2005-2015, in totaal goed voor 308.965 bedrijf-jaar waarnemingen. De variabelen hernemen de omzet, toegevoegde waarde, aantal werknemers in voltijdse equivalenten (VTE), materiële vaste activa, kost van materialen en de loonmassa. De steekproef herneemt enkel waarnemingen die voor alle voorgaande variabelen waarden laten optekenen, dit om de schattingen van productiviteit op het ondernemingsniveau in de eerste stap van de hierboven beschreven methode te kunnen uitvoeren.

Bevindingen

De hoofdbevinding van deze aanvullende TL-gebaseerde studie is dat regionale verschillen in marktmacht verdwijnen zodra de inherente verschillen in productiviteit tussen bedrijven in rekening worden gebracht. De implicatie is bijgevolg dat productiviteitsverschillen de drijvende kracht vormen achter verschillen in markups en niet locatie. Deze bevinding blijft ongewijzigd indien de steekproef beperkt wordt tot de maakindustrie of tot bedrijven met één vestiging.

De replicatie van de initiële CD-benadering op basis van dezelfde steekproef levert de volgende resultaten op: ten eerste wordt het vorige resultaat dat bedrijven in Wallonië een hogere markup kennen (na controle voor productiviteit) bevestigd, ook indien de steekproef beperkt wordt tot bedrijven met één vestiging. Deze “premie” in de markup kan toegeschreven worden aan niet-waargenomen factoren zoals inkomen, de prijselasticiteit van de vraag, consumentenvoorkeuren of andere factoren die via prijsverschillen aanleiding geven tot verschillen in markups. Ten tweede, wanneer de steekproef beperkt wordt tot de maakindustrie, stellen we vast dat Vlaamse bedrijven lagere markups kennen dan gelijkaardige bedrijven in Brussel. Een mogelijke verklaring hiervoor ligt in het feit dat Vlaanderen in het algemeen meer bedrijven in de maakindustrie telt dan de overige gewesten en dat dit hoger aantal een neerwaartse competitieve druk uitoefent op hun marktmacht.

In het licht van de voorgaande vaststellingen kunnen daarom de volgende onderwerpen verder onderzocht worden en als dusdanig deel uitmaken van het langere termijnonderzoek van het Steunpunt Economie en Ondernemen: (*i*) de mate waarin regionale verschillen resulteren in productiviteitsverschillen tussen ondernemingen; (*ii*) de invloed van vraaggebonden en andere (institutionele, politieke, …) factoren die wegens de beperkte opzet van deze studie niet aan bod kwamen, en (*iii*) de (regionale) evolutie van bedrijfsprestaties (productiviteit, markups, …) over de tijd die toelaat om economische tendensen te identificeren en analyseren.

1. Introduction

This report is a follow-up to the study by El Gallaa and Reynaerts (2017, STORE-17-015) that verifies whether and to what extent firm-level *market power* differs by regions in Belgium. In that study, market power–defined as the ratio of the per unit product price over the per unit cost of production–is first estimated using annual accounts data and then regressed on a geographical firm location indicator. The findings suggest Walloon firms to have a markup that is on average 5% higher than markups of comparable firms in the Brussels-Capital region; the result for Flemish firms was not statistically different from zero.

When estimating firm markups, the underlying assumption was that a firm's production technology could be described by the commonly known Cobb-Douglas production function. The resulting *output elasticity* of a variable input needed to compute markup estimates,[2] is constant across firms and over time. While simple in estimation, this assumption does not necessarily agree with the observed differences in firm performance. Reflecting these substantial differences between firms in terms of size, sales, investment, markups, productivity, and other variables, this report adopts a more flexible functional form for the underlying production function and assumes that the firm production function is a so-called *translog* production function. As such, the analysis makes an explicit tradeoff between benefits (increased *realism*: the resulting output elasticity in this case is firm-specific and varies over time) and costs (computational: the parameters of the translog production function are more difficult to estimate; research: interpretation is less clear; data: not all sectors lend themselves …). In what follows, we succinctly describe the changes in both data and methodology and also report some of the remaining issues that could not be dealt with, either due to lack of time or absence of the required data.

First, output and location data used in this report are the same; updates are documented in the data description section. The descriptive statistics of both production and location remain unchanged. Second, as in the previous report, we first

[2] The output elasticity of an input is defined as the percentage increase in output following a one percent increase in the corresponding input.

estimate the firm-level production function (sector-by-sector) and then back out the corresponding firm-level markups. Assuming a translog production function, we face a trade-off between firm-specific output elasticities on the one hand and introducing a bias coming from unobserved prices on the other. However, as this bias only affects the *level* of the markup (markups are underestimated), it does not affect the relation between location and markups. In a third step we regress the markup estimates on a location indicator to verify whether markups for firms in Flanders and Wallonia differ from markups in the Brussels-capital region. This regression framework assesses average markup differences across firms conditional on firm-specific characteristics such as firm size, capacity, age and productivity.

Based on the new translog-based markups, we find that there is neither an economically nor a statistically significant difference in markups between firms located in Flanders or Wallonia and firms located in Brussels-capital region. This result also holds when restricting the sample to single-plant firms, i.e. firms that are not affected by the allocation rule of physical activity for multi-plant firms.[3]

The remainder of this report is organized as follows. Section 2 first introduces the translog production specification and describes the methodology used to estimate firm-level markups. Assumptions as well as issues underlying this application are discussed. Section 3 describes the production as well the location data, in particular the differences with respect to the original data set. Section 4 presents the results of the regression framework. Section 5 concludes.

[3] Recall that this rule assigns a multi-plant firm to the region that accounts for its largest share in labor.

2. Methodological approach

2.1. Estimation of markups

In the previous report we covered the idea behind the markup as the wedge between the output elasticity of a variable input and its expenditure share in revenues. We closely followed the empirical procedure of De Loecker and Warzynski (2012) to (*i*) estimate the coefficients of the production function and the resulting output elasticity, and (*ii*) compute firm-level markups. Specifically, to compute markups, a variable input is required that is free of adjustment costs. As in the previous report, we consider material inputs: these inputs are less subjected to the kind of adjustment costs that firms face when varying labor (for example hiring and firing costs).

The previous set of results were based on the assumption that firms in the same industry follow a Cobb-Douglas (CD) production function with three inputs, i.e. labor, capital, and materials:

$$s_{it} = \beta_0 + \beta_l\, l_{it} + \beta_k\, k_{it} + \beta_m m_{it} + \omega_{it} + \varepsilon_{it}.$$

In the CD specification, s_{it} denotes the (log of sales) of firm *i* at time *t*, l_{it} is (the log of) the number of employees, k_{it} is (the log of) physical capital, m_{it} is (the log of) materials, and ω_{it} is unobserved productivity (known to the firm but not to the researcher). Furthermore, ε_{it} is a zero-mean production shock, and $\beta = (\beta_0, \beta_l, \beta_k, \beta_m)$ is the set of technology parameters common to firms in the same industry. This specification yields an output elasticity of materials $\hat{\theta}_{it}^m = \hat{\beta}_m$ that is constant over time and across firms and produces the markup estimate as $\hat{\mu}_{it}^m = \frac{\hat{\beta}_m}{\alpha_{it}^m}$. Because the material input coefficient $\hat{\beta}_m$ is the same for all firms in the same 2-digit industry, we clearly see that variations in markups are simply the variations of the inverse of the material inputs share, α_{it}^m.

