DISCUSSION PAPER SERIES

DP16796

Price-Cost Margins and Fixed Costs

Filip Abraham, Yannick Bormans, Jozef Konings and Werner Roeger

INDUSTRIAL ORGANIZATION

ISSN 0265-8003

Price-Cost Margins and Fixed Costs

Filip Abraham, Yannick Bormans, Jozef Konings and Werner Roeger

Discussion Paper DP16796
Published 09 December 2021
Submitted 07 December 2021

Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

Price-Cost Margins and Fixed Costs

Abstract

This paper provides a new method to estimate price-cost margins in the presence of fixed costs of production. We exploit properties of the primal and dual revenue based and cost based Solow residual. Ignoring fixed costs in production underestimates price-cost margins and overestimates excess profit margins. Using a 30 year panel of Belgian firms we estimate price cost margins of 25.9% on average, with fixed costs as a fraction of sales of 23.4%. Fixed costs as well as price-cost margins have declined in the last three decades, pushing excess profit margins close to zero, suggesting competitive markets. The presence of fixed costs implies that price-cost margins might change not only due to a change in firms' market power, but also due to changes in the production process (i.e., the mix between variable and fixed costs) or even due to a combination of both. Our novel methodology is able to distinguish these underlying mechanisms, thereby providing an additional layer of insight to the ongoing academic and policy debate on firms' market power.

JEL Classification: N/A

Keywords: Price-cost margins, Fixed Costs, excess profits, market power

Filip Abraham - filip.abraham@kuleuven.be
KU Leuven and Vlerick Business School

Yannick Bormans - Yannick.Bormans@kuleuven.be
VIVES, KU Leuven

Jozef Konings - joep.konings@kuleuven.be
Nazarbayev University Graduate School of Business and VIVES, KU Leuven and CEPR

Werner Roeger - w.roeger@web.de
DIW Berlin, EIIW Univesität Wuppertal and VIVES, KU Leuven

Acknowledgements
We acknowledge research support of the Methusalem grant (METH/15/004) KU Leuven on Granularity and the Small Research Grant of Nazarbayev University (16133385).

Price-cost margins and fixed costs

Filip Abraham[1], Yannick Bormans[2], Jozef Konings[3] and Werner Roeger[4]

7 December 2021

Abstract

This paper provides a new method to estimate price-cost margins in the presence of fixed costs of production. We exploit properties of the primal and dual revenue based and cost based Solow residual. Ignoring fixed costs in production underestimates price-cost margins and overestimates excess profit margins. Using a 30 year panel of Belgian firms we estimate price cost margins of 25.9% on average, with fixed costs as a fraction of sales of 23.4%. Fixed costs as well as price-cost margins have declined in the last three decades, pushing excess profit margins close to zero, suggesting competitive markets. The presence of fixed costs implies that price-cost margins might change not only due to a change in firms' market power, but also due to changes in the production process (i.e., the mix between variable and fixed costs) or even due to a combination of both. Our novel methodology is able to distinguish these underlying mechanisms, thereby providing an additional layer of insight to the ongoing academic and policy debate on firms' market power.

Keywords: Price-cost margins, fixed costs, excess profits, market power, firm level data

JEL codes: D21, L13, L16

[1] KU Leuven, Department of Economics, VIVES & Vlerick Business School; filip.abraham@kuleuven.be
[2] KU Leuven, Department of Economics, VIVES ; yannick.bormans@kuleuven.be
[3] Nazarbayev University Graduate School of Business and KU Leuven, VIVES; joep.konings@kuleuven.be
[4] DIW Berlin, EIIW Universität Wuppertal ; w.roeger@web.de
* This paper has benefitted from comments and suggestions at seminars at the University of Leuven, the European Commission, the University of Liverpool, the University of Cambridge and the Bank of Italy. We thank Meredith Crowley, Lu Han, Jan De Loecker, Balszs Murakozy and Angelos Theodorakopoulos for their suggestions and feedback.
** We are grateful for the financial support from Methusalem that made this study possible.

1. Introduction

The economic implications of institutional change, trade liberalization and anti-trust policy on market power have been widely conjectured and researched. The long-term trend of the rise in US markups has stirred concerns about the rise of superstar firms and the potential macroeconomic effects of rising market power (De Loecker, Eeckhout & Unger, 2020; Diez, Leigh & Duval, 2018; Hall, 2018). The documented rise in US markups has been accompanied by a fall in investment rates (Gutierrez & Philippon, 2017), declining business dynamism (Decker, Haltiwanger, Jarmin & Miranda, 2017) and the fall in the labor share (Autor, Dorn, Katz, Patterson & Van Reenen, 2020). This suggests that increased market power may have detrimental effects going beyond a single industry, affecting the overall economy (Syverson, 2019).

However, there is still considerable controversy both conceptually and empirically about existing markup estimates. On the conceptual side, especially industrial organization economists (Berry, Gaynor & Morton, 2019) stress that there can be diverse reasons for rising markups apart from increasing market power, in particular a rise in fixed costs. These authors stress that taking fixed costs into account makes results from markup estimates alone ambiguous. There is a need to account for the presence of fixed costs. At the empirical level, it is not straightforward to classify certain factors of production as (entirely) fixed and others as (entirely) variable. Often in this literature, capital is classified as being entirely fixed while labor and intermediate inputs are regarded as entirely variable. The latter has been recognized by De Loecker et al. (2020) as a problem. They try to take into account that there is overhead labor and make attempts to control for it. They make use of the fact that US firms report costs of production in two main categories: costs of goods sold (COGS) and selling, general & administrative costs (SG&A). De Loecker et al. (2020) interpret them as a proxy for variable and fixed costs respectively and they document a rise of SG&A in total costs from 15% (1980) to 21% (2014). However, this has been the subject of considerable controversy in the US. For example, Traina (2018) as well as Karabarbounis and Neiman (2018) argue that this choice could be the main reason for the large increase in the De Loecker et al. (2020) markup estimates for the US, since firms have potentially changed reporting expenditure from formerly COGS to now SG&A in their income statements. They show that using COGS plus SG&A as a measure for variable cost nearly eliminates the entire increase of the markup in the US.

In his survey of the recent literature, Basu (2019) recognizes the variable cost measurement issue, but is skeptical that it can be resolved with existing methods, since they rely on a distinction between variable and fixed costs provided by statisticians. He finds that the Compustat data are not informative enough to allow such a distinction. In particular he is skeptical about the choice made by de Loecker et al. (2020) because of reclassification issues and economic changes such as outsourcing which may have reduced COGS and increased SG&A. Also this problem is not restricted to labor input but similar problems arise for intermediate inputs. This is shown by de Loecker et al. (2018) for a Belgium firm level dataset from the National Bank of Belgium (NBB), which distinguishes between materials and service inputs. Looking at individual service categories they are likely to have more of a fixed cost nature. Similar to the US experience with labor input data, depending on whether service inputs are treated as fixed or variable in the markup estimation, De Loecker et al. (2018) find different trends and levels of markups in Belgium.

This leaves the literature with somewhat arbitrary classifications into fixed and variable inputs, dictated by the limited availability of data.[5] In this paper we propose to overcome this problem and propose a methodology to estimate the share of fixed cost for capital, labor and intermediate inputs separately and jointly with the price-cost margin, using information from revenue- and cost-weighted Solow residuals based on standard firm level data on expenditures of inputs and revenues.[6] We start from the framework introduced by Hall (1988), and further extended by Roeger (1995).[7] In our view, this helps both to overcome the conceptual problem that markups and fixed cost developments should be reported jointly and it overcomes the lack of adequate data.

The main advantage of our approach is that it allows not only for the flexible treatment of capital (either fixed, variable or a combination of both) but also for the flexible treatment of other input factors, such as labor and intermediate inputs. We do not have to classify costs as quasi-variable or quasi-fixed[8], nor do we have to assume that one or all inputs are entirely variable.[9] Instead, our model estimates the share of fixity for each input factor based on variation in the underlying firm level data.

[5]While Compustat and the NBB dataset allow for some disaggregation, most other firm level datasets only report aggregate inputs.

[6] In particular, we exploit observed variation in nominal input and nominal output values.

[7] This approach has been used to obtain an average estimate of the price-cost margin. A price-cost margin estimate larger than zero rejects the model of perfect competition. This approach has been used in many papers using industry level or firm level data (e.g. Amit, Domowitz & Fershtmann, 1988; Waldmann, 1991; Morrison, 1992; Levinsohn, 1993; Norrbin, 1993; Harrison, 1994; Basu and Fernald, 1994; Klette, 1999; Konings, Van Cayseele & Warzynski, 2001; Hall, 2018). An important issue, however, in Hall (1988) is that unobserved productivity shocks may be positively correlated with output (or input) growth. One possibility to address this is the use of instrumental variables but it is often challenging to find good instruments, especially when firm level data are used. In addition, when the impact of policy changes is analyzed, not only price-cost margins may be affected, but also productivity and productivity growth (Harrison, 1994), which can bias the estimated change in price-cost margins. Finally, deflated sales are used to proxy for physical output, but with firm heterogeneity and multiple-product firms, this can introduce a bias (see Klette & Griliches, 1996; De Loecker, 2011; De Loecker & Warzynski, 2012).

[8] U.S. firms classify costs into costs of goods sold (COGS) or selling, general & administrative (SG&A). Classifying costs into the appropriate category is not always straightforward. Sometimes, costs are classified as COGS in one industry while being classified as SG&A in another industry, and vice versa.

[9] De Loecker and Warzynski (2012) develop a widely used method to estimate markups using production data. The assumption that at least one input is completely variable is key in this method. Often, capital and labor are thought of as at least partially fixed. Therefore, applications assume that intermediate inputs are entirely variable. However, it is very unlikely that each and every category within intermediate inputs is completely variable. In section 4.3, we compare estimation results from both methods.

Further, unlike most other approaches, we do not need to rely on unobserved product price data for deflating firm level sales or deflating input factors such as material costs. Our method makes use of nominal values rather than price deflators and real values. Another advantage of our approach is that it deals with the endogeneity problems caused by unobservable productivity shocks (Roeger, 1995; Konings, Van Cayseele and Warzynski, 2005). Finally, the method allows to directly estimate both an aggregate price-cost margin and an aggregate excess profits ratio.

We derive the estimation formula by postulating a general production function for variable factors of production where we allow a returns to scale parameter which is *not* restricted to one. We show that we can identify a markup over average variable cost and fixed cost shares separately for capital, labor and intermediate inputs. However, separating the scale parameter from the markup over marginal cost requires additional information about the scale parameter. This parameter could be obtained by applying similar methods as in De Loecker et al. (2020), for estimating production function parameters. In this paper we refrain from doing this but only report the markup over average variable cost. We show that this estimate together with the fixed cost estimate provides sufficient information about excess profits. The comparison of US markup estimates with profit rates has also played a major role in the US debate. Our estimate of the profit rate is similar to the rate proposed by Barkai (2020).

We illustrate our method using longitudinal firm level data for Belgium for the period 1985-2014. We study both the level and the evolution of the price-cost margins over time. The rich time dimension of the data set enables us to distinguish cyclical variation from a secular trend. Our main empirical findings can be summarized as follows. First, accounting for the distinction between fixed and variable costs has a profound impact on the estimation of price-cost margins. Ignoring fixed costs typically underestimates price-cost margins and overestimates excess profitability. Second, the largest part of price-cost margins is needed to cover the fixed costs while only a smaller part remains left as excess profits ratio. In particular, as a fraction of sales, the price-cost margins, the fixed cost ratio and the excess profit margin are estimated at 25.9%, 23.4% and 2.5% respectively over the sample period. Third, Belgian price-cost margins decline by 4.6 percentage points between 1985 and 2014. Our method allows to decompose the change of the price-cost margin into a change in the fixed costs ratio on the one hand and a change in the excess profits margin on the other hand. These components decrease respectively by 3.7 and 0.9 percentage points, thereby reinforcing each other. Finally, our results show that for the aggregate markup, the strategy of keeping service inputs fixed (and material inputs variable) generates markup estimates reported by De Loecker et al. (2018) for Belgium which are close to our estimates.

The remainder of the paper is structured as follows. In the next section 2, we introduce the theoretical framework which allows us to simultaneously estimate the price-cost margin and the share of fixity for *each* input. In section 3, we describe our data set, while section 4 discusses the estimation results and compares our estimation results to other common methods in the literature. Section 5 provides a more in-depth analysis of various aspects of our methodology, both from a theoretical and an empirical point of view, ensuring the robustness of our estimation results. In particular, we look into measurement issues (e.g. cost of capital), specification issues and monopsony power in the labor and intermediate input market, among others. Finally, we conclude in section 6.

2. Theoretical framework

Our approach is an extension of Hall (1988) and Roeger (1995). In particular, we allow for the presence of fixed costs while we also explore the consequences of non-constant returns to scale on the variable inputs for the interpretation of our results. Our methodology builds on the concept of the Solow residual, which is a measure of total factor productivity (TFP) growth. The Solow residual can differ in two main dimensions. First, Solow residuals might use shares of inputs in operating revenue or in total costs. Second, Solow residuals can be derived from the production function (primal) or the cost function (dual). Contrasting these four different Solow residuals enables us to estimate price-cost margins in the presence of fixed costs.[10]

The intuition of the method builds on two principles. First, linking changes in output (i.e. quantity in the primal; prices in the dual) to weighted changes in inputs informs us about price-cost margins, i.e. how much prices differ from marginal costs. Second, if a firm wants to increase its output in the short-run, it can only do so by raising its variable inputs as fixed inputs cannot be adjusted in the short-run. This gives information about the fixity of each input. Finally, we can decompose the price-cost margin into a part which covers the fixed costs and the remaining fraction represents excess profitability.