Relaxing the assumption of a CD production function, with the more flexible translog production function firms in the same industry produce output according to the following specification:

$$\begin{aligned} s_{it} = {} & \beta_0 + \beta_l\, l_{it} + \beta_k\, k_{it} + \beta_m m_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_m m_{it}^2 + \beta_{lk}\, l_{it} k_{it} + \beta_{km}\, k_{it} m_{it} \\ & + \beta_{lm} l_{it} m_{it} + \beta_{lkm} l_{it} k_{it}\, m_{it} + \omega_{it} + \varepsilon_{it} \end{aligned}$$

The output elasticity of materials based on this specification is the following:

$$\hat{\theta}_{it}^{m} = \hat{\beta}_m + 2\hat{\beta}_{mm} m_{it} + \hat{\beta}_{ml} l_{it} + \hat{\beta}_{km} k_{it} + \hat{\beta}_{lkm} l_{it} k_{it},$$

is firm-specific and varies over time as it also depends on the firm- and time-specific choices of materials, labor and capital. Hence, we allow firm size to affect the elasticity and the resulting markup estimate. The variations of markups in this case reflect both the variations of the materials share (in the denominator) as well as their output elasticity (in the numerator). Note that the translog specification embeds the CD specification as a special case when we restrict the higher-order terms and the interaction terms to be zero.

Given the estimate of the firm-specific output elasticity of materials, the markup of firm i at time t is computed as $\hat{\mu}_{it}^{m} = \frac{\hat{\theta}_{it}^{m}}{\alpha_{it}^{m}}$, where $\hat{\theta}_{it}^{m}$ is the estimate of the output elasticity of materials and α_{it}^{m} is the expenditure share of materials in revenues obtained from accounting data.

2.2. Main assumption underlying markup estimation

The maintained assumption underlying markup estimation in this follow-up is that firms located in different regions might face different input prices for reasons related to the prevailing heterogeneity in the economic environment of firms such as: differences in number of firms, labor productivity, unemployment rate, and other factors. Hence, we assume that location differences affect input prices, which in turn affects firms' optimal input demand.

Firm-level productivity (ω_{it}) is typically unobserved, hence we proxy it via firms' material inputs. We thus assume that more productive firms have higher demand for material inputs (keeping physical capital and technology fixed). From an econometric perspective, this implies that in estimation of the translog (or CD) production function, in addition to labor, capital, materials, the wage bill, and their interactions, we also

include location dummies (Flanders and Wallonia relative to Brussels-capital) in the polynomial to proxy for productivity.[4]

$$\omega_{it} = h_l(l_{it}, k_{it}, m_{it}, wb_{it}, Flanders_i, Wallonia_i)$$

3. Data description

In this update we use the same data sources on firm activities and location to construct our sample of firms. However, a couple of elements in the construction of the sample are warranted given that they result into a drop in the number of observations used. In the previous report, the number of firms was 58,928 (corresponding with a total of 334,058 firm-year observations). For the TL specification however, a sufficiently large number of observations are required to identify the coefficients of the underlying production function. This implies that in this analysis industries are removed where the number of observations is too low. In addition, we restrict the sample to firms operating in the private economy, meaning that all firms operating in NACE 2-digit sectors above 82 are dropped. The next subsections present detailed data description and descriptive statistics of the data at hand as well as the results for the ensuing firm-level markup estimates based on this new sample of firms.

3.1. Construction of the sample

The resulting dataset in this study is an unbalanced panel of 53,185 firms (308,965 firm-year observations) spanning the years 2005-2015, and belong to the NACE 2-digit industries 01 to 82. The dataset is constructed extracting information form three sources: (*i*) the Belfirst database which provides company accounts, (*ii*) the KBO database which provides information on the number of plants owned by each firm, and (*iii*) the RSZ database which provides information on the number of employees at each location (plant). The three sources are merged using the kbo number, which is the unique identifier for each firm.

[4] This is the step that yields unbiased estimated of the coefficients of the production function, see Ackerberg, Caves and Frazer (2015) for a discussion.

3.1.1. Firm accounting data

Firm-level information on turnover, value added, number of employees (in full time equivalents, FTE), tangible fixed assets, material costs and the wage bill is extracted from the Belfirst dataset. The sample is limited to firms that report positive values for these variables. We need industry-specific deflators to remove price variations from turnover and input expenditures. However, we do not have industry-specific deflators that cover the entire sample period, and instead remove output and input price variation using time dummies in the estimation of production function[5].

As mentioned above, the estimation of the TL specification for the production function at the NACE 2-digit industry level, requires a sufficiently large number of observations at this level of aggregation. Industries 03, 05, and 09 (with 47, 8, and 14 observations respectively) are omitted due to a low number of observations. Moreover, firms that shift between industries over the sample period are assigned to the industry that was most frequently observed. In case of a tie (industries are observed with equal frequency), firms are assigned to the most recent industry. We keep only firms who report at least two consecutive periods in time.

3.1.2. Location data and the allocation rule

The KBO and the RSZ databases enable us to distinguish between single-plant and multi-plant firms. A single-plant firm is a firm that owns one establishment located in a certain region in a given year, while a multi-plant firm owns more than one establishment. The establishments of a multi-plant firm can be located in the same or in a different region for any given year. Single-plant firms typically have the same location as their headquarters (NUTS-1: Brussels, Flanders, Wallonia, or abroad). When the location of a single-plant is abroad or unknown we use its ZIP-code (postal code) information to designate it to a certain region.

Since headquarters not always correspond with the physical location of economic activity for multi-plant firms, headquarter location is not suited to assess the relation

[5] According to De Loecker and Goldberg (2014) deflators or time dummies in the production function are both ways to remove price variation from turnover and input expenditures.

between markups and location. To address this issue, we exploit the information on the number of plants as well as the number of employees in each plant provided by KBO and RSZ. Hence, a multi-plant firm is assigned to the region that accounts for the largest share of firm employment. For example, a multi-plant firm will be located in Flanders if the share of employment of the plant(s) in Flanders is higher than the share of employment of its plant(s) in Brussels and Wallonia.

Most multi-plant firms have their highest employment consistently in one region; thus, they are located in the same region throughout the sample period. However, a handful of multi-plant firms reallocate labor across regions over the sample period (different regions have the highest share of employment in different years). We assign these firms to be located in the region with the highest employment share in the latest year observed.

Finally, a small number of single-plant firms expand to become multi-plant firms, and a small number of multi-plant firms close down plants and become single-plant firms; an even smaller number of firms expand and shrink activity throughout the sample period. Firms that fall in these categories are also assigned to their latest observed location with (highest) employment. The following tables provide descriptive statistics of the number of firms, single-plant and multi-plant firms, by year and region.

3.2. Descriptive statistics

In this section we report descriptive statistics on the accounting and location data used to answer the research question. The following tables highlight average differences between firms in terms of sales, size, age, and input use. We later present the regional differences in the number of firms operating in the Belgian private economy.

3.2.1. Accounting data

Tables 1, 2, 3 and 4 present descriptive statistics of firm turnover, input expenditures and age in the private economy and across regions. Table 1 shows that the average firm in this sample hires 40 employees, while the median firm has 5 employees. Firms are on average mature (the average age of the firm is 20 and the median is 17 years old). This

implies that this sample of firms covers mainly medium-size and large firms and mature/old firms. This is a limitation caused by the under-reporting of information on turnover and materials by small- and medium-sized firms (SMEs).