2.1 Primal and dual Solow residuals with revenue-based shares

We start from a standard short run[11] production function F(.) for firm *i* at period *t*[12] which is homogenous of degree γ w. r. t. the variable production factors capital, labour and intermediate inputs (respectively K^v, L^v, M^v) and there is Hicks-neutral technological progress θ. Neutral technological progress implies that each production factor is multiplied with the same technology component,

$$Q = F(\theta K^v, \theta L^v, \theta M^v)^\gamma \qquad (1)$$

which means that we can write the production function as follows[13],

$$Q = F(K^v, L^v, M^v)^\gamma \theta^\gamma \qquad (2)$$

[10] Unobserved productivity shocks cancel out, like in Roeger (1995).

[11] In the short run, we would expect that capital displays the highest level of fixity while intermediate inputs and labor are more variable. Our empirical findings will support this idea. Further, moving from the short run (Δ1 year) to the middle (Δ5 year) and long run (Δ10 year), we would expect that the level of fixity decreases for each input, and especially so for capital. Robustness section 5.6 provides evidence for this idea.

[12] To simplify notation, we omit firm and time subscripts. The empirical analysis is at the firm-year level. We add the subscripts again in the baseline regression equation (20).

[13] See Appendix section 7.4.1 for an example in which we consider the CES production function with scale parameter γ.

where Q, K, L and M are quantities of output, capital, labor and intermediate inputs, respectively. Variable capital input equals $K^v \equiv K - K^f$, variable labor input $L^v \equiv L - L^f$ and variable intermediate inputs $M^v = \mathrm{M} - \mathrm{M}^f$. $K^v(L^v\ ;\ M^v)$ is the part of total capital (labor; intermediates) which adjusts within a time period to current demand and cost changes without friction. $K^f(L^f\ ;\ M^f)$ is the part of total capital (labor; intermediates) which is fixed and does not adjust within a period to current demand and cost changes. Fixed inputs do not directly enter into the short run production function.[14] We implicitly assume that firms are price-takers in their input markets.[15]

Examples of fixed capital, labor and intermediate inputs include rent for buildings, administration staff, or the inventory costs of raw materials, respectively. Examples of variable capital, labor and intermediate inputs include printers, production workers or electricity, respectively. In a typical firm level dataset, there is information on the total amount of an input, but no clear distinction can be made between the variable and fixed component of an input.

Define sv^k, sv^l and sv^m as the share of variable capital $\frac{K^v}{K^v+K^f}$, the share of variable labor input $\frac{L^v}{L^v+L^f}$ and the share of variable intermediate inputs $\frac{M^v}{M^v+M^f}$, respectively. These terms contain the production technology that firms use but are not observable to the econometrician.

In the following we generalize the approach of Hall (1988) and Roeger (1995). Hall looks at the implications of relaxing the condition that price equals marginal cost for the derivation of the (primal) Solow residual, while Roeger looks at the implications for the dual Solow residual and uses both residuals for eliminating unobserved TFP growth. In this paper we generalize this approach by looking at the implications for both residuals if some or all factors of production are fixed at various degrees. In addition, we make use of the fact that the Solow residual can be written in revenue and cost shares. The latter is not sensitive to the presence of markups but it is sensitive to the presence of fixed factors (see Hall, 1990).

Appropriate combination of these four residuals allows us to eliminate unobserved growth of fixed factors and TFP growth; and estimate price-cost margins and shares of fixed factors of production.[16] A key feature of our approach is that we do not have to make assumptions on the level of fixity of each

[14] A firm uses both fixed and variable inputs in its production process. Every period, the firm has to pay, or allocate, a certain level of fixed factor inputs in order to be able to produce. These fixed inputs are necessary but, by definition, do not produce any output. For this, the firm needs variable input. At the margin, the firm can only vary its variable input whereas it cannot change its fixed input anymore within that time period.
[15] Crépon, Desplatz and Mairesse (2005) extend Hall's (1988) approach by relaxing the condition that the labor market is perfectly competitive. For applications of this approach, see Dobbelaere (2004) and Dobbelaere and Mairesse (2013). See section 5.2 for a discussion on how monopsony power in the labor and intermediate inputs market might affect our coefficients.
[16] The roadmap of the derivations as well as the notation of this section builds on earlier work of Konings, Roeger and Zhao (2011).

input, but our approach allows us to estimate the share of each input which is variable i.e. which can be adjusted within the period.[17]

In the main text we provide the intuition for the wedges implied by the various Solow residuals. The appendix contains a detailed derivation.

2.1.1 Deriving the primal revenue-based Solow residual: SRQ^R

The primal revenue based Solow residual is defined as in Hall (1988) and equals:[18]

$$SRQ^R \equiv \Delta q - \frac{WL}{PQ}\Delta l - \frac{P^M M}{PQ}\Delta m - (1 - \frac{WL}{PQ} - \frac{P^M M}{PQ})\Delta k \qquad (3).$$

Define Δq , Δl, Δm and Δk as the growth rates of output, labor, intermediate inputs and capital, respectively. $\frac{\mathrm{WL}}{\mathrm{PQ}}$ and $\frac{\mathrm{P^M M}}{\mathrm{PQ}}$ are the shares of labor cost and intermediate input cost in operating revenue, respectively. W and $\mathrm{P^M}$ are the wage rate and the price of intermediate inputs.

Solow (1957) shows that SRQ^R is a correct measure for TFP growth under the assumption of perfectly competitive product markets and the absence of fixed production factors (except capital). Hall (1988) has shown how the presence of a price-cost margin drives a wedge between the Solow residual and TFP growth, which can be used to estimate the price cost margin. Here we show that the presence of fixed factors and the scale parameter add additional wedges (see Appendix section 7.4.2 for a detailed derivation to obtain Δq in equation (4)).

Using the FOCs of the profit maximization problem of the firm, the growth rate of output can be written as

$$\Delta q = \frac{1}{\gamma(1-B)}\left(\frac{sv^K RK}{PQ}\Delta k^v + \frac{sv^l WL}{PQ}\Delta l^v + \frac{sv^M P^M M}{PQ}\Delta m^v\right) + \gamma\Delta\vartheta \qquad (4)$$

Where $\mathrm{B} \equiv \frac{\mathrm{P-MC}}{\mathrm{P}}$ is the price cost margin and $\frac{\mathrm{sv^k RK}}{\mathrm{PQ}}$, $\frac{\mathrm{sv^l WL}}{\mathrm{PQ}}$ and $\frac{sv^m P^M M}{\mathrm{PQ}}$ are shares of variable capital cost, variable labor cost and variable intermediate input cost in revenue, respectively. $\Delta\vartheta$ represents the growth rate of total factor productivity.

Inserting equation (4) into (3) gives the primal Solow residual with revenue-based shares,

[17] Shapiro (1987) focuses on capital fixity to explain why the primal Solow residual might be poorly correlated to the dual Solow residual. Roeger (1995) stresses imperfect competition in explaining the difference between the primal Solow residual and dual Solow residual. Konings, Roeger and Zhao (2011) consider fixed capital and fixed labor to explain the difference between the primal and dual Solow residual.

[18] Assume for example that the product quantity increases by 5% (Δq) while the inputs (Δl, Δk and Δm) increase by 3%, then the firm becomes 2% more productive (SRQ^R).

$$SRQ^R = (1-\gamma(1-B))(\Delta q - \Delta k) + \left(\frac{sv^K RK}{PQ}(\Delta k^v - \Delta k) + \frac{sv^l WL}{PQ}(\Delta l^v - \Delta l) + \frac{sv^M P^M M}{PQ}(\Delta m^v - \Delta m)\right) + \frac{(1-sv^L)WL}{PQ}(\Delta k - \Delta l) + \frac{(1-sv^M)P^M M}{PQ}(\Delta k - \Delta m) + \gamma^2(1-B)\Delta\theta \qquad (5)$$

Equation (5) gives the correct representation of SRQ^R and shows that the presence of fixed factors and the scale parameter introduces additional wedges between SRQ^R and $\Delta\theta$ beyond the wedge imposed by positive price cost margin.[19] When the share of variable factors is less than one, then the variation of factor inputs affects SRQ^R. Assume for example that $0 < sv^l < 1$, $\Delta l^v > 0$, $\Delta l^f = 0$, such that $\Delta l^v > \Delta l$. This implies that the growth rate of labor underestimates the true increase of variable labor and therefore attributes part of Δq to an increase in efficiency. In the extreme case that all inputs are fixed (e.g. $sv^l = 0$), this bias disappears in the second term of equation (5), however it remains in the third term. Both the deviations from CRS and a positive price-cost margin drive a wedge between SRQ^R and efficiency growth.

2.1.2 Deriving the dual revenue-based Solow residual: SRP^R

Similar to the approach introduced by Roeger (1995), we consider alternative representations of the Solow residual which are based on the cost function (see Appendix section 7.4.1 for a derivation)

$$C^v = C^v(W, R, P^M, Q, \theta) = G(W, R, P^M)\theta^{-1}(Q)^{1/\gamma}$$

corresponding to the production function in equation (2) with marginal cost,

$$MC_Q = \frac{dC}{dQ} = G(W, R, P^M)\frac{1}{\gamma}(Q)^{\frac{1}{\gamma}-1}\left(\frac{1}{\theta}\right)$$

Under the assumption that price equals marginal cost and no fixed factors of production, the dual revenue-based Solow residual is defined as,[20]

$$SRP^R \equiv \frac{WL}{PQ}\Delta w + \frac{P^M M}{PQ}\Delta p^M + \left(1 - \frac{WL}{PQ} - \frac{P^M M}{PQ}\right)\Delta r - \Delta p \qquad (6)$$

where Δp, Δw, Δp^M and Δr are the growth rates of product price, wage per employee, intermediate input price and the rental price of capital, respectively. As we will show next, only in the absence of fixed factors, zero markups and CRS, SRP^R is an unbiased measure of TFP growth

Logarithmic differentiation of marginal costs and Shepard's lemma yields the following expression for the growth rate of the price (see section 7.4.3):

[19] This expression simplifies to $SRQ^R = B(\Delta q - \Delta k) + (1-B)\Delta\theta$ under the simplifying assumptions of no fixed costs and a scale parameter of one, as shown by Hall (1988).
[20] Assume for example that the product price increases by 2% while all input prices increase by 1%, then SRP^R will equal -1% indicating that a firms' output price increases faster than its input prices.

$$\Delta p = \left(\left(1-\gamma(1-B)\right)\Delta p + \left(\frac{sv^K RK}{PQ}\Delta r + \frac{sv^l WL}{PQ}\Delta w + \frac{sv^M P^M M}{PQ}\Delta p^m\right) - \gamma(1-B)\Delta\theta + \gamma(1-B)\left(\frac{1}{\gamma}-1\right)\Delta q\right) \quad (7)$$

Substituting equation (7) into equation (6), we obtain equation (8):

$$SRP^R = -\left(1-\gamma(1-B)\right)(\Delta p - \Delta r) + \frac{(1-sv^l)WL}{PQ}(\Delta w - \Delta r) + \frac{(1-sv^M)P^M M}{PQ}(\Delta p^m - \Delta r) + \gamma(1-B)\Delta\theta - \gamma(1-B)\left(\frac{1}{\gamma} - 1\right)\Delta q \quad (8)$$

Equation (8) shows that SRP^R is the correct representation of TFP growth, if labour and materials are variable factors of production, markups are zero and there are constant returns to scale. Wedges arise if these conditions do not hold. Suppose for example that $sv^l < 1$ and $\Delta w > \Delta r$ then SRP would wrongly signal an increase in TFP because the wage increase would signal a too strong increase of marginal cost. Note, the fact that the difference between Δw and Δr matters for the bias derives from the fact that both factor prices are multiplied with the wage share (with opposite sign) which is mis-measured in the case of partially fixed labour. Obviously in case of increasing returns (and zero markups), SRP^R overestimates TFP growth, while in the CRS case SRP^R is a weighted average of the markup component and TFP growth.

2.2 Primal and dual Solow residuals with cost-based shares

Hall (1990) proposes a cost-weighted measure as a way of avoiding the bias caused by imperfect competition. The cost-weighted primal and dual Solow residual are not subject to the price-cost margin but the fixity of the inputs as well as the scale parameter drive additional wedges.

2.2.1 Deriving the primal cost-based Solow residual: SRQ^C

The primal Solow residual with cost-based shares SRQ^C is defined as follows:

$$SRQ^C \equiv \Delta q - \frac{WL}{C}\Delta l - \frac{P^M M}{C}\Delta m - \frac{RK}{C}\Delta k \quad (9)$$

Similarly, the growth rate of output can be written as a cost-weighted average of the growth rate of variable inputs plus the growth rate of productivity, adjusted by the scale parameter (see section 7.4.3 for a detailed derivation of equation (10)) as follows,

$$\Delta q = \frac{sv^K RK}{C^v}\Delta k^v + \frac{sv^l WL}{C^v}\Delta l^v + \frac{sv^M P^M M}{C^v}\Delta m^v + \gamma\Delta\theta \quad (10)$$

Substituting equation (10) into (9), we get:

$$SRQ^C = \frac{(1-sv^K)RK}{C}(\Delta q - \Delta k) + \frac{(1-sv^L)WL}{C}(\Delta q - \Delta l) + \frac{(1-sv^M)P^M M}{C}(\Delta q - \Delta m) + \frac{sv^K RK}{C}(\Delta k^v - \Delta k) + \frac{sv^l WL}{C}(\Delta l^v - \Delta l) + \frac{sv^M P^M M}{C}(\Delta m^v - \Delta m) + \frac{C^v}{C}\gamma\Delta\theta \quad (11)$$

If all factors of production are variable, then TFP growth is correctly mapped into $\mathrm{SRQ^C}$. If instead a particular producction factor is partly fixed, then output growth exceeding factor growth would wrongly indicate an efficiency improvement (while the growth of the fixed factor would indicate a decline of TFP). Also in the presence of fixed production factors, $\mathrm{SRQ^C}$ underestimates $\Delta\theta$ by the factor $\frac{\mathrm{C^v}}{\mathrm{C}}\gamma$. Unlike the revenue-based measure $\mathrm{SRQ^C}$ is not affected by *B*.