Table 1: Firm turnover and input expenditure in the sample of Belgian firms

Variables	Mean	Median	Std. Dev.
Turnover	20954.54	1512.169	277607.4
Number of employees (FTE)	40.97282	5.35	377.2064
Tangible fixed assests	3509.416	164.171	40827.93
Materials costs	17662.36	988.805	267185.5
Wage bill	2608.359	256.663	21946.08
Age	20	17	16

Note: Total number of observations is 308,965. All nominal variables are expressed in thousands of Euros

Turning to the regional differences, the average firm in Brussels has 39 employees (median 3), while the average firm in Flanders and Wallonia hires 52 employees (median 8), and 23 employees (median 3) respectively. The average age of a firm in Flanders is 21, while the average age of firms Brussels-capital and Wallonia is similar.

Table 2: Firm turnover and input expenditures in the Brussels-capital region

Variables	Mean	Median	Std. Dev.
Turnover	23365.05	877.66	379683.5
Number of employees (FTE)	39.18216	3.42	578.0837
Tangible fixed assests	4437.878	53.681	62821.37
Materials costs	19394.65	591.302	366741.5
Wage bill	2820.219	152.413	34642.02
Age	19	15	17

Note: Total number of observations is 45,239. All nominal variables are expressed in thousands of Euros

Table 3: Firm turnover and input expenditure in the Flemish region

Variables	Mean	Median	Std. Dev.
Turnover	27315.87	3047.977	319509.3
Number of employees (FTE)	51.67314	8.19	405.5372
Tangible fixed assests	4098.194	261.547	40938.49
Materials costs	23278.08	1985	307608.8
Wage bill	3237.037	459.084	22583.44
Age	21	18	16

Note: Total number of observations is 166,727. All nominal variables are expressed in thousands of Euros

Table 4: Firms' turnover and inputs expenditures in the Walloon region

Variables	Mean	Median	Std. Dev.
Turnover	8896.128	774.035	50518.85
Number of employees (FTE)	23.41568	3.5	119.0269
Tangible fixed assests	2064.369	118.927	24190.21
Materials costs	7201.845	521.093	43045.53
Wage bill	1428.946	132.447	9782.633
Age	18	15	15

Note: Total number of observations is 96,999. All nominal variables are expressed in thousands of Euros

3.2.2. Location data

Table 5 presents the number of firms in the dataset for every year in the sample period 2005-2015. The number of firms is consistent over the period up to 2013, when it starts to progressively decline. The Belgian economy seems to mainly contain single-plant firms who outnumber the multi-plant firms. The latter display a steady increase over the sample period.

Table 5: Number and type of firms by year

Year	Firms	Single-plant firms	Multi-plant firms
2005	25,942	24,383	1,559
2006	29,719	27,850	1,869
2007	30,258	28,317	1,941
2008	30,500	28,473	2,027
2009	29,590	27,554	2,036
2010	29,455	27,365	2,090
2011	31,017	29,039	1,978
2012	30,243	28,127	2,116
2013	26,326	23,753	2,573
2014	24,682	21,559	3,123
2015	21,233	18,244	2,989
Total	308,965	284,664	24,301

Table 6 presents the division of firms by region. The bulk of the number of firms, both single- and multi-plant firms, is located in Flanders; Wallonia and Brussels-Capital come in second and third position respectively. From these tables one is tempted to conclude that the bulk of economic activity is concentrated in the Flanders region.

Table 6: Number and type of firms by year and region

Year	Number of firms			Multi-plant firms			Single-plant firms		
	Brussels	Flanders	Wallonia	Brussels	Flanders	Wallonia	Brussels	Flanders	Wallonia
2005	3,749	14,145	8,048	198	968	393	3,551	13,177	7,655
2006	4,291	16,061	9,367	226	1,131	512	4,065	14,930	8,855
2007	4,379	16,315	9,564	222	1,181	538	4,157	15,134	9,026
2008	4,444	16,373	9,683	244	1,232	551	4,200	15,141	9,132
2009	4,350	15,796	9,444	243	1,223	570	4,107	14,573	8,874
2010	4,353	15,792	9,310	258	1,255	577	4,095	14,537	8,733
2011	4,531	16,649	9,837	234	1,212	532	4,297	15,437	9,305
2012	4,466	16,236	9,541	244	1,317	555	4,222	14,919	8,986
2013	3,985	14,126	8,215	289	1,599	685	3,696	12,527	7,530
2014	3,684	13,464	7,534	354	1,946	823	3,330	11,518	6,711
2015	3,007	11,770	6,456	333	1,847	809	2,674	9,923	5,647
Total	45,239	166,727	96,999	2,845	14,911	6,545	42,394	151,816	90,454

A characteristic common to both single- and multi-plant firms in this dataset is that their locations do not change over time. For example, if a multi-plant firm has the highest employment share in Flanders in 2005, this typically remains constant over time. However, a small number of single-plant firms relocate (shut down business in one region to open in another region in subsequent years) and some multi-plant firms reallocate labor throughout the sample period (different regions have highest employment shares over time). Table 7 presents the number of single-plant firms who relocate over time and the number of multi-plant firms who reallocate labor across regions during the period of observation.

Table 7: Number of multi-plant firms with changing regional share of employment or single-plant firms changing geographical location

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Multi-plant firms	14	18	17	19	19	18	15	13	15	14	15	177
Single-plant firms	11	7	10	8	9	7	11	10	8	8	6	95

3.3. Descriptive statistics of markup estimates by region

Table 8 shows the average and median markups for the entire private economy and across regions. The average markup in the Belgian private economy is 1.09 while the median is 1.02. Stated differently, on average Belgian firms set prices 2% above marginal cost. Interpreting the markup as a measure for anti-competitive behavior, this suggests that the Belgium is characterized by a low degree of market power.

Table 8: Descriptive statistics of markups by region

	Number of observations (1)	Mean (2)	Median (3)	Std. Dev. (4)
Entire economy	240,570	1.09	1.02	0.009
Brussels	337,220	1.10	1.03	0.012
Flanders	132,394	1.09	1.03	0.011
Wallonia	74,454	1.07	1.02	0.009

Note: For every NACE 2-digit industry, we remove outliers at the 1st and 99th percentile of the distribution of (the log of) markups. Column (1) shows the number of observations in the total sample of firms after estimating the markups, as well as the number of observations by region. The standard deviation around the average markup by region is obtained via block bootstrapping with 250 replications.

When it comes to the regional differences, the markups range between 1.07 and 1.10 on average. The average markup in the Brussels-capital region is 1.10, while it is 1.09 in Flanders and 1.07 for Wallonia. The median markups are similar. This confirms the low degree of market power observed in the aggregate economy. More importantly this doesn't suggest the presence of regional difference in average markups of firms located in the different regions.

3.4. Descriptive statistics of markup estimates by region and industry

We estimate the production function at the NACE 2-digit industry level. The dataset covers the industries 01-82 where sectors 10-33 relate to the manufacturing sector. We use the estimates of markups to investigate average markups differences across regions. Table 9 presents the average by NACE 2-digit industry and by region. All industries are present in each of the three regions; however, no firm located in the Brussels-capital region reports to be operating in the industries 19 (Manufacture of coke and refined

petroleum products) and 39 (Remediation activities and other waste management services). Since we do not have an official measure of concentration of activities by region, we restrict ourselves into saying that all sections of the economy are spread over the three regions.

Table 9: Average markup at the aggregate economy by industry and by region

NACE industry	Average markup			
	Aggregate (1)	Brussels (2)	Flanders (3)	Wallonia (4)
1 Crop and animal production	1.1 (0.12)	1.10	1.12	1.08
2 Forestry and logging	1.25 (0.95)	0.81	1.15	1.29
8 Other mining and quarrying	1.02 (0.12)	1.10	1.10	0.98
10 Manufacture of food products	1.06 (0.12)	1.05	1.06	1.06
11 Manufacture of beverages	1.22 (0.28)	1.36	1.20	1.25
12 Manufacture of tobacco products	1.04 (0.63)	1.31	1.03	1.00
13 Manufacture of textiles	1.04 (0.13)	1.00	1.04	1.02
14 Manufacture of wearing apparel	1.05 (1.56)	1.07	1.03	1.13
15 Manufacture of leather and related products	0.83 (1.05)	0.84	0.82	0.84
16 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1.09 (0.06)	1.04	1.09	1.08
17 Manufacture of paper and paper products	1.01 (0.59)	1.03	1.01	0.98

18 Printing and reproduction of recorded media	1.06 (0.03)	1.11	1.05	1.06
19 Manufacture of coke and refined petroleum products	0.92 (2.33)		0.95	0.10
20 Manufacture of chemicals and chemical products	1.12 (0.06)	1.16	1.11	1.12
21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	1.01 (0.84)	1.18	0.95	1.02
22 Manufacture of rubber and plastic products	1.09 (0.03)	1.15	1.08	1.09
23 Manufacture of other non-metallic mineral products	1.08 (0.02)	0.98	1.10	1.07
24 Manufacture of basic metals	1.1 (0.27)	1.02	1.11	1.09
25 Manufacture of fabricated metal products, except machinery and equipment	1.08 (0.01)	1.07	1.09	1.07
26 Manufacture of computer, electronic and optical products	0.99 (0.16)	1.06	0.99	0.98
27 Manufacture of electrical equipment	1.06 (0.03)	1.07	1.07	1.06
28 Manufacture of machineryand equipment n.e.c.	1.07 (0.08)	1.14	1.07	1.04
29 Manufacture of motor vehicles, trailers and semi-trailers	1.03 (0.08)	1.22	1.02	1.05
30 Manufacture of other transport equipment	1.15 (0.36)	1.02	1.15	1.18
31 Manufacture of furniture	1.08 (0.16)	1.03	1.08	1.08
32 Other manufacturing	1.08 (0.33)	1.04	1.08	1.12
33 Repair and installation of machinery and equipment	1.12 (0.03)	1.40	1.10	1.14

35 Electricity, gas, steam and air conditioning supply	1.16 (2.04)	1.40	1.02	1.36
36 Water collection, treatment and supply	1.1 (1.21)	1.03	1.09	1.14
37 Sewerage	1.11 (0.81)	1.11	1.09	1.16
38 Waste collection, treatment and disposal activities; materials recovery	1.16 (0.03)	1.28	1.13	1.19
39 Remediation activities and other waste management services	0.32 (0.48)		0.35	0.28
41 Construction of buildings	1.05 (0.02)	1.09	1.03	1.05
42 Civil engineering	1.03 (0.01)	0.96	1.03	1.03
43 Specialised construction activities	1.07 (0.01)	1.08	1.09	1.05
45 Wholesale and retail trade and repair of motor vehicles and motorcycles	1.01 (0.01)	1.02	1.02	0.99
46 Wholesale trade, except of motor vehicles and motorcycles	1.01 (0.01)	1.01	1.01	0.99
47 Retail trade, except of motor vehicles and motorcycles	1.02 (0.01)	1.01	1.02	1.02
49 Land transport and transport via pipelines	1.28 (0.06)	1.36	1.26	1.29
50 Water transport	1.02 (0.11)	0.93	1.09	0.93
51 Air transport	0.99 (0.04)	0.96	0.99	0.98
52 Warehousing and support activities for transportation	1.09 (0.06)	1.04	1.10	1.04

53 Postal and courier activities	1.08 (0.36)	1.08	1.07	1.10
55 Accommodation	1.26 (0.04)	1.30	1.25	1.26
56 Food and beverage service activities	1.13 (0.02)	1.12	1.15	1.12
58 Publishing activities	1.16 (0.04)	1.10	1.17	1.20
59 Motion picture, video and television programme production, sound recording and music publishing activities	1.13 (0.19)	1.26	1.01	1.14
60 Programming and broadcasting activities	1.15 (0.22)	1.08	1.16	1.17
61 Telecommunications	1.06 (0.12)	0.99	1.11	1.13
62 Computer programming, consultancy and related activities	1.15 (0.03)	1.18	1.16	1.13
63 Information service activities	1.04 (0.13)	1.03	1.02	1.13
64 Financial service activities, except insurance and pension funding	0.88 (0.11)	0.75	0.97	0.69
65 Insurance, reinsurance and pension funding, except compulsory social security	0.77 (1.17)	0.95	0.71	0.71
66 Activities auxiliary to financial services and insurance activities	1.28 (0.19)	1.34	1.33	1.22
68 Real estate activities	1.31 (0.07)	1.24	1.38	1.27
69 Legal and accounting activities	1.3 (0.02)	1.22	1.33	1.31
70 Activities of head offices; management consultancy activities	1 (0.06)	0.97	1.02	0.97

71 Architectural and engineering activities; technical testing and analysis	0.99 (0.06)	1.01	1.00	0.96
72 Scientific research and development	0.89 (0.16)	0.94	0.86	0.91
73 Advertising and market research	1.1 (0.1)	1.08	1.12	1.11
74 Other professional, scientific and technical activities	1.04 (0.06)	1.01	1.05	1.05
75 Veterinary activities	1.19 (0.95)	1.17	1.11	1.25
77 Rental and leasing activities	1.17 (0.09)	1.23	1.20	0.99
78 Employment activities	1.8 (0.27)	1.46	1.93	1.97
79 Travel agency, tour operator reservation service and related activities	1.28 (0.2)	1.25	1.31	1.27
80 Security and investigation activities	1.42 (0.13)	1.22	1.48	1.55
81 Services to buildings and landscape activities	1.44 (0.06)	1.47	1.46	1.39
82 Office administrative, office support and other business support activities	1.14 (0.04)	1.08	1.16	1.18

Note: For every NACE 2-digit industry, we remove outliers at the 1st and 99th percentiles of the distribution of (the log of) markups. Columns (2) to (4) present the average markup at the aggregate, by industry and by region. Standard deviations (in parenthesis) are obtained by block bootstrapping with 250 replications.

4. Regression Analysis

This section relies on a regression framework to answer the question whether and to what extent markups differ by region. The interpretation of the coefficient of interest, an indicator of regional location, is the *ceteris paribus* effect of regional location on the firm-level markups and provides the answer to the question whether, on average, similar firms set different markups depending on the regional they operate in. In addition, we quantify the extent to which markup differences are driven by differences in firm-level productivity.