2.2.2 Deriving the dual cost-based Solow residual: $\boldsymbol{SRP^C}$

The dual Solow residual with cost-based shares $\mathrm{SRP^C}$ is defined as follows:

$$SRP^C \equiv \frac{WL}{C}\Delta w + \frac{P^M M}{C}\Delta p^m + \frac{RK}{C}\Delta r - \Delta p \qquad (12)$$

The dual cost minimization problem implies that the growth rate of the product price can be written as a variable cost-weighted average of the growth rate of inputs' prices minus the growth rate of productivity, adjusted by the scale parameter (see Appendix section 7.4.3.).

$$\Delta p = \left(\frac{sv^K RK}{C^v}\Delta r + \frac{sv^l WL}{C^C}\Delta w + \frac{sv^M P^M M}{C^v}\Delta p^m\right) - \Delta\theta + \left(\frac{1}{\gamma} - 1\right)\Delta q \qquad (13)$$

The dual Solow residual with cost-based shares is then,

$$SRP^C = \frac{(1-sv^l)WL}{C}(\Delta w - \Delta p) + \frac{(1-sv^M)P^M M}{C}(\Delta p^m - \Delta p) + \frac{(1-sv^K)RK}{C}(\Delta r - \Delta p) + \frac{C^v}{C}\Delta\vartheta - \frac{C^v}{C}\left(\frac{1}{\gamma} - 1\right)\Delta q \qquad (14)$$

Finally, equation (14) shows the equivalence between SRP^C and TFP growth when all factors of production are variable and there are CRS, to the extent in which the share of factor fixity increases a factor price increase is wrongly interpreted as an efficiency improvement by SRP^C. This is because the Solow residual assumes total labour input enters marginal cost. Similar to the primal cost based residual, when factors of production are partly fixed $\mathrm{SRP^C}$ underestimates variations of TFP and also responds to variations in output in case of deviations from CRS.

2.3 Difference-in-differences approach

As shown in the previous section the four alternative Solow residuals measure variations of TFP correctly in the absence of price cost margins, factor fixity and under CRS. And equations (5), (8), (11) and (14) reveal the wedges inflicted. We can now exploit the differences between these variants of the Solow residual for eliminating the unobservable components.[21] We multiply the difference of equation (5) and (8) by PQ on the one hand and multiply the difference of equation (11) and (14) by total costs C on the other hand. Finally, we take the difference of these two terms and obtain the following equation,

$$(SRQ^R - SRP^R)PQ - (SRQ^C - SRP^C)C = \big(1-\gamma(1-B)\big)[(\Delta p + \Delta q) - (\Delta k + \Delta r)]PQ - (sf^k)RK[(\Delta p + \Delta q) - (\Delta k + \Delta r)] - (sf^l)WL[(\Delta p + \Delta q) - (\Delta k + \Delta r)] - (sf^m)P^M M[(\Delta p + \Delta q) - (\Delta k + \Delta r)] \qquad (15)$$

Equation (15) allows us to estimate the average shares of fixed labor, materials and capital as well as the term $B^{AVC} = 1 - \gamma(1-B)$. As can be seen from this expression, the scale parameter and the price cost margin cannot be identified separately, unless there is additional information available for γ.[22] However the term B^{AVC} can itself be interpreted as price cost margin in terms of average variable cost (AVC). It is easy to see that given the postulated technology, the pricing rule of the (imperfectly competitive) firm can be written both in terms of a markup over marginal and as a markup over average variable cost. To show this we consider the period profit maximization problem of a firm which faces an imperfectly elastic demand schedule $P(Q_t)$, with a price elasticity equal to ε . Hence, allowing for non-constant returns to scale on the variable inputs, we are able to recover an estimate of the price-cost margin in terms of average variable cost,

$$\underset{Q}{\text{Max}}\, P(Q_t)Q_t - C_t^v = P(Q_t)Q_t - G(W,R,P^M)\theta^{-1}(Q)^{1/\gamma}$$

Profit maximization yields the familiar price equation with prices as a markup over marginal cost, where $B = 1/\varepsilon$

$$(1-B)P_t = \frac{\frac{1}{\gamma}G(W,R,P^M)\theta^{-1}(Q)^{\frac{1}{\gamma}}}{Q}$$

There exists the following relationship between marginal and average variable cost

$$MC^Q = \frac{\frac{1}{\gamma}G(W,R,P^M)U^{-1}(Q)^{\frac{1}{\gamma}}}{Q} = \frac{\frac{1}{\gamma}C^v(W,R,P^M,Q,U)}{Q} = \frac{1}{\gamma}AVC$$

Thus the price equation consistent with profit maximization can also be written as

[21] Roeger and Warzynski (2004) exploit the difference between the primal and dual revenue-based Solow residual as well. However, they assume that the unobservable growth rate of variable capital can be proxied by the growth rate in labor productivity. Further, they do not allow for quasi-fixed labor, nor for quasi-fixed intermediate inputs.

[22] This equation also shows that the scale parameter γ does not affect our estimated shares of fixed inputs sf_t^k, sf_t^l and sf_t^m. Second, in the case of constant returns to scale $B^{AVC} = B$.

$$(1 - B^{AVC})P_t = AVC$$

The parameter B^{AVC} has an economic interpretation, i.e. it shows whether prices are large enough to cover the average variable costs in the short run which is broadly known as the "shutdown rule". However, B^{AVC} larger than zero is a necessary condition for a firm to be profitable but not sufficient, since the markup must be large enough to cover fixed costs. We rewrite B^{AVC} as,

$$B^{AVC} = 1 - \frac{C^v}{PQ} \qquad (16)$$

while we define the fixed costs C^f as a share of revenues as,

$$C^f = FCR * PQ \qquad (17)$$

with FCR as the share of fixed costs in operating revenue. Subtracting the fixed costs ratio from the markup in terms of average variable costs gives the excess profit rate EPR,

$$B^{AVC} - FCR = EPR = 1 - \frac{C^v}{PQ} - \frac{C^f}{PQ} = 1 - \frac{C}{PQ} \qquad (18)$$

Note, the excess profit rate can be calculated directly by using data on costs and revenues (see Barkai 2020). The excess profit rate therefore serves as a plausibility check for our estimate of the price cost margin and the fixed cost ratio, which of course cannot be inferred from the profit rate.

Our measure of the excess markup can be directly compared to estimates of the profit rate (Barkai, 2020). As shown in discussions (see e.g. Basu, 2019) of recent US estimates, it is often difficult to link the markup estimates to profit estimates, since information about fixed cost is missing. Our estimate of $B^{AVC} > 0$ can have three different interpretations:

- Case 1: $\gamma = 1$ and $B^{AVC} = B$: In this case our estimated price-cost margin in terms of average variable cost is identical with the price-cost margins in terms of marginal cost. In particular we know in this case that factors of production are paid less than their marginal product if $B^{AVC} = B > 0$. A positive estimate for B^{AVC} signals that the price exceeds marginal cost, which are identical to average variable cost.
- Case 2: $\gamma > 1$ and $B^{AVC} < B$: In this case B^{AVC} is underestimating the price-cost margin, i. e. we are underestimating the degree in which factors of production are paid less than their marginal product. Note under this technological constellation the sum of marginal products (multiplied with their respective factor inputs) exceeds the level of output. Paying production factors their marginal product would result in losses for the firm. A markup is necessary for

avoiding a loss. This makes it difficult to interpret the presence of a price-cost margin as sign for imperfect competition. But a positive estimate of B^{AVC} unambiguously informs about the difference between revenue and average variable cost.

- Case 3: $0 \leq \gamma < 1$ and $B^{AVC} > B$: In this case B^{AVC} is overestimating the price-cost margin. There could even be the limit case where factors of production are paid their marginal product, but since the sum of marginal products (multiplied with their respective factor inputs) is smaller than output there is nevertheless an extra return.

Thus in all three cases the estimate of B^{AVC} unambiguously tells us whether prices exceed average variable cost, though we cannot exactly infer the underlying reason ($\gamma < 1 \; or \; B > 0$). And second, since we know the share of fixed costs, our estimate tells us whether this extra return is sufficient to cover fixed costs.

We apply equation (15) to a firm panel dataset with firms $i \,\epsilon\, (1, I)$ and $1 \leq t \leq T$ as in equation (20). Note in particular that the dependent variable and the explanatory variables can all be formulated in nominal terms. In particular the differences of the primal and dual Solow residuals which enter the LHS can be expressed in terms of nominal variables and they are multiplied with nominal revenue and nominal cost respectively. The regressors are also growth rates of nominal variables. This makes our approach especially suitable for firm panel applications where generally only nominal variables are observed.

$$(SRQ_{it}^{R} - SRP_{it}^{R})PQ_{it} - (SRQ_{it}^{C} - SRP_{it}^{C})C_{it} = (B_{t}^{AVC} + \epsilon_{it}^{B})PQ_{it}[(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] - (sf_{t}^{k} + \epsilon_{it}^{k})RK_{it}[(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] - \left(sf_{t}^{l} + \epsilon_{it}^{l}\right)WL_{it}[(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] - (sf_{t}^{m} + \epsilon_{it}^{m})P^{M}M_{it}[(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] + \epsilon_{it} \qquad (20).$$

We formulate our regression model as a static correlated random coefficients model and allow for firm-specific heterogeneity by assuming that B_i, sf_i^k, sf_i^l and sf_i^m are i.i.d. with unconditional mean $B, sf^k, sf^l \; and \; sf^m$ and stochastic terms $\epsilon_i^B, \epsilon_i^k, \epsilon_i^l, \epsilon_i^m$ with a mean of zero and variance $\sigma_i^B, \sigma_i^k, \sigma_i^l, \sigma_i^m$ respectively, in each year *t*. We regard firm-specific heterogeneity as the main source of the error term, and assume that any other errors are captured by the pure measurement error term ϵ_{it}. Since the regression equation can be formulated in nominal terms, this reduces measurement error significantly. As shown by Hsiao et al. (2019) the unconditional mean of the price-cost margin and the shares of fixed costs can be estimated consistently with a fixed effects estimator, even if the error terms are correlated with the regressors, provided regressors and error terms are distributed symmetrically.[23,24] Since the left-hand side of equation (20) is the difference of the difference of the primal and dual Solow residual with revenue-based shares and the difference of the primal and dual Solow residual with cost-based shares, we refer to it as a "difference-in-differences" (DID) approach.[25]

2.4 Challenges and limitations

The main advantages of our approach are that (i) we do not have to classify inputs as quasi-variable or quasi-fixed[26], (ii) we do not need to rely on price deflators, (iii) the endogeneity problem between productivity shocks and growth in output or input factors is resolved and (iv) we obtain an aggregate price-cost margin estimate which can be decomposed into a fixed costs ratio and an excess profits ratio.[27, 28]

In comparison with Roeger (1995), we relax the assumption of constant returns to scale on all inputs to non-constant returns to scale on the variable inputs.[29] Further, we assume that all inputs are non-dynamic such that we rule out, for example, adjustment costs.[30]

Another concern might be measurement error in input factors. Since our model is estimated in first differences, it may exacerbate measurement errors, which leads to a downward bias of the estimates as suggested by Griliches and Hausman (1986) and Griliches and Mairesse (1995). However, this conclusion rests on the classical errors in variables in models under strict exogeneity. So whether the bias in first differences is larger than that in OLS, or vice versa, is unknown (Wooldridge, 2002). Nevertheless, we argue that the scope of mismeasurement issues is limited because we can use

---

[23] An important advantage of equation (20) is the fact that all variables are expressed in nominal terms, hence, price deflators are not required for estimating B consistently. In particular, we can use the growth rate of operating revenue ($\Delta p + \Delta q$) which combines the growth rate of the product price (Δp) and the product quantity (Δq).

[24] At this stage, we assume that there is no measurement error, nor any specification error. We come back to these issues in this section (2.4) and in the robustness tests (5.1 and 5.4).

[25] Our method assumes that inputs cannot influence demand (for a discussion on this, see Syversson (2011)). Furthermore, we have to assume that prices are uncorrelated with input choices at the firm level. Firms do not have market power in the input market. For a discussion on how monopsony power affects our estimates, see section 5.2.

[26] See section 4.3 for a discussion on the assumption of quasi-variable and quasi-fixed inputs in the De Loecker and Warzynski (2012) framework.

[27] Much of the current debate is about the evolution of the aggregate price-cost margin. De Loecker et al. (2020) show that the aggregate markup rises from 21% above marginal costs in 1980 to 61% in recent years in the United States.

[28] Our method links changes in inputs to changes in output, and identifies the aggregate price-cost margin which suits the data best. Firms are not assumed to have the same markup, rather, we are only able to estimate an aggregate price-cost margin. Recent papers (e.g. De Loecker et al., 2020) have shown that markups might differ substantially at the firm-year level. Our approach is able to estimate price-cost margins and the shares of fixity as soon as we are able to aggregate up one level. We discuss this in more detail in section 5.8.

[29] When external information on the returns to scale is unavailable, the assumption of constant returns to scale on *all* inputs is commonly used in applied production papers as well as in applied work with firm level data as aid to identification (Flynn, Gandhi and Traina, 2019).

[30] Ackerberg, Benkard, Berry and Pakes (2007) or Asker, Collard-Wexler and De Loecker (2014) focus on the issue of dynamic inputs. An input is static if its current choice has no impact on future profits whereas an input is dynamic if it does. Intermediate inputs, and regularly labor as well, are considered to be non-dynamic or static inputs while capital can be thought of as dynamic due to, for example, adjustment costs.

nominal values rather than deflated input or output quantities, and especially so for labor or intermediate input costs. Unfortunately, the nominal cost of capital is not observed and estimating this variable remains challenging. Therefore, we provide various robustness tests in robustness section 5.1. Reassuringly, our main results are robust to alternative definitions of the cost of capital.

Finally, we might worry about a specification error. Following Roeger (1995), we allow the price-cost margin *B* and the various shares of fixed factor inputs sf^l, sf^k and sf^m to vary systematically with firm size. We provide a discussion about these concerns in robustness section 5.4.

3. Data

We illustrate our method by applying it to Belgian unconsolidated firm level data, obtained from the National Bank of Belgium.[31] This dataset covers all for-profit firms from 1985 until 2014. Our sample uses all incorporated firms which report full company accounts. Small firms have to report abbreviated company accounts (see section 7.1 for more details). We use the following balance sheet variables in our analysis: operating revenue[32], wage costs, intermediate input costs, tangible fixed assets and depreciation. In order to compute the cost of capital, we extend the definition used by Hall and Jorgenson (1967). We refer to the data appendix in section 7.1 for more detailed information about the data.

Table 1 Summary Statistics

Variable	Mean	SD	P25	P50	P75	N
PQ	34.05	282.16	2.90	7.67	18.79	358,143
WL	4.44	29.81	0.39	1.07	2.59	358,143
$P^M M$	26.63	258.09	1.57	5.19	13.96	358,143
TFA	6.92	81.84	0.11	0.57	2.05	358,143
Depreciation	1.30	13.86	0.04	0.16	0.53	253,451
$(\Delta p+\Delta q)$	7.1%	24.4%	-2.5%	4.7%	13.9%	316,232
$(\Delta w+\Delta l)$	4.8%	21.8%	2.0%	3.7%	10.1%	316,232
$(\Delta p^M+\Delta m)$	7.3%	26.3%	-3.1%	5.0%	15.5%	316,232
ΔTFA	1.7%	34.2%	-11.4%	-1.5%	1.04%	316,232
LS	0.126	0.137	0.022	0.085	0.170	358,143
MS	0.779	0.199	0.687	0.838	0.940	358,143
CS	0.096	0.119	0.029	0.052	0.115	358,143

Notes: : *The mean, standard deviation, P25, P50 and P75 are shown in nominal million EUR for operating revenue, wage costs, intermediate input costs, tangible fixed assets and depreciation. The number of observations are shown in units. The summary statistics for the growth rates and the input shares have been weighted by firm-year operating revenue. The labor (intermediates) share is calculated as total labor (intermediate input) cost divided by operating revenue.*

[31] We provide a robustness test in which we exploit a proxy for consolidated accounts in section 5.7.

[32] Operating revenue captures the value of output produced in one period. We link this to the value of inputs used in the same period. Operating revenue deviates from sales as the later captures the value of output sold and is not directly linked to the value of inputs. Taken to the extreme, a firm which does not produce anything (and thus uses no inputs) might still be able to sell some of its inventory. In this case, the operating revenue will be zero whereas sales will be positive. Note that we use operating revenue rather than revenue.

Table 1 provides summary statistics. The average firm in our sample has an operating revenue (PQ) of 34.05 million EUR, a wage bill (WL) of 4.44 million EUR , intermediate input costs ($P^M M$) of 26.63 million EUR and tangible fixed assets (TFA) of 6.92 million EURO. Nominal operating revenue grows on average by 7.1% per year, labor costs by 4.8% and intermediate inputs by 7.3%.[33] Tangible fixed assets increase by 1.7% on average per year. Further, note that the intermediate input share (77.9%) is the most dominant input factor, followed by the labor share (12.6%) and the capital share (9.6%).

4. Results

Our results section consists out of three main parts. First, we present pooled estimation results over the period 1985-2014. We start by considering price-cost margins in the absence of fixed factors of production, which we then relax to allow each input factor to have a variable and a fixed component. We compare these estimation results and show that ignoring fixed input factors overestimates the excess profits ratio while it underestimates price-cost margins. We then estimate the same for each year, which allows us to analyse potential secular trends. Finally, we compare our results to other common methods in the literature.

4.1 Pooled estimation results: with and without fixed costs

Following Roeger (1995), we estimate price-cost margins, and pool over the period 1985-2014. At this stage, we assume that capital, labor and intermediate inputs are fully flexible and adjust immediately to their equilibrium values without any adjustment costs. We weigh this regression by firm-year operating revenue to obtain a weighted aggregate price-cost margin for Belgium. We include a broad set of fixed effects: year, industry[34] and/or year-industry fixed effects.[35]

We then allow each input factor to have a variable and a fixed part. We make use of equation (20) to jointly estimate price-cost margins and the share of fixity for each input, and pool the data over the entire sample period. Columns (1)-(6) and column 7 in Table 2 show the estimation results for the case without and with fixed costs, respectively.

As long as inputs are fully variable, price-cost margins are equal to the excess profits ratio since there are no fixed costs to cover. Introducing fixed input factors leads to a decomposition of price-cost margins into two components: one part is needed to cover fixed costs while the remaining part

[33] We calculate the growth rate in year t as the increase (decrease) between year t-1 and year t relative to the average of the values in year t-1 and year t. This ensures that growth rates are part of the interval [-2.00, 2.00].
[34] An industry is defined as a NACE (rev. 2) two digits category.
[35] Note that the yearly estimates (section 4.2) include only industry fixed effects while the industry estimates (section 5.8) include only year fixed effects.

represents firms' profitability. We include the fixed costs ratio and the excess profits ratio as additional rows in Table 2.

Table 2 Price-cost margins

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Price-cost Margins	0.079***	0.079***	0.080***	0.079***	0.080***	0.080***	0.259***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.012)	(0.012)	(0.016)
Share of Fixed Capital							0.679***
							(0.036)
Share of Fixed Labor							0.169***
							(0.028)
Share of Fixed Intermediates							0.236***
							(0.017)
Fixed Costs Ratio	-	-	-	-	-	-	*0.234****
	-	-	-	-	-	-	*(0.016)*
Excess Profits Ratio	*0.079****	*0.079****	*0.080****	*0.079****	*0.080****	*0.080****	*0.025****
	(0.010)	*(0.010)*	*(0.010)*	*(0.010)*	*(0.012)*	*(0.012)*	*(0.002)*
Year FE	No	Yes	No	Yes	No	No	No
Industry FE	No	No	Yes	Yes	No	No	No
Year-Industry FE	No	No	No	No	Yes	Yes	Yes
N	280,252	280,252	280,252	280,252	280,252	280,252	280,252
r2	0.272	0.276	0.274	0.278	0.349	0.349	0.510

Notes: *Columns (1)-(6) show results from equation (3). Column (7) shows results from equation (20). Regressions are weighted by operating revenue at the firm-year level. Standard errors in parentheses (+ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001). Standard errors are clustered by NACE 2 digits.*

Considering first the scenario without fixed costs in columns (1)-(6), we find that a price-cost margin of 8.0% maps one-to-one into an excess profits ratio of 8.0% due to the fact that the fixed costs ratio equals 0.0%. Column (7) shows the estimation results once we allow for fixed costs. Allowing for fixed cost, increases the estimated price-cost margin from 8% to 25.9%. The largest part (23.4%) of this price-cost margin, however, is required to cover fixed costs as a percentage of operating revenue while only a smaller part remains left as excess profits ratio (2.5%).[36, 37]

The estimated shares of fixed input factors are all highly statistically significantly different from zero, with the highest share of fixed costs is found for capital (67.9%), followed by intermediate inputs (23.6%) and labor (16.9%).[38]

We are now able to define the price-cost margin 'bias' as the difference between the price-cost margins in the absence of fixed costs (column 6) and price-cost margins in the presence of fixed costs

[36] Note that total costs do not increase once we account for fixed costs. Rather, we are able to estimate which share of total costs is variable and which share is fixed.

[37] Traina (2018) defines the share of fixed costs in total costs as SG&A / (SG&A + COGS). Considering U.S. firms in 2016, it approximately equals 22% which is in the same order of magnitude as our Belgian fixed costs ratio.

[38] This does not mean that fixed capital will also be the largest component in terms of absolute fixed costs. In particular, the intermediate input share is 8.1 time as large as the capital share but the estimated share of fixed capital is 'only' 2.9 times as large as the estimated share of fixed intermediate inputs. Ignoring the presence of fixed intermediate inputs in the estimation of price-cost margins might induce a substantial bias.

(column 7). Likewise, we can define the excess profits ratio 'bias' as the difference between the excess profits ratio in the absence of fixed costs (i.e. this equals the price-cost margins in the absence of fixed costs) and the excess profits ratio in the presence of fixed costs. The PCM bias and the EPR bias are respectively equal to 17.9% and 5.5%. The sum of these two types of bias is equal to the fixed costs ratio of 23.4%. Ignoring the existence of fixed costs would thus underestimate the price-cost margin and overestimate the excess profitability.

4.2 Annual estimation results: with and without fixed costs

By pooling the data over the different years we implicitly assume that the price-cost margin and shares of fixed input factors remain constant over time. However, firms are likely to vary their price-cost margin as well as their mix of variable and fixed input factors in response to changing economic circumstances over time. In particular, the recent work of De Loecker et al (2020) has pointed to a potential substantial increase in market power. We therefore estimate equation (20) for each year such that we obtain a yearly price-cost margin estimate and yearly estimates for the shares of fixed input factors.

Figure 1 shows the results of this estimation and plots the evolution of the aggregate price-cost margin, the fixed costs ratio and the excess profits ratio.[39] As a comparison, we add the evolution of the price-cost margin in the absence of fixed costs. Note that we lose the year 1985 due to the fact that we use growth rates in our regressions.[40] Figure 1 reveals various interesting patterns. Overall, the price-cost margin displays a moderately decreasing trend and goes from 28.7% in 1986 to 24.1% in 2014.[41] This evolution seems to be driven by the fixed costs ratio which drops from 25.6% in 1986 to 21.9% in 2014. Both components experience quite some fluctuations from one year to the other.[42] Further, the excess profits ratio has been rather stable, especially during the past two decades. It falls from 3.1% in 1986 to 2.0% in 1993 after which it increases again until 3.0% in 2006. From 2007 onwards, the Belgian economy is hit by respectively the financial and European debt crisis such that the excess profits ratio falls again to a value of 2.2% in 2014.

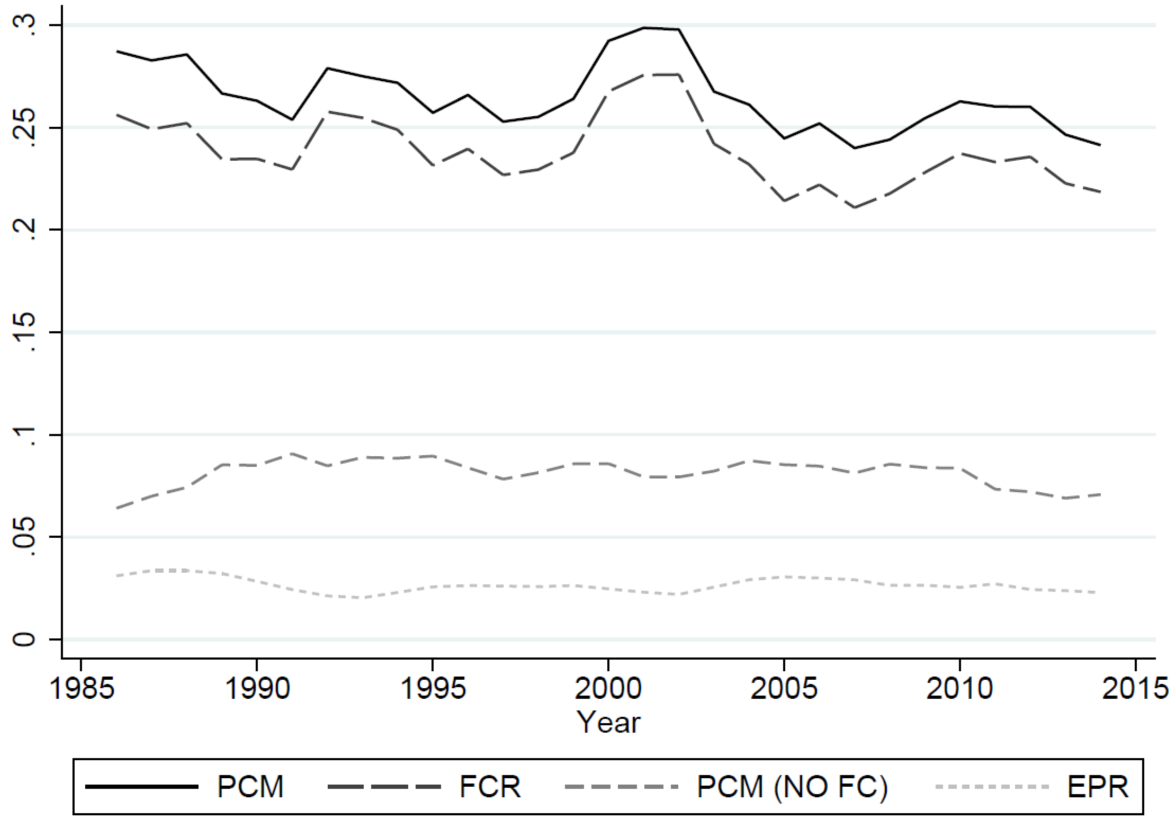
[39] (Appendix) Table 7 displays the corresponding actual values for the price-cost margin, fixed-cost ratio and excess profits ratio. Figures display smoothed values. We also include standard errors and significance stars. Note that figures and numbers in the text refer to smoothed values.