4.1. Regression framework

We regress the firm-level markups obtained in the first step on firm characteristics and regional location indicators ("regional dummies"). The baseline regression specification is

$$\ln \hat{\mu}_{it} = \delta_0 + \delta_1 Flanders_{it} + \delta_2 Wallonia_{it} + X'_{it} b + \nu_{it},$$

where $\ln\hat{\mu}_{it}$ is the log of the estimated firm-level markup, $Flanders_{it}$ is a dummy equal to 1 if a firm is located in Flanders and 0 otherwise, $Wallonia_{it}$ is a dummy equal to 1 if a firm is located in Wallonia and 0 otherwise. X'_{it} is a set of firm-level control variables including the number of employees (l_{it}), tangible fixed assets (k_{it}), the interaction between the number of employees and tangible fixed assets ($l_{it}k_{it}$), and the age of the firm. We additionally control for full year-industry interactions to remove industry-specific aggregate trends in markups (NACE 2-digit industry). Because both left- and right-hand-side variables are expressed in logs, δ_1 and δ_2 express the percentage difference in markups between firms in Flanders and Wallonia relative to firms in the Brussels-capital region. We are interested in both the sign and the magnitude of the coefficients associated with these location dummies.

The baseline specification is augmented to include the estimated firm-level productivity from the first step to additionally control for the effect of firm productivity on markups:

$$\ln \hat{\mu}_{it} = \delta_0 + \delta_1 Flanders_{it} + \delta_2 Wallonia_{it} + \delta_3 \hat{\omega}_{it} + X'_{it} b + \nu_{it},$$

The interpretation of the associated coefficient δ_3 is the percentage effect of a one percent increase in firm productivity on firm-level markups.

4.2. Regression results

Table 10 presents the results of the regression of the firm-level markups on the location dummies for all private sectors in the economy.[6, 7] Columns (1) and (2) respectively show results for the baseline specification without and with sector-year fixed effects while columns (3) and (4) additionally control for firm characteristics and firm productivity.

[6] For every NACE 2-digit industry, we remove outliers at the 1st and 99th percentiles of the distribution of (the log of) markups. Markups are trimmed to remove the effects of outliers on the estimation results. The findings are qualitatively the same for different robustness checks: both sign and magnitude of the effect of location dummies are robust to alternative trimming procedures (for example trimming at the 3rd and 97th percentiles), and the absence of trimming.

[7] Baseline results are robust to controlling for multi-plant status of the firm, and aggregate trends in markups at the NACE 4-digit level.

Table 10: Regression results for the effect of location on markups – all private sectors

	Dependent variable: markups (ln $\hat{\mu}_{it}$)			
RHS VARIABLES	(1)	(2)	(3)	(4)
Flanders	0.00567	0.0221*	0.0209**	0.00938
	(0.00773)	(0.00543)	(0.00542)	(0.00579)
Wallonia	-0.00910	-0.00127	-0.0156**	-0.00963
	(0.00823)	(0.00546)	(0.00565)	(0.00478)
ln number of			0.0441***	0.0533***
employees			(0.00415)	(0.00588)
ln fixed assets			0.0126***	0.0156***
			(0.00198)	(0.00266)
ln material costs			-0.0508***	-0.0594***
			(0.00371)	(0.00489)
number of			-0.00138**	-0.00167
Employees * fixed			(0.00053)	(0.00081)
assets				
ln age			0.00614***	0.00102
			(0.00133)	(0.00179)
ln productivity				0.689***
				(0.17243)
Constant	0.0581**	0.0466**	0.274***	-1.649**
	(0.00929)	(0.00789)	(0.02302)	(0.47992)
Observations	240,570	240,570	240,560	240,560
R-squared	0.001	0.241	0.311	0.535
Sector-Year FE	NO	YES	YES	YES

*Markups are obtained using materials as variable input. The output elasticity of materials is based on a gross output translog production function. We control for input use (labor, capital, and materials) to correct for the bias in the estimate of the output elasticity of materials. Bootstrapped standard errors in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.*

The coefficients associated with the Flanders dummy have a positive sign, while coefficients associated with the Wallonia dummy have a negative sign. Column (1) presents the results of a simple regression of firm-level markups on the location dummies. As such, this column simply reports the (percentage) difference in average

markups relative to firms in Brussels. Firms in Flanders appear to have slightly higher markups than firms in the Brussels-capital region, while firms in Wallonia appear to charge lower markups. Removing industry-specific aggregate trends from markups via the industry-year interaction reported in column (2), we see that firms in Flanders charge markups that are roughly 2% higher than firms in Brussels-capital, while firms in Wallonia charge lower markups. In column (3), we control for differences in terms of size, capacity, material use and age. The markup premium of firms in Flanders is unaffected, while firms in Wallonia now charge even lower markups (up to 1.5% lower on average). In column (4), we additionally control for differences in productivity at the firm level. In this case, firms in Flanders appear to set marginally higher markups (0.9%) while the markup differential of firms in Wallonia drops to 0.9%. More important than the signs and size however is that in this case the coefficients are not statistically significant. This finding suggests two things: first that regional differences are neither economically nor statistically significant, and second, that regional differences in markups are driven by cost differences (as proxied by the firm-level productivity estimates).

Three concerns are raised that might question these results: first, the methodology used to estimate markups was developed with manufacturing firms in mind. Second, the debate on how firms use certain technology to transform inputs into output (i.e., the production function) is subject to ongoing debate (even for the manufacturing sector). Third, understanding of how firms in non-manufacturing operate (produce) remains limited. We therefore now restrict the study of markup differences across regions to firms in the manufacturing sector, in particular the NACE 2-digits industries 10 to 33. Table 11 presents the corresponding regression results.

Table 11: Regression results for the effect of location on markups – manufacturing sectors only

	Dependent variable: markups (ln $\hat{\mu}_{it}$)			
RHS VARIABLES	(1)	(2)	(3)	(4)
Flanders	-0.00337	-0.0204	-0.00971	-0.0102
	(0.03812)	(0.01436)	(0.01303)	(0.01371)
Wallonia	-0.00799	-0.0274	-0.0251	-0.0193
	(0.04149)	(0.01395)	(0.01346)	(0.01419)
ln number of			0.0216	0.0216
employees			(0.00969)	(0.01046)
ln fixed assets			0.00838	0.00788
			(0.0044)	(0.00465)
ln material costs			-0.0251***	-0.0267**
			(0.00659)	(0.00712)
number of			-0.00106	-0.000650
employees * fixed			(0.00115)	(0.00126)
assets				
ln age			0.00602	0.00369
			(0.0032)	(0.00334)
ln productivity				0.372**
				(0.14805)
Constant	0.0605	0.0774	0.165**	-0.970
	(0.05192)	(0.02593)	(0.04576)	(0.46405)
Observations	37,368	37,368	37,368	37,368
R-squared	0.000	0.116	0.149	0.295
Sector-Year FE	NO	YES	YES	YES

*Note: Markups are obtained using materials as variable inputs. The output elasticity of materials is based on gross output translog production function. We control for input use (labor, capital, and materials) to correct for the bias in the estimate of the output elasticity of materials. Bootstrapped standard errors in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1*

The coefficients on the regional dummies are statistically not significant, irrespective the regression specification; a discussion of their signs is therefore meaningless. From column (4) we once more derive the finding that markups differences between firms are mainly driven by difference in productivity. The interpretation here is that a 10% increase in firm-level productivity is associated with a 3,7% increase in the markup.

4.3. Robustness check – Single-plant firms

As a robustness check of the relation between markups and location, we restrict the analysis to single-plant firms. As suggested by EWI, the underlying reasoning is that, in contrast to the multi-plant firms, their location is not subject to the allocation rule discussed in Section 3.1.2. Table (12) presents the regression results for single-plant firms.