[40] We omit confidence intervals in the figures in order to simplify it. All yearly coefficients are always highly significant in Figure 1.

[41] De Loecker, Fuss and Van Biesebroeck (2018) also find that Belgian price-cost margins are falling in recent decades.

[42] Moreover, part of the variation in the price-cost margin and the fixed costs ratio seems to be linked to the business cycle. The price-cost margins and the fixed costs ratio reach a peak around the early '90s, the early '00s and the end of the '00s, which corresponds to years with an economic slowdown or recession in Belgium.

Figure 1 Evolution of price-cost margins



Notes: *This figure shows the evolution of price-cost margins (equation 3), and the evolution of the price-cost margins, fixed cost ratio and the excess profits ratio (equation 20) at the yearly level. The evolution of variables has been smoothed. Each observation is the simple average of its current observations and one observation before and after its current observation.*

Looking at price-cost margins in the absence of fixed costs, we find that they increase and decrease moderately at respectively the beginning and the end of the sample period while they barely move between 1990 and 2009.[43] These dynamics differ clearly from the evolution of the price-cost margins and the excess profits ratio in the presence of fixed costs. The next section compares our estimates to other common methods in the literature.

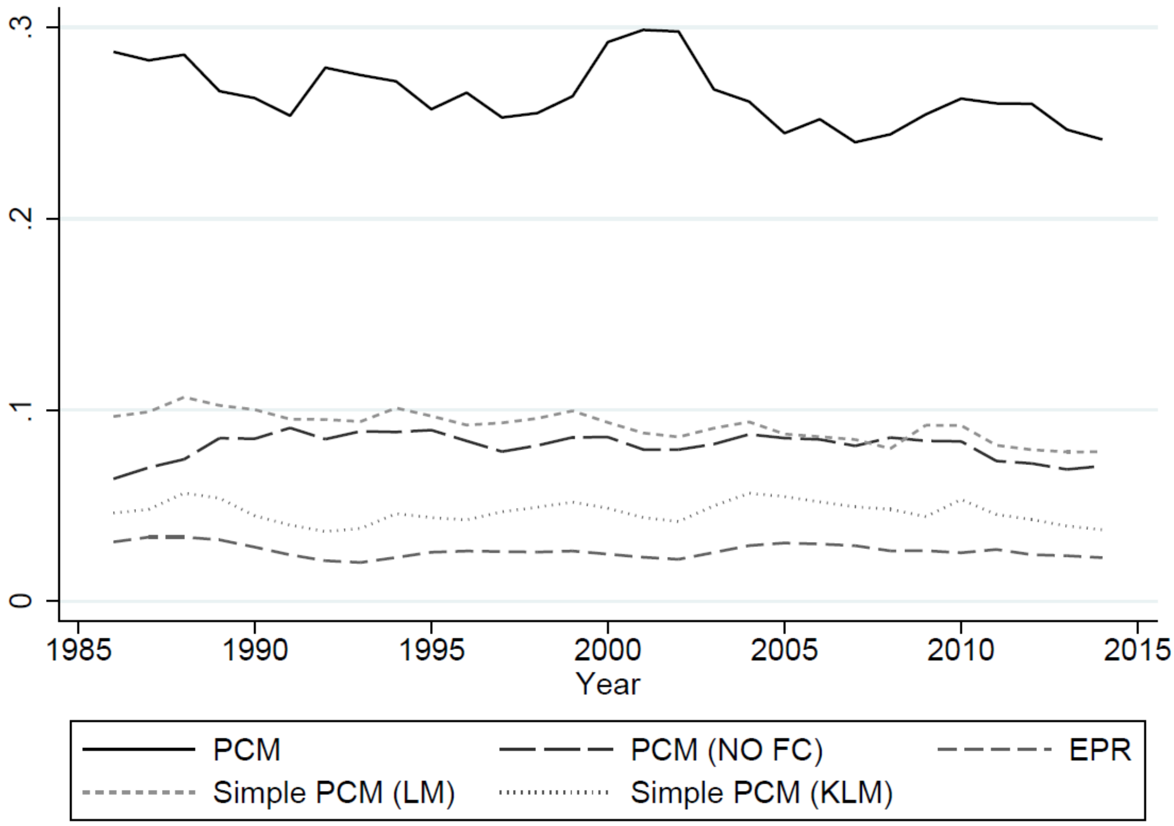
4.3 Comparison with other price-cost margin estimation methods

We compare our estimation results to two other methods. First of all, we look at price-cost margins based on the accounting approach. Second, we compare our estimates to the De Loecker and Warzynski (2012) framework.

[43] The correlation between the price-cost margins without fixed costs and the price-cost margins with fixed costs (excess profits ratio) equals -0.13 (-0.19).

Computing price-cost margins from the income statements is a straightforward approach, which does not require any estimation. For example Cavallerri et al. (2019) use such an accounting approach to explore the evolution of the markup in the Euro Area. They define the markup as the ratio of operating revenue over the sum of wage costs and intermediate input costs at the country-year level. We use the 'simple' approach to compute the accounting price-cost margin. Following Barkai (2020) we also calculate a price-cost margin in which we also incorporate capital costs, thus total cost are then the sum of wage costs, intermediate input costs and capital costs.

Figure 2 Evolution of price-cost margins and simple price-cost margins



Notes: *This figure shows the evolution of the price-cost margin, excess profits ratio (equation 20), price-cost margins (equation 3) and the two simple price-cost margins at the yearly level. The evolution of variables has been smoothed. Each observation is the simple average of its current observations and one observation before and after its current observation.*

Figure 2 compares our estimated price-cost margins, with and without fixed costs, the excess profits ratio with the two 'simple' price-cost margins. LM refers to the one which considers labor (L) and intermediate inputs (M) as costs, while KLM refers to total costs including also capital costs (K). We observe similarity between the price cost margin which ignores fixed costs and the simple PCM (LM). It is more interesting to compare our excess profit rate to what is denoted by Barkai (2020) as the pure profit rate. As shown by equation (18), both rates should coincide. As shown by Figure 2, both rates are indeed very close and only differ by about 1ppt and both measures show a similar evolution over time. They convey a similar economic message, namely that excess profits are small in Belgium and have remained fairly stable over time.

Next, we compare our estimation results to the markups obtained by De Loecker et al. (2018), building on De Loecker and Warzynski (2012). Their markup can be obtained as follows:

$$\mu_{it} = \theta_{it}^{V} * (\alpha_{it}^{V})^{-1}$$

with μ_{it}, θ_{it}^{V} and $(\alpha_{it}^{V})^{-1}$ denoting respectively the markup, the output elasticity of the variable input and the inverse of the corresponding revenue share at the firm-year level. Firm-specific markups are then aggregated into an aggregate markup, taking firm size weights into account. This looks as follows:

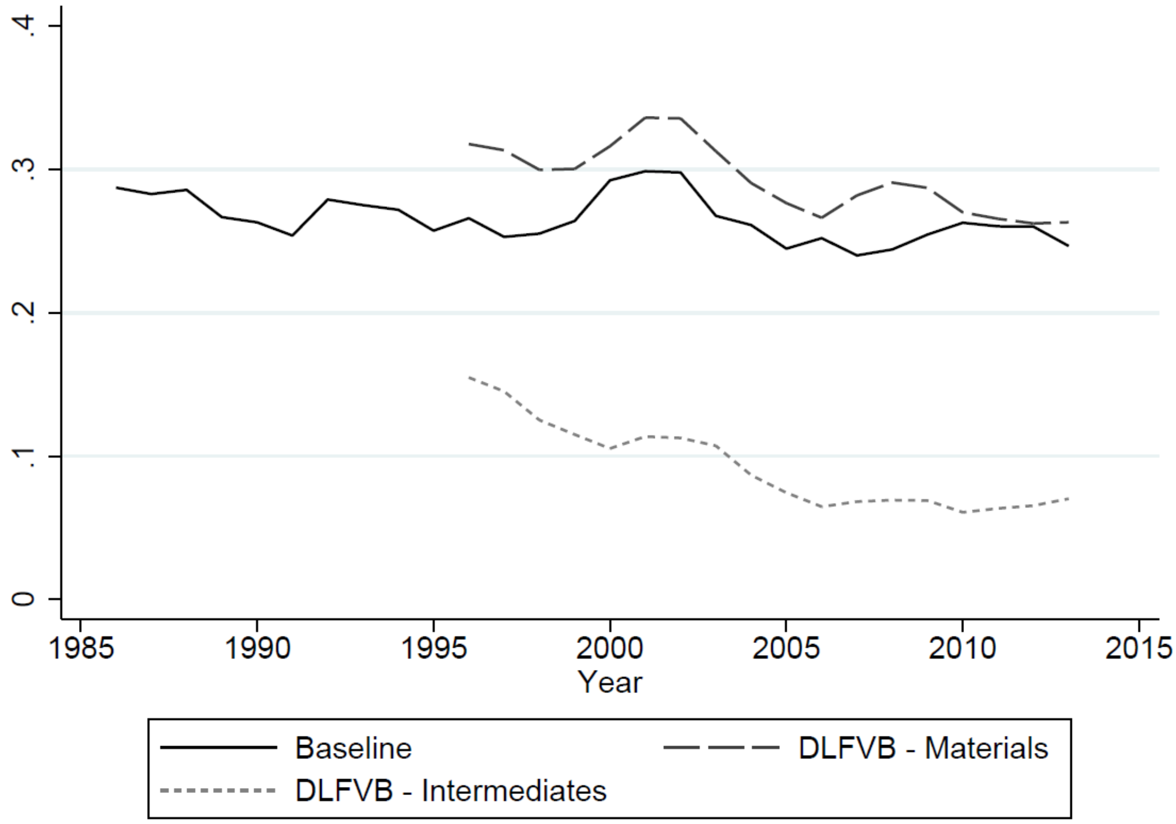
$$\mu_t = \sum_i m_{it}\mu_{it}$$

with m_{it} denoting the market share for firm *i* in a specific market in year t.

The method requires one input which is entirely variable and usually intermediate inputs are used for this. However, De Loecker, Fuss and Van Biesebroeck (DLFVB, 2018) discuss that intermediate inputs might still contain various quasi-fixed categories.[44] They exploit a unique feature of the Belgian firm level data: since 1996, firms have to break down their intermediate inputs into materials and services inputs.[45] They argue that service inputs are quasi-fixed whereas materials are quasi-variable. In this case, markups computed relying on material inputs on the one hand and markups based on services inputs on the other hand would lead to different estimated markups. The former markup should be accurate while the latter one would be biased. We follow the estimation procedure used in DLFVB (2018)[46] and estimate markups, one based on material inputs only and one based on total intermediate inputs. We convert these aggregate markups in aggregate price-cost margins. Figure 3 shows the evolution of these estimates as well as the evolution of the price-cost margins obtained from our approach, allowing for fixed costs.

[44] We use the abbreviation DLFVB to refer to the estimation procedure used in their paper.
[45] Intermediate inputs, material inputs and services inputs are respectively classified as category 60/61, 60 and 61 in the financial statement. The sum of material and services inputs is equal to intermediate inputs.
[46] We follow De Loecker et al. (2018) and compute a normalized aggregate markup in which we normalize the output elasticity such that the median firm markup equals 1.1 over the sample.

Figure 3 Evolution of price-cost margins: Baseline and DLFVB estimates

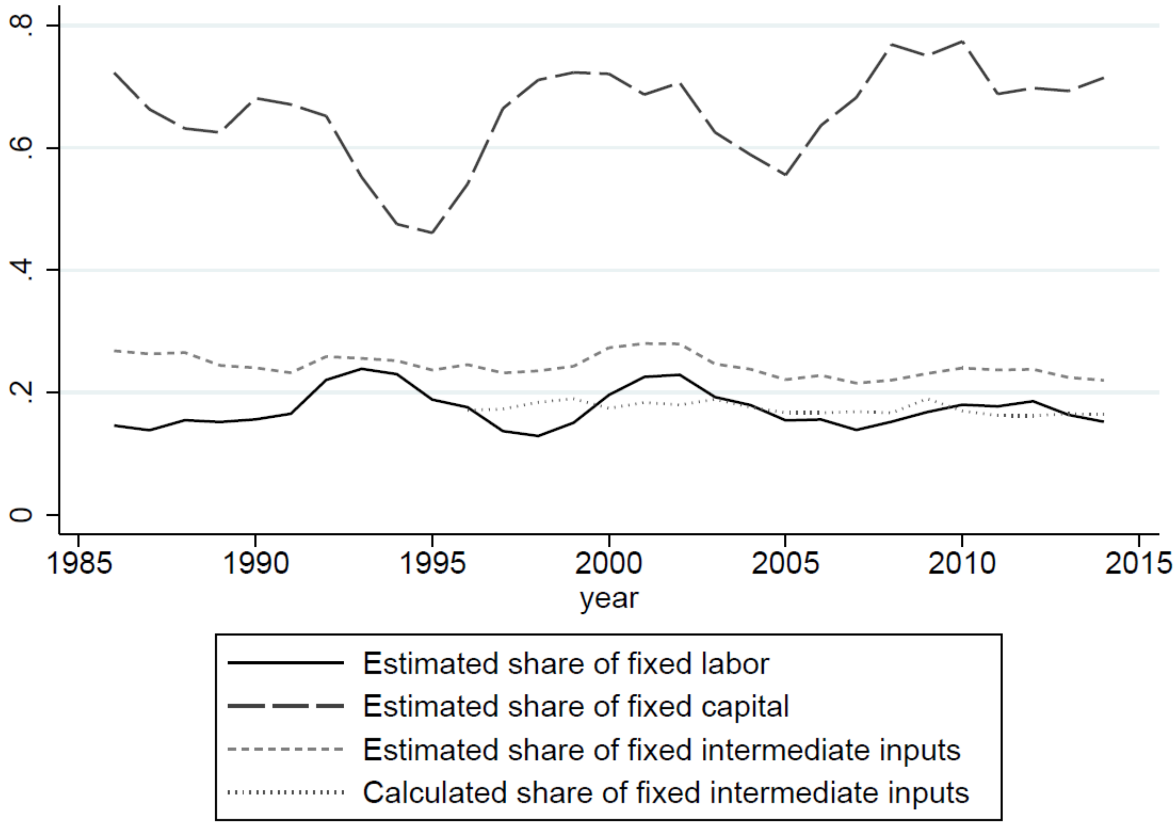


Notes: *This figure shows the evolution of our baseline price-cost margins, and the price-cost margins based on DLFVB estimates (once based on materials as variable input and once based on intermediate inputs as variable input) at the yearly level. The evolution of variables has been smoothed. Each observation is the simple average of its current observations and one observation before and after its current observation. DLFVB refers to the estimation procedure applied by De Loecker et al. (2018).*

The DLFVB price-cost margins based on just materials fall from 31.8% in 1996 to 26.3% in 2014 while our baseline price-cost margins fall from 26.6% in 1996 to 24.1% in 2014. The DLFVB price-cost margins based on intermediate inputs, thus including service inputs, fall from 15.5% in 1996 to 7.0% in 2014. Thus, our baseline price-cost margins correspond reasonably well to the DLFVB price-cost margins based on *materials*, in level as well as in (secular and cyclical) trend.

Yet, our baseline results clearly differ from the DLFVB price-cost margins based on total *intermediate inputs*. This suggests that one should estimate price-cost margins based on material inputs rather than intermediate inputs, as total intermediate inputs might contain a substantial part of quasi-fixed categories, i.e. service inputs. However, this distinction between material inputs and services inputs is typically not available in European firm level datasets.

Figure 4 Estimated and calculated share of fixed intermediate inputs



Notes: *This figure shows the evolution of the estimated share of fixed intermediate inputs (equation 20) and the calculated share of fixed intermediate inputs for the Belgian economy.*

If one assumes that material inputs and services inputs are quasi-variable and quasi-fixed, respectively, then we should find that our estimated share of fixed intermediate inputs $\widehat{sf^m}$ is reasonably similar to a proxy for this, i.e. the calculated share of fixed intermediate inputs. The calculated share of fixed intermediate inputs is defined as service inputs over intermediate inputs (i.e. the sum of material and services inputs).

Figure 4 shows the evolution of the estimated share of fixed inputs using our approach and the calculated share of fixed intermediate inputs.[47] Both trends appear to evolve in parallel over time.[48] The calculated share is in the same order of magnitude, but it is a bit lower than the estimated share of fixed intermediate inputs.

Note that the calculated share of fixed intermediate inputs assumes that materials and services are respectively entirely variable and fixed. This might hold for the vast majority of these categories, however, one can argue that some of the underlying components are respectively fixed and variable.

[47] Note that the Belgian dataset allows to construct a proxy for the share of fixed intermediate inputs, however, this level of disaggregation is not needed for the main analysis.

[48] The estimated share of fixed intermediate inputs equals 24.5% in 1996 and moves to 22.0% in 2014, whereas the calculated share of fixed intermediate components equals 17.1% in 1996 and 16.4% in 2014.

This is likely to shift the level of the calculated share of fixed intermediate inputs upwards.[49] Our estimated share of fixed intermediate inputs does not require us to specify ex-ante whether a specific input is fixed or variable.

5. Robustness

Various aspects of our novel methodology require a more in-depth analysis to ensure robustness of the results, both from a theoretical as well as from an empirical point of view. First, we discuss the issue of measurement error, and especially so for the cost of capital (section 5.1). Second, we explore how monopsony power in the labor or intermediate inputs market might affect our estimates. Although we are not able to separately estimate these parameters within our framework, these derivations provide insight on the interpretation of the estimates (section 5.2). Furthermore, we look into the issue of (un)weighted aggregate price-cost margins (section 5.3), specification issues (section 5.4), large versus small firms (section 5.5), longer time horizons, i.e. five-year and ten-year differences (section 5.6), a proxy for consolidated accounts (section 5.7) and more disaggregated results, i.e. industry level estimates (section 5.8). Overall, our main findings are robust across this broad set of robustness checks.

5.1 Measurement error: cost of capital

Pinning down the cost of capital remains challenging as there might be measurement error in the nominal cost of capital. We provide three alternative definitions: the first one considers the firms' loan rate instead of the Belgian government long-term interest rate. The second one uses an adjusted formula for the capital allowance by including a capital allowance for patents as well. The third adjustment considers a risk premium for the Belgian market.

5.1.1 Loan rate

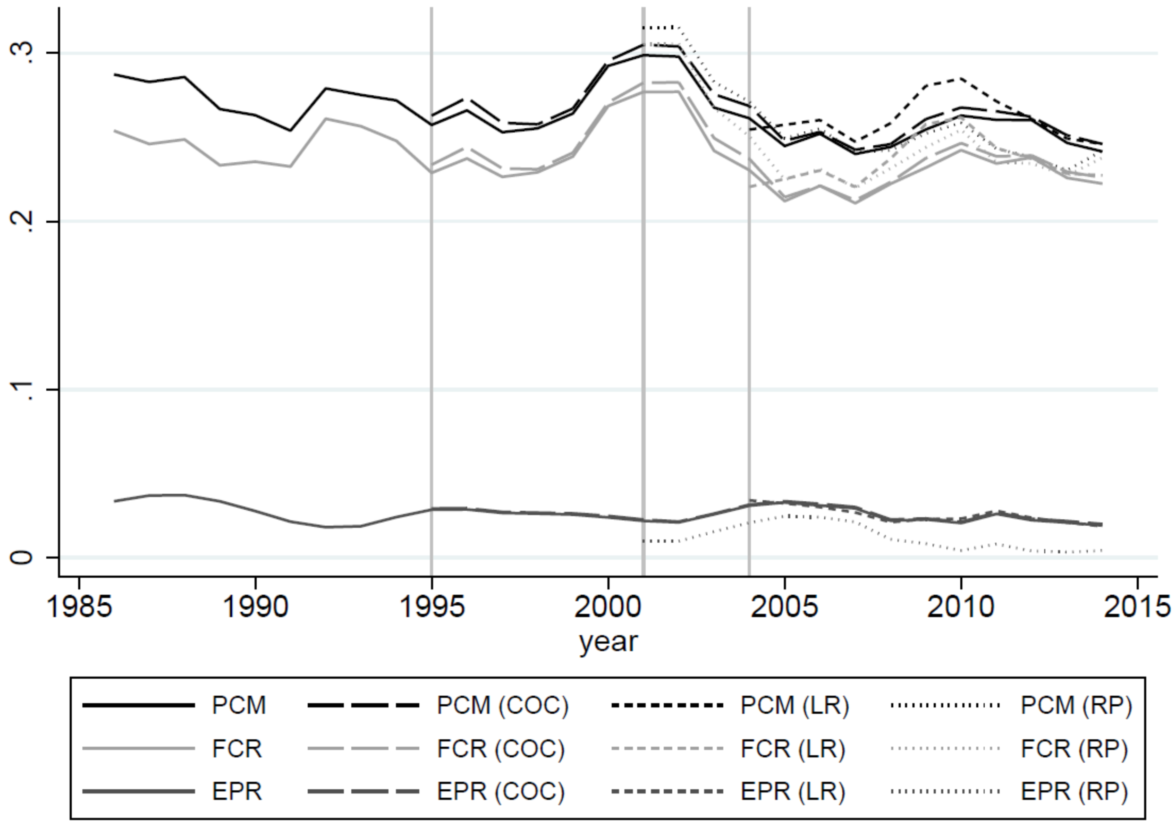
First, we replace the Belgian long-term interest rate by the cost of borrowing for firms, which we call the loan rate. This loan rate is closer related to the real borrowing cost for corporations than the Belgian long-term interest rate, however, data are only available from 2003 onwards. The loan rate is made available by the Statistical Data Warehouse of the European Central Bank. Appendix table 6 displays the values for the nominal interest rate and the loan rate. During the Financial crisis, the loan

[49] It is likely that this will increase the calculated share of fixed intermediate inputs as this measure assumes that materials, by far the largest component of intermediate inputs, are entirely variable. Even if a small fraction of materials is quasi-fixed, then, this might dominate the possibility that a fraction of services is quasi-variable. However, the data does not allow us to verify this claim. The correlation between the estimated and calculated share of fixed intermediate inputs is 0.45.

rate is above the Belgian long-term interest rate. During the European debt crisis, the loan rate is lower than the Belgian long-term interest rate.

We compare our new results with our baseline results in Figure 5.[50] The new results are consistent with our main findings: the excess profits ratio remains basically unchanged while the fixed costs ratio and the price-cost margins are close to the baseline results, i.e. they are slightly higher, especially during the Financial Crisis.

Figure 5 Evolution of excess profits ratio: cost of capital & loan rate



Notes: *This figure shows the evolution the excess profits ratio (equation 20) under various robustness tests for the Belgian economy. The evolution of Belgian variables has been smoothed. Each observation is the simple average of its current observations and one observation before and after its current observation.*

5.1.2 Capital allowances

The second robustness test considers an adjustment of the cost of capital. Our baseline cost of capital measure considers capital allowances for machines and buildings. Additionally, we also take patents into account, made available by the OECD (2021). Note that these data are only available from 1994 onwards. We add these values to (appendix) table 6 as well.

[50] (Appendix) Table 8 displays the corresponding actual (not smoothed) values for the price-cost margin, fixed-cost ratio and excess profits ratio. We also include standard errors and significance stars.

We show the results in Figure 5 and demonstrate that our main findings still hold.[51] The price-cost margins, fixed costs ratio and excess profits ratio are very similar to our baseline results.

5.1.3 Risk premium

Next, we include a market risk premium in the calculation of our cost of capital. We source the values for this risk premium from Fenebris (2021). Data is available from 2000 onwards and included in appendix table 6. Figure 5 visualizes the new results, and shows that the excess profits ratio follows the same trend but at a lower level.[52] The aggregate risk premium increases the cost of capital, which decreases the excess profits ratio. The price-cost margin and the fixed cost ratio follow a similar pattern as the baseline results.

5.2 Exploring monopsony power in the labor and intermediate inputs market

We explore the consequences of monopsony power in the labor and intermediate inputs market for the interpretation of our results.[53] Although we are not able to estimate the monopsony power in the labor market and intermediate inputs market, defined by B^L and B^M, it is valuable to understand how a deviation from these assumptions might affect our coefficients.

Building on equation (20), we introduce monopsony power in the labor market as well as in the intermediate inputs market while assuming a scale parameter of one. Building on Curry, Love and Shumway (2007), and our own derivations, equation (20) becomes:

$$(SRQ^R - SRP^R)PQ - (SRQ^C - SRP^C)C = -B * PQ[(\Delta p + \Delta q) - (\Delta k + \Delta r)] - (sf_t^k)RK_{it}[(\Delta p + \Delta q) - (\Delta k + \Delta r)] - \left(\frac{sf_t^l + B^L}{1+B^L}\right) WL_{it}[(\Delta p + \Delta q) - (\Delta k + \Delta r)] - \left(\frac{sf_t^m + B^M}{1+B^M}\right) P^M M_{it}[(\Delta p + \Delta q) - (\Delta k + \Delta r)] \quad (22)$$

With B^L and B^M being defined as $B^L = \frac{VMP_L - w}{w}$ and $B^M = \frac{VMP_M - P^M}{P^M}$ with VMP_L and VMP_M reflecting the value of the marginal product of labor and intermediate inputs, respectively. B^L and B^M capture monopsony power in the labor and intermediate inputs market, respectively, with larger values indicating more market power. Note that we still assume perfectly competitive capital markets.