Table 12: Markups and location - single-plant firms only

	Dependent variable: markups (ln $\hat{\mu}_{it}$)			
RHS VARIABLES	(1)	(2)	(3)	(4)
Flanders	0.00973	0.0238*	0.0222**	0.00707
	(0.00812)	(0.00571)	(0.00572)	(0.00642)
Wallonia	-0.00416	-0.000557	-0.0150**	-0.00916
	(0.00861)	(0.00576)	(0.00589)	(0.00454)
ln number of employees			0.0405***	0.0505***
			(0.00432)	(0.00612)
ln fixed assets			0.0138***	0.0176***
			(0.00198)	(0.00267)
ln material costs			-0.0478***	-0.0581***
			(0.00371)	(0.00532)
number of employees			-0.00172**	-0.00214**
* fixed assets			(0.00061)	(0.00094)
ln age			0.00704***	0.00138
			(0.00141)	(0.00188)
ln productivity				0.773***
				(0.17954)
Constant	0.0539**	0.0452**	0.251***	-1.916***
	(0.00952)	(0.00816)	(0.02281)	(0.50075)
Observations	206,773	206,773	206,773	206,773
R-squared	0.001	0.231	0.297	0.569
Sector-Year FE	NO	YES	YES	YES

*Note: Markups are obtained using materials as variable inputs. The output elasticity of materials is based on gross output translog production function. We control for input use (labor, capital, and materials) to correct for the bias in the estimate of the output elasticity of materials. Bootstrapped standard errors in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.*

Skipping to column (3) immediately, the results show that single-plant firms located in Flanders appear to charge higher markups than firms in Brussels-capital (2.2% on average) while firms in Wallonia appear to charge lower markups (-1.5% on average). Controlling for productivity differences as reported in column (4), the coefficients of the location dummies once more are not statistically significant, corroborating the previous finding that we fail to detect any regional difference in markups once productivity differences are accounted for. This also implies that the allocation rule does not seem to affect the findings with the entire sample of firms.

5. Discussion and concluding remarks

El Gallaa and Reynaerts (2017, STORE-17-0015) study the relationship between firm location and firm markups to verify whether and to what extent firms in different regions set different markups. The report concludes that firms in the Walloon region set higher markups than comparable firms in the Brussels-capital region and finds no statistical evidence of higher markups by Flemish firms. In this follow-up, these findings are subjected to a series of robustness checks that involve (*i*) removing sample outliers (trimming), (*ii*) a less restrictive production framework than the simple Cobb-Douglas (CD) specification, (*iii*) a restriction of the sample to manufacturing sectors only, and (*iv*) a restriction of the sample to single-plant firms to test the effect of the allocation of economic activity rule.

The main conclusion of this follow-up study based on a flexible translog (TL) production function that captures inter-firm heterogeneity is that while we initially find firms in Flanders and Wallonia to respectively set higher and lower markups than comparable firms in the Brussels-capital region, this difference disappears (economically and statistically) when controlling for *productivity* differences between firms. This implies that productivity differences across firms are the main driver of differences in observed markups, not location. These findings are based on markups computed using a TL approach that yields firm- and time-specific output elasticities, as opposed to the uniform and constant elasticities resulting from the previous CD approach. This finding remains when restricting the sample to manufacturing firms or to single-plant firms.

Comparing with the TL-based outcomes, the replication of the analysis for the CD-based approach (see Tables 13, 14 and 15 in appendix) shows that firms in Flanders and Wallonia charge higher markups than firms in Brussels-capital. When controlling for productivity differences, the difference in markups between Flemish and Brussels firms disappears but not for Walloon firms. This finding remains unchanged when restricting the sample to single-plant firms. The markup premium for Walloon firms relative to Brussels-based firms could be attributed to differences in unobserved demand factors such as income, the price elasticity of demand, consumer preferences, or any other factor affecting price variation in shaping the markup differential. When restricting the sample to manufacturing firms only, it is shown that Flemish firms set lower markups than comparable firms in Brussels; the difference for Walloon firms on the other hand is not statistically significant. In search of potential explanations, the data show that the Flemish region in general has a substantially higher number of manufacturing firms relative to the other two regions.[8] Competitive pressure on markups could therefore be higher in Flanders than in the other two regions, explaining the lower markups of in Flanders. This finding holds irrespective of the measure of the markups.

The results for the TL-based markups in this report highlight the importance of allowing for firm-level heterogeneity in the estimation of the output elasticity of materials in the first step of the procedure. The data show substantial heterogeneity in sales, firm size, and productivity levels, which are expected to affect the output elasticity of firms. In turn, allowing the output elasticity to vary across firms and over time enables us to capture markup differences stemming from the variations in the output elasticity (technology parameters and input use) as well as the materials share in revenues. As a result, we no longer find statistical evidence for firms located in different regions charging different markups. As was the case before, we additionally show that productivity differences across firms are the most important determinant of markups.

This points us in the direction of two areas we think are promising (for both policy and research) to explore in the future. First, given that the main determinant of markup

[8] The total number of firms in the sample is 53,185 of which 27,691 are located in Flanders. This is roughly 52% of the total number of firms. There are 6,588 manufacturing firms in the sample of which 4,104 are located in Flanders. This amounts to more than half the number of manufacturing firms.

differences across firms is productivity, it would be interesting to see how regional differences affect the productivity of firms and hence the level of market power across regions. Second, in this analysis we focused on supply factors affecting markup differences and as such, demand factors are missing. Hence including demand factors as determinants of markups would produce a more complete assessment of the role of location of firms. Moreover, other factors (political, institutional, others) that affect markups are largely unexplored given the modest scope of this short-term assignment. Finally, the evolution of (regional) firm performance over time (in terms of productivity, markups, etc.) is of interest as it enables assessment of regional economic trends. These research avenues can be integrated in the longer-term research work packages of the Steunpunt.

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Appendix

A1. Note on technicalities underlying markup estimation and empirical procedure

A1.1. Persistent price bias

Because data on the actual physical output of firms is missing, we revert to firm sales to estimate a sales-generating (translog) production function (also known as a gross output production function). In this case, the estimates of the technology parameters and productivity are biased if the reseracher fails to control for input and output prices variations. By the law of demand, we expect prices and quantities of inputs to be negatively correlated, which results in a downward bias in the estimated output elasticity of materials, $\hat{\theta}_{it}^{m}$, and hence, underestimation of firm markups.[9] However, according to De Loecker and Warzynski (2012), unobserved prices will only affect the *level* of the estimated markup and not the relation between markups and firm location. In fact, we already correct markups from price variation related to the variables in the proxy for productivity (by introducing regional differences in the control function). Moreover, price variation correlated with variation in productivity is also controlled for using the proxy for productivity. However, price variation related to demand shocks remains uncontrolled for and can still bias the estimated production function coefficients.