This derivation shows that our estimate of the price-cost margin is not affected by the presence of firms' monopsony power in the labor and/or intermediate inputs market. However, the share of fixed

[51] (Appendix) Table 9 displays the corresponding actual (not smoothed) values for the price-cost margin, fixed-cost ratio and excess profits ratio. We also include standard errors and significance stars.
[52] (Appendix) Table 10 displays the corresponding actual (not smoothed) values for the price-cost margin, fixed-cost ratio and excess profits ratio. We also include standard errors and significance stars.
[53] See Rubens (2021) and Morlacco (2019) for the joint estimation of markups and markdowns in the De Loecker and Warzynski (2012) framework.

labor and the share of fixed intermediate inputs are now intertwined with the monopsony power in the labor and intermediate inputs market, respectively. In the case that monopsony power equals zero, this equation collapses again into equation (20). From the moment that B^L and/or B^M become larger than zero, then, we overestimate the share of fixed labor and/or the share of fixed intermediate inputs. For example, if B^L equals 0.1 and sf_t^l is estimated to be 0.4 based on equation (20), then, we can find that the unbiased sf_t^l in equation (22) equals only 0.34.

The excess profitability still captures the rents extracted from the output market, however, total rents are larger due to the additional rents generated from the input market(s). It is not possible to jointly identify the monopsony power coefficients and the shares of fixity within this framework, nevertheless, it generates insight on how we can interpret our coefficients as soon as the assumption of perfectly competitive input markets does not hold, and allows to evaluate our results accordingly.

5.3 (Un)weighted aggregate price-cost margins

This section looks into the difference between the unweighted and the weighted aggregate price-cost margin. Hall (1988) and Roeger (1995) estimate an unweighted aggregate price-cost margin. Their empirical analysis uses industry level data. The approach basically links the growth rate of inputs to the growth rate of output, thereby implicitly assuming equal weight for all the industries.

Table 3 Price-cost margins: Weighted and Unweighted

	(1)	**(2)**	**(3)**	**(4)**
Weighted	**Yes**	**No**	**Yes**	**No**
Price-Cost Margins	0.080^{***}	0.116^{***}	0.259^{***}	0.416^{***}
	(0.012)	(0.016)	(0.016)	(0.045)
Share of Fixed Capital			0.679^{***}	0.924^{***}
			(0.036)	(0.050)
Share of Fixed Labor			0.169^{***}	0.331^{***}
			(0.028)	(0.040)
Share of Fixed Intermediates			0.236^{***}	0.419^{***}
			(0.017)	(0.053)
Fixed Costs Ratio	-	-	$.234^{***}$	$.407^{***}$
	-	-	(0.016)	(0.048)
Excess Profits Ratio	-	-	$.025^{***}$	$.009^{***}$
	-	-	(0.002)	(0.003)
Year-Industry FE	Yes	Yes	Yes	Yes
N	280,252	280,252	280,252	280,252
r2	0.349	0.327	0.510	0.534

Notes: *Standard errors are clustered by NACE 2 digits. Standard errors in parentheses (* p < 0.05, ** p < 0.01, *** p < 0.001). Odd (even) columns are (not) weighted by operating revenue at the firm-year level. Columns (1) and (2) show results based on Roeger (1995) while columns (3) and (4) show results on the baseline approach from this paper. Columns (1) and (3) show weighted results while columns (2) and (4) show unweighted results.*

In order to estimate a weighted aggregate price-cost margin, we deviate on two aspects. First, we use firm level data rather than industry level data. This allows to exploit variation between industries as well as between firms within an industry. Second, we weigh our regressions. We take into account that larger firms have a stronger impact on the aggregate price-cost margin. In the absence of fixed factors, we estimate Roeger (1995) and weigh this by operating revenue at the firm-year level in column (1). The weights are allowed to vary over time. This allows to capture potential reallocation effects. In particular, assume that a large firm with a high price-cost margins is growing, then this would push the aggregate price-cost margin upwards. In the presence of fixed factors, firm-year specific weights are introduced as we go from equations (5), (8), (11) and (14) to equation (20). The former equations are multiplied by firm-year operating revenue or firm-year total costs. We divide equation (20) again by operating revenue at the firm-year level. This eliminates the firm size dimension as all firms have a 'rescaled' operating revenue of one, while the growth rates remain the same. Doing so, all firms have an equal weight and regression results are no longer driven by firm size but only by the growth rates of the (variable) inputs and output.

Table 3 displays a comparison of weighted and unweighted aggregate price-cost margins based on firm level data. Columns (1) and (3) display the weighted aggregate price-cost margin while columns (2) and (4) display the unweighted aggregate price-cost margin. We find that weighted price-cost margins are smaller than unweighted price-cost margins. This suggests that large firms are characterized by lower price-cost margins. This is at odds with the bulk of the literature which finds that large firms also have large markups (e.g. Autor et al., 2020; De Loecker et al., 2020). However, the literature typically assumes that price-cost margins can be interpreted as profitability and vice versa. As we already showed, this is no longer necessarily the case once fixed costs are present. Therefore, we decompose the price-cost margin into the fixed costs ratio and the excess profits ratio. We find that the estimated weighted share of factor inputs in column (3) is smaller than the estimated unweighted share of factor inputs in column (4) for each input. Therefore, large firms have lower price-cost margins as well as a lower fixed costs ratio. Ex-ante, it is not clear whether large firms have a higher profitability or not.

Therefore, we decompose the price-cost margin into a fixed costs ratio and an excess profits ratio. We find that the unweighted excess profits ratio equals 0.9% whereas the weighted excess profits ratio equals 2.5%. Thus, we can conclude that large firms have a lower price-cost margin and a lower fixed costs ratio, however, they are able to generate a higher excess profits ratio than smaller firms. Again, this shows that fixed costs create a wedge between price-cost margins and the excess profits ratio and both concepts cannot be used interchangeably. The literature typically finds that large firms possess more market power which is in line with our finding that large firms have a higher profitability level.

5.4 Specification error

Now, we look into a possible specification error. We allow the price-cost margin and the shares of fixed factor inputs to vary by firm size. We start from equation (20), pooled over the sample period, and allow the price-cost margin and shares of fixed factor inputs to depend on firm size. We introduce the impact of firm size as follows,

$$B_i = B + \beta_1 * [PQ_{it} - mean(PQ_{it})]$$

$$sf_i^k = sf^k + \beta_2 * [PQ_{it} - mean(PQ_{it})_t]$$

$$sf_i^l = sf^l + \beta_3 * [PQ_{it} - mean(PQ_{it})_t]$$

$$sf_i^m = sf^m + \beta_4 * [PQ_{it} - mean(PQ_{it})_t]$$

and introduce this into equation (20) such that we obtain,

$$\begin{aligned}&\left(SRQ_{it}^R - SRP_{it}^R\right)PQ_{it} - \left(SRQ_{it}^C - SRP_{it}^C\right)C_{it} = B * PQ_{it} * [(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] - sf^k * RK_{it} * [(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] - sf^l * WL_{it} * [(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] - sf^m * P^M M_{it} * [(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] + \beta_1 * PQ_{it}[PQ_{it} - mean(PQ_{it})_t] * X_{1it} - \beta_2 * RK_{it} * [PQ_{it} - mean(PQ_{it})_t] * X_{2it} - \beta_3 * WL_{it} * [PQ_{it} - mean(PQ_{it})_t] * X_{3it} - \beta_4 * P^M M_{it} * [PQ_{it} - mean(PQ_{it})_t] * X_{4it} + FE + \varepsilon_{it}.\end{aligned} \quad (21)$$

Assuming that fixed costs are not present and dividing again by PQ_{it}, this formula collapses to equation (21),

$$SRQ_{it}^R - SRP_{it}^R = B[(\Delta q + \Delta p)_{it} - (\Delta k + \Delta r)_{it}] + \beta_1 * [PQ_{it} - mean(PQ_{it})_t][(\Delta q + \Delta p)_{it} - (\Delta k + \Delta r)_{it}] + FE + \varepsilon_{it} \quad (22)$$

We divide equation (21) again by PQ_{it} and show the results in Table 4. This repeats the unweighted results for Belgium between 1985 and 2014 in columns (1) and (3). Columns (2) and (4) extend these estimation results by taking into account the components linked to firm size as in equation (22) and (21) respectively.

Looking at columns (1) and (2), we find that, evaluated at the mean, price-cost margins are approximately the same. As firm size increases, the estimated price-cost margin decreases. This implies that large firms are estimated to have lower price-cost margins. The estimated coefficient is significant, however, the economic magnitude is small as firms need to have an operating revenue of one billion euros above the mean value to lower the average price-cost margins by 1.35 percentage points.[54] Next, column (4) shows that β_1 is significant and negative. Firms with an operating revenue of one billion

[54] Firm-specific operating revenue is divided by one billion in order to be able to interpret the estimated coefficients.

euros above the mean value have a price-cost margin which is 4.1 percentage points lower. Larger firms also have a lower share of fixed capital, fixed labor and intermediate input. So, large firms tend to have lower price-cost margins and a lower fixed cost ratio. Nevertheless, they have a higher excess profits ratio (see section 5.5).

Table 4 Price-cost margins and shares of fixed input factors: Control for firm size

	(1)	(2)	(3)	(4)
Price-cost Margins	0.116***	0.116***	0.416***	0.416***
	(0.0156)	(0.0157)	(0.045)	(0.045)
Share of Fixed Capital			0.924***	0.920***
			(0.050)	(0.050)
Share of Fixed Labor			0.331***	0.328***
			(0.040)	(0.040)
Share of Fixed Intermediates			0.419***	0.418***
			(0.053)	(0.053)
β_1		-0.0135**		-0.041**
		(0.00399)		(0.013)
β_2				-0.218*
				(0.102)
β_3				-0.154*
				(0.063)
β_4				-0.043**
				(0.015)
Year-Industry FE	Yes	Yes	Yes	Yes
N	280252	280252	280252	280252
r2	0.327	0.327	0.534	0.535

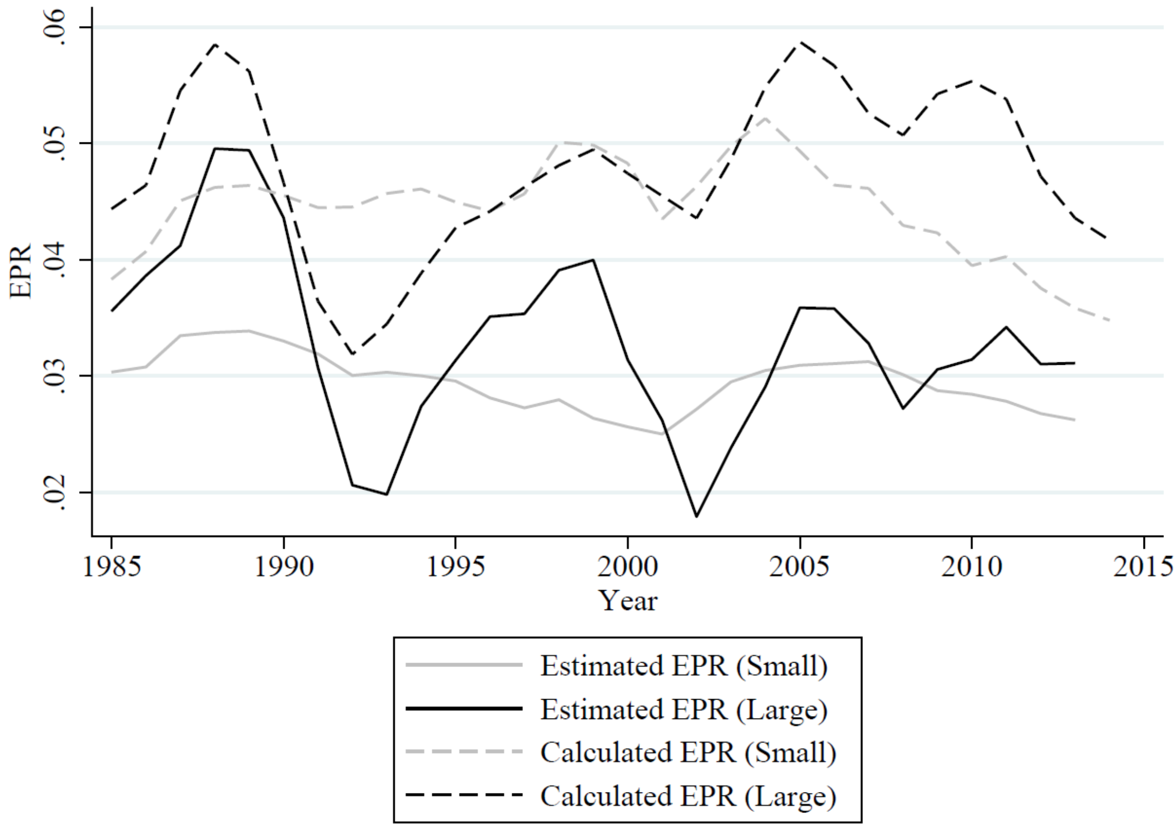
Notes: *Standard errors in parentheses (+ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001). Standard errors are clustered by NACE 2 digits. Columns (1) and (2) show unweighted results based on Roeger (1995). Columns (3) and (4) show unweighted results based on our methodology.*

5.5 Excess profits for large and small firms

Another way of looking into differences among the firm size distribution is to look at the subsamples of large firms (>= 250 FTE) and small firms (< 250 FTE). Figure 6 shows both the calculated profitability, i.e. (PQ-TC)/PQ, and the estimated excess profitability for the two subsamples.