When estimating a CD production function, we do not need to worry about the downward bias of markups coming from the bias of the output elasticity. Given that output elasticity in this case is constant across firms and over time, the relation between markups and firm location is unaltered and the bias only affects the estimate of the constant term. However, since we are interested in obtaining firm-specific output elasticities of materials (and therefore estimate a translog production function), the estimate of the average markup differences between regions is consistent only if the price bias is not correlated with firm location. To counteract this bias, we control for

9 We refer to De Loecker and Goldberg (2014) for a detailed discussion of the effect of the price bias.

labor, capital as well as material use in the regression of the translog-based markups on the location dummies.[10]

A1.2. Bootstrapping of standard errors

Given that the markup estimates depend on the *estimated* output elasticity of materials, this creates an additional source of variability in the second-step dependent variable. This additional variability is accounted for by block bootstrapping (i.e. computing correct standard errors for the estimated regression coefficients by resampling firms with replacement) over the *entire* procedure, i.e. including the first-stage production function estimation. The steps in this empirical procedure are therefore as follows: (*i*) estimate the production function, (*ii*) recover the output elasticities of materials, (*iii*) compute firm-level markups, (iv) regress markups on regional dummies and a set of controls. These steps are replicated 250 times using bootstrapped (with replacement) samples whose size is equal to that of the original sample. This allows for computing bootstrapped standard errors on the regional dummies and the set of controls needed for the purposes of statistical inference (in this case, testing the null hypothesis that the coefficients on the regional indicators are zero).[11]

[10] Given data on inputs and output prices at the firm level, the price bias can be circumvented and consistent estimates of firm-level productivity and markups can be obtained.

[11] Ignoring this estimated dependent variable (EDV) issue, the usual standard errors reported by the regression output are too small and therefore lead to over rejection of the null hypothesis. In other words, the *t*-value (usually compared with the critical level of 2) is too high because the denominator for the test statistic (which is the corresponding standard error of the estimated coefficient) is too small.

A2. CD-based markup estimates

A2.1 Descriptive statistics of markups by region

Table 11 shows how markups differ across firms. The average markup in the entire private economy is 1.27 while the median is 1.09. Average markups are similar across regions; however, the markup of the median firm in Wallonia is 1.11 which is higher than the economy's median as well as the median of the other two regions.

Table 11: Descriptive statistics of markups by region – CD approach

	Number of observations (1)	Mean (2)	Median (3)	Std. Dev. (4)
Entire economy	240723	1.27	1.09	0.011
Brussels	33926	1.27	1.08	0.015
Flanders	132085	1.28	1.07	0.014
Wallonia	74712	1.26	1.11	0.011

Note: For every NACE 2-digit industry, we remove outliers at the 1st and 99th percentile of the distribution of (the log of) markups. Column (1) shows the number of observations in the total sample of firms after estimating the markups, as well as the number of observations by region. The standard deviation around the average markup by region is obtained via block bootstrapping with 250 replications.

A2.2 Average markup estimates for the entire economy, by region and by industry

Table 12: Average markup estimates for the entire economy, by region and by industry – CD approach

Nace2d Industry	Average markup			
	(1) Aggregate	(2) Brussels	(3) Flanders	(4) Wallonia
1 Crop and animal production	1.23 (0.07)	1.24	1.24	1.21
2 Forestry and logging	1.31 (0.35)	1.57	1.38	1.29
8 Other mining and quarrying	1.28 (0.26)	1.11	1.14	1.34
10 Manufacture of food products	1.14 (0.04)	1.23	1.11	1.19
11 Manufacture of beverages	1.34 (0.12)	1.32	1.34	1.34
12 Manufacture of tobacco products	1.28 (0.47)	1.00	1.30	1.31
13 Manufacture of textiles	1.08 (0.07)	1.18	1.07	1.14
14 Manufacture of wearing apparel	1.14 (0.09)	1.26	1.05	1.45
15 Manufacture of leather and related products	1.12 (0.74)	1.11	1.10	1.15
16 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1.16 (0.07)	1.11	1.15	1.18
17 Manufacture of paper and paper products	1.18 (0.16)	1.13	1.22	1.05
18 Printing and reproduction of recorded media	1.33 (0.06)	1.39	1.32	1.34
19 Manufacture of coke and refined petroleum	1.36		1.37	1.01

products	(1.31)			
20 Manufacture of chemicals and chemical products	1.07 (0.09)	1.10	1.06	1.11
21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	1.26 (0.11)	1.21	1.18	1.35
22 Manufacture of rubber and plastic products	1.22 (0.14)	1.32	1.21	1.25
23 Manufacture of other non-metallic mineral products	1.11 (0.05)	1.04	1.12	1.10
24 Manufacture of basic metals	0.89 (0.45)	0.76	0.91	0.88
25 Manufacture of fabricated metal products, except machinery and equipment	1.31 (0.04)	1.44	1.29	1.33
26 Manufacture of computer, electronic and optical products	0.95 (0.15)	0.83	0.94	0.99
27 Manufacture of electrical equipment	1.08 (0.12)	1.33	1.05	1.09
28 Manufacture of machineryand equipment n.e.c.	1.15 (0.09)	1.25	1.14	1.16
29 Manufacture of motor vehicles, trailers and semi-trailers	1.09) (0.15	1.30	1.07	1.12
30 Manufacture of other transport equipment	1.28) (0.19	1.45	1.22	1.38
31 Manufacture of furniture	1.26) (0.06)	1.13	1.27	1.24
32 Other manufacturing	1.33 (0.14)	1.37	1.26	1.54
33 Repair and installation of machinery and equipment	1.19) (0.15)	1.92	1.11	1.28
35 Electricity, gas, steam and air conditioning supply	1.87 (0.44)	2.69	1.48	2.16
36 Water collection, treatment and supply	1.32 (0.32)	1.54	1.25	1.40

37 Sewerage	1.63) (1.91	1.65	1.60	1.68
38 Waste collection, treatment and disposal activities; materials recovery	1.20) (0.05	1.41	1.12	1.28
39 Remediation activities and other waste management services	1.57) (0.50		1.49	1.67
41 Construction of buildings	1.19) (0.04	1.20	1.14	1.25
42 Civil engineering	1.20) (0.09	1.06	1.17	1.26
43 Specialised construction activities	1.31) (0.02	1.33	1.30	1.31
45 Wholesale and retail trade and repair of motor vehicles and motorcycles	1.08) (0.02	1.13	1.08	1.07
46 Wholesale trade, except of motor vehicles and motorcycles	1.06) (0.04	1.07	1.05	1.08
47 Retail trade, except of motor vehicles and motorcycles	1.07) (0.01	1.07	1.07	1.07
49 Land transport and transport via pipelines	1.39) (0.07	1.41	1.38	1.40
50 Water transport	1.11) (0.13	0.98	1.20	0.99
51 Air transport	1.10) (0.04	1.13	1.08	1.11
52 Warehousing and support activities for transportation	1.27) (0.04	1.11	1.28	1.28
53 Postal and courier activities	1.18 (0.11)	1.11	1.24	1.16
55 Accommodation	1.46 (0.04)	1.54	1.42	1.44
56 Food and beverage service activities	1.23 (0.02)	1.23	1.24	1.22
58 Publishing activities	1.31 (0.09)	1.21	1.33	1.37

59 Motion picture, video and television programme production, sound recording and music publishing activities	1.24 (0.34)	1.37	1.13	1.23
60 Programming and broadcasting activities	1.24 (0.23)	1.15	1.26	1.29
61 Telecommunications	1.07 (0.13)	0.96	1.11	1.33
62 Computer programming, consultancy and related activities	1.46 (0.07)	1.43	1.47	1.47
63 Information service activities	1.28 (0.15)	1.23	1.29	1.34
64 Financial service activities, except insurance and pension funding	1.85 (0.21)	1.34	2.17	1.28
65 Insurance, reinsurance and pension funding, except compulsorysocial security	1.38 (2.03)	1.83	1.11	1.38
66 Activities auxiliary to financial services and insurance activities	1.65 (0.09)	1.68	1.72	1.57
68 Real estate activities	2.11 (0.13)	1.86	2.20	2.20
69 Legal and accounting activities	1.48 (0.05)	1.31	1.54	1.51
70 Activities of head offices; management consultancy activities	1.49 (0.11)	1.30	1.55	1.62
71 Architectural and engineering activities; technical testing and analysis	1.22 (0.08)	1.10	1.31	1.13
72 Scientific research and development	1.21 (0.25)	1.39	1.19	1.12
73 Advertising and market research	1.22 (0.08)	1.15	1.28	1.26
74 Other professional, scientific and technical activities	1.32 (0.09)	1.21	1.34	1.38
75 Veterinary activities	1.66 (1.73)	1.86	1.53	1.73

77 Rental and leasing activities	1.66 (0.14)	1.84	1.69	1.38
78 Employment activities	3.00 (0.66)	1.48	3.59	3.78
79 Travel agency, tour operator reservation service and related activities	1.00 (0.08)	0.92	1.03	1.04
80 Security and investigation activities	1.71 (0.27)	1.51	1.90	1.55
81 Services to buildings and landscape activities	1.93 (0.11)	2.17	1.92	1.79
82 Office administrative, office support and other business support activities	1.39 (0.06)	1.26	1.37	1.56

A2.3 Regression results

This appendix shows regression results for the CD-based markups. This specification produces output elasticities that are constant across firms and over time (in the same industry), hence the variations of markups reflect simply the variations of the inverse of materials share in revenues. The following tables reproduce the results of the first report using a CD specification as a baseline with which to compare the TL-based results. Table 13 presents regression results for markups based on a CD production function for the entire economy; Tables 14 and 15 respectively are the CD counterparts of the robustness checks for manufacturing firms only and single-plant firms only.

Table 13: Average markup differences across regions - CD approach

	Dependent variable: markups (ln $\hat{\mu}_{it}$)			
RHS VARIABLES	(1)	(2)	(3)	(4)
1.Flanders	0.00563	0.0346**	0.0232**	-0.000308
	(0.00815)	(0.00628)	(0.00646)	(0.00576)
1.Wallonia	0.0167	0.0375**	0.0394***	0.0526***
	(0.00874)	(0.00612)	(0.00625)	(0.00493)
ln number of			0.0719***	0.0560***
employees			(0.00314)	(0.00438)
ln fixed assets			0.0110***	0.00382
			(0.00158)	(0.00209)
number of			-0.00714***	-0.00531***
employees * fixed			(0.00048)	(0.0006)
assets				
ln age			-0.00643**	-0.0135***
			(0.00195)	(0.00212)
ln productivity				0.966***
				(0.13087)
Constant	0.152***	0.130***	0.0457**	-1.190***
	(0.01062)	(0.00998)	(0.01168)	(0.16154)
Observations	240,723	240,723	240,713	240,713
R-squared	0.000	0.166	0.190	0.489
Sector-Year FE	NO	YES	YES	YES

*Note: Markups are obtained using materials as variable inputs. The output elasticity of materials is based on gross output Cobb Douglas production function. Bootstrapped standard errors in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.*

Firms in both Flanders and Wallonia seem to charge higher markups than firms in Brussels-capital, see columns (2) and (3). However, firms in Wallonia seem to charge even higher markups (around 4% higher). Controlling for productivity (column 4), the markup difference between firms in Flanders and Brussels-capital disappears while the difference with firms in Wallonia increases (up to 5%). This result could point to other factors such as the role of demand-side factors in explaining markup differences between firms located in Wallonia and the Brussels-capital region.

Table 14: Average markup differences across regions – CD approach, manufacturing firms only

	Dependent variable: markups (ln $\hat{\mu}_{it}$)			
RHS VARIABLES	(1)	(2)	(3)	(4)
1.Flanders	-0.0730	-0.0678*	-0.0633**	-0.0565**
	(0.02234)	(0.01641)	(0.01709)	(0.01593)
1.Wallonia	-0.0404	-0.0319	-0.0277	-0.00626
	(0.02549)	(0.0170)	(0.01753)	(0.01597)
ln number of employees			0.0341***	0.0276**
			(0.00744)	(0.00973)
Ln fixed assets			-0.00608	-0.0128**
			(0.00372)	(0.00459)
number of employees*fixed assets			-0.00298**	-0.00185
			(0.00088)	(0.00114)
ln age			-0.0121**	-0.0168**
			(0.00428)	(0.00453)
ln productivity				0.864***
				(0.17896)
Constant	0.187**	0.182**	0.220***	-0.945**
	(0.02682)	(0.02448)	(0.03134)	(0.24252)
Observations	37,384	37,384	37,384	37,384
R-squared	0.006	0.134	0.143	0.404
Sector-Year FE	NO	YES	YES	YES

*Note: Markups are obtained using materials as variable inputs. The output elasticity of materials is based on gross output Cobb Douglas production function. Bootstrapped standard errors in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.*

Manufacturing firms in both Flanders seem to charge lower markups than firms in Brussels-capital based on columns (2), (3) and (4), while manufacturing firms in Wallonia do not seem to charge different markups given that the coefficient estimate in not statistically significant. Manufacturing firms in Flanders charge roughly 6% lower markups. The markup premium of manufacturing firms in Brussels-capital relative to firms in Flanders is robust when controlling for productivity. This result might be due to the difference in the number of manufacturing firms across regions, since the location

of manufacturing firms is concentrated in Flanders, and there are few manufacturing firms in Brussels-capital, which might account for the higher degree of market power.

Table 11: Average markup differences across regions - CD approach, single-plant firms only

	Dependent variable: markups (ln $\hat{\mu}_{it}$)			
RHS VARIABLES	(1)	(2)	(3)	(4)
1.Flanders	0.0118	0.0317**	0.0212**	-0.00564
	(0.00865)	(0.00679)	(0.00694)	(0.00605)
1.Wallonia	0.0258	0.0371**	0.0377***	0.0493***
	(0.00913)	(0.00666)	(0.00674)	(0.00508)
ln number of			0.0724***	0.0565***
employees			(0.00368)	(0.00448)
ln fixed			0.0141***	0.00595**
assets			(0.00168)	(0.00217)
number of			-0.00832***	-0.00612***
employees*fixed assets			(0.00064)	(0.00067)
ln age			-0.00233	-0.0100***
			(0.00205)	(0.00212)
ln productivity				0.954***
				(0.12357)
Constant	0.145***	0.131**	0.0374**	-1.179***
	(0.01085)	(0.01029)	(0.01221)	(0.15099)
Observations	206,932	206,932	206,932	206,932
R-squared	0.001	0.160	0.181	0.494
Sector-Year FE	NO	YES	YES	YES

Note: Markups are obtained using materials as variable inputs. The output elasticity of materials is based on gross output Cobb Douglas production function. Bootstrapped standard errors in *parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.*

Single-plant firms in both Flanders and Wallonia seem to charge higher markups than firms in Brussels-capital, see columns (2) and (3). The markup premium of single-plant firms in Flanders disappears when controlling for productivity, while the markup premium of single-plant firms in Wallonia relative to firms in Brussels-capital increases. These results are in line with the markup differences of firms across regions depicted in the entire sample of firms.