This generates three main results. First, this figure shows that the estimated excess profitability of large firms is larger than the excess profitability of small firms in the vast majority of the years. Given that the excess profitability is defined as a percentage of the operating revenue, the amount of *absolute* (rather than relative) profits is clearly skewed towards large firms. Second, we compare the estimated and calculated excess profitability for the subsamples of large and small firms. Reassuringly, we find that the estimated and calculated excess profitability move approximately in parallel over time, i.e. they display similar volatility over time. Third, the calculated excess profitability is higher than the estimated excess profitability within the subsamples of large and small firms.

Figure 6 Excess profitability for large and small firms



Notes: *This figure shows the evolution the excess profits ratio, both the calculated (i.e. [revenue-total costs]/revenue) and the estimated. The evolution of Belgian variables has been smoothed. Each observation is the simple average of its current observations and one observation before and after its current observation.*

5.6 Longer horizon differences

In this section, we compare five-year and ten-year differences to our benchmark result in which we use one-year differences. As we consider a longer time horizon, we would expect to find that the share of fixity decreases for each input factor such that the fixed costs ratio falls. Table 5 summarizes these estimation results based on five-year and ten-year differences.

Looking at the five-year differences in column (2) and the ten-year differences in column (3), we find that the fixed costs ratio decreases to 21.1% and 18.3%, respectively, in comparison with the baseline value of 23.4% of column (1). This fall is predominantly driven by the decrease in the share of fixed capital shrinking from 67.9% to 43.6%. This is in line with the idea that capital is quasi-fixed in the short run whereas it becomes more and more flexible over longer time periods. Additionally, comparing columns (1) and (3), we find that the share of fixed intermediate inputs falls moderately from 23.6% to 19.2% while the share of fixed labor decreases from 16.9% to 11.9%.

Table 5 Price-cost margins and shares of fixed input factors: Longer horizon differences

	(1) Baseline	(2) Δ5yr	(3) Δ10yr
Price-cost Margins	0.259***	0.243***	0.214***
	(0.016)	(0.019)	(0.021)
Share of fixed capital	0.679***	0.537***	0.436***
	(0.036)	(0.048)	(0.075)
Share of fixed labor	0.169***	0.142***	0.119***
	(0.028)	(0.033)	(0.036)
Share of fixed intermediate inputs	0.236***	0.219***	0.192***
	(0.017)	(0.020)	(0.022)
Fixed costs ratio	0.234***	0.211***	0.183***
	(0.016)	(0.020)	(0.022)
Excess profits ratio	0.025***	0.032***	0.031***
	(0.002)	(0.002)	(0.002)
Year-Industry FE	YES	YES	YES
N	280,252	47,116	18,068
r2	0.500	0.586	0.606

***Notes:** Standard errors in parentheses (+ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001). Standard errors are clustered by NACE 2 digits. Column (2) shows the results for the five-year differences and keeps only the years 1990, 1995, 2000, 2005, 2010 and 2014. Column (3) shows the results for the ten-year differences and keeps only the years 1995, 2005 and 2014.*

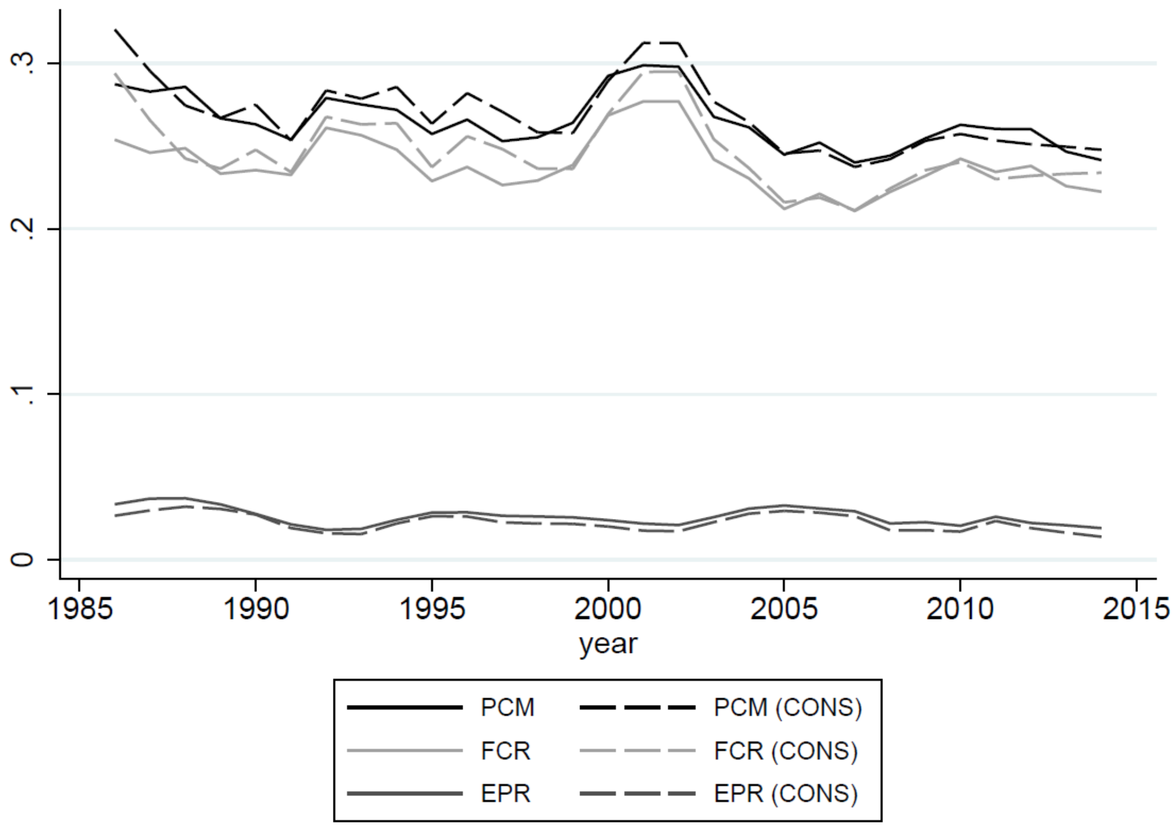
5.7 Proxy for consolidated accounts

The unit of analysis is the unconsolidated firm level account, as this is how firms report their annual income statement at the National Bank of Belgium. However, firms with a different legal VAT number might be controlled by the same parent company. Goutsmet, Lecocq & Volckaert (2017) use the concept of a 'domestic ultimate owner' to indicate whether a firm is owned by another firm within Belgium. This is the case if a firm has more than 50% of the shares of another firm. We exploit these linkages and aggregate the Belgian annual income statements of firms which are owned by the same parent company. We use this as a proxy for consolidated firm level accounts at the Belgian level.[55]

We show the evolution of the price-cost margins, fixed costs ratio and excess profits ratio for both unconsolidated accounts and our proxy for consolidated accounts in Figure 7.[56] Our results are robust to this alternative boundary definition of a firm. We find that price-cost margins and the fixed costs ratio are a bit higher in some years whereas in other periods, they are a bit lower. Overall, they fluctuate around the baseline results. The new excess profits ratio displays the same evolution over time albeit being slightly smaller.

[55] Note that this alternative definition of the frontier of a firm is a technical one and does not exist in reality.
[56] (Appendix) Table 11 displays the corresponding actual (not smoothed) values for the price-cost margin, fixed-cost ratio and excess profits ratio. We also include standard errors and significance stars.

Figure 7 Evolution of excess profits ratio: consolidated accounts



Notes: *This figure shows the evolution the price-cost margin, fixed costs ratio and excess profit ratio for unconsolidated and consolidated accounts based on equation (20). The evolution of the variables has been smoothed. Each observation is the simple average of its current observations and one observation before and after its current observation.*

5.8 More detailed estimates

Our methodology is also able to obtain even more detailed results than just the aggregate estimate, as we have shown with our yearly results. In particular, we can estimate industry-year level price-cost margins or firm level (but not firm-year level) price-cost margins.[57]

We briefly illustrate this by estimating price-cost margins, fixed costs ratios and excess profit ratios at the NACE-two digit category level for the period 1985-2014. Appendix Table 12 summarizes the results and shows (1) that fixed costs are sizable and significant in nearly all industries and (2) that industry-level heterogeneity matters. This opens interesting avenues for future research in which the industry or yearly dimension can be exploited in more detail.

[57] This implies that we estimate an ‘aggregate’ price-cost margin at the industry-year level. On the other hand, we are able to estimate firm level price-cost margins by assuming a constant price-cost margin at the firm level during a fixed time horizon. Estimates at the firm-year level are not possible as we would have to estimate four coefficients based on one observation.

6. Conclusion

In this paper, we introduce and illustrate a new method which allows to estimate aggregate price-cost margins in the presence of fixed factors of production. The price-cost margin can be interpreted as a price-cost margins in terms of average variable costs as long as we allow for non-constant returns to scale, while we can reinterpret it is a price-cost margin over marginal costs in the case of constant returns of scale on the variable inputs.

Our method exploits properties of the primal and dual (revenue- and cost-based) Solow residuals. It allows for a flexible treatment of all input factors: labor, capital and intermediate inputs. Each input can be variable, fixed or a combination of both. The model jointly estimates price-cost margins and the share of fixity for each input. The estimated price-cost margin can be decomposed into two components: one part is used to cover fixed costs while the other part represents firms' profitability.

We apply our method to Belgian firm level data from 1985 until 2014. Our main findings can be summarized as follows. First, allowing input factors to be variable, fixed or a mix of both has a profound impact on the estimation of price-cost margins. Once fixed factors of production are taken into account, price-cost margins rise from 8.0% to 25.9%. However, this does not necessarily imply that firms' profitability has risen as well. High price-cost margins are predominantly used to cover fixed costs (23.4%) whereas only a small fraction remains left as excess profits (2.5%). Ignoring fixed costs underestimates price-cost margins while it overestimates firms' profitability. Second, the evolution of price-cost margins consists of the evolution of the fixed costs ratio and the evolution of the excess profits ratio. These components can reinforce or offset each other. We find that both the fixed costs ratio (-3.7%) and the excess profits ratio (-0.9%) have fallen between 1985 and 2014 such that price-cost margins decreased by 4.6% in Belgium. Finally, price-cost margins, and their components, can vary over time. We show that price-cost margins have declined in the last three decades pushing excess profit margins close to zero, suggesting competitive markets.

Understanding the decomposition and evolution of price-cost margins is an important tool to assess firms' market power and its evolution. The presence of fixed costs implies that price-cost margins might change not only due to a change in firms' market power, but also due to changes in the production process (i.e., the mix between variable and fixed costs) or even due to a combination of both. Our novel methodology is able to distinguish these underlying mechanisms, thereby providing an additional layer of insight to the ongoing academic and policy debate on firms' market power.

7. Appendix

7.1 Data appendix

Our application uses Belgian unconsolidated firm level accounts from the National Bank of Belgium (1985-2014).[58] Firms are identified as a legal entity by their unique VAT number. NACE rev. 2 codes are used to assign a firm to an industry (NACE 2-digit).[59] The dataset includes all for-profit firms which file an annual income statement, however, 'small firms' do not have to report this information.[60] They can choose to do this at a voluntary basis. The dataset does not include data on self-employed people.

We obtain the following balance sheet variables: operating revenue, wage costs, intermediate inputs, depreciation and tangible fixed assets. We have 358,143 firm-year observations. From 1996 onwards, firms report employment in terms of full-time equivalents (FTE).[61] Our dataset covers an increasing number of employees over time: total employment in FTE equals 1,042,861.8 in 1996. This increases to 1,298,381.4 in 2014.

Before running our regressions, we need to make some data adjustments. First, we only keep firms which belong to NACE rev. 2 categories 10/82. Next, we solely keep firms which have no missing values for operating revenue, wage costs, intermediate inputs, tangible fixed assets, depreciation and their NACE two digits code. We drop firms with a negative or zero value for operating revenue, wage costs, intermediate inputs, tangible fixed assets or depreciation. We drop firms which have a labor or intermediate input share above one and winsorize the labor and intermediate input share at the 95th percentile.[62] Finally, we winsorize the components for the regressions at the 1st and 99th percentiles to account for outliers in terms of growth rates.

In order to calculate the nominal rental cost of capital $R_{it} = P_{I_t}(r_t - \pi_t + \delta_{it})$ for firm i in year t, we start from Hall & Jorgenson (1967). We calculate the depreciation rate δ_{it} as the ratio of depreciation in year t-1 and tangible fixed assets in year t for firm i, thereby following Konings, Van Cayseele and

[58] Belgian annual accounts are freely accessible through the NBB. The past ten years can be downloaded online. Older firm accounts can be requested at a cost.
[59] NACE is the industry standard classification system used in the European Union. It is the acronym of the French translation of the Statistical Classification of Economic activities in the European Community. The first four digits are common across all European countries.
[60] We refer to Bijnens & Konings (2018) for more detailed information on the filing requirements. Small firms are firms that do not exceed the following criteria: average number of employees above 50 FTE, €7.3 million for turnover and €3.65 for balance sheet total (2014 levels).
[61] Before 1996, firms report the number of jobs instead of full-time equivalents.
[62] Under the assumption of constant returns to scale, a labor (intermediate input) share larger than one implies that the capital share would be negative. We only retain observations which have a labor (intermediate input) share smaller or equal to one. We replace negative capital shares by a value of zero.

Warzynski (2005).[63] The cost of capital does not include a cost for intangible assets. The price index of investment goods P_I is obtained from the World Bank. Inflation π and the nominal interest rate r are sourced from the OECD (2021).[64] The three latter variables are at the Belgian country-year level.

Further, we extend the calculation of the cost of capital by accounting for capital allowances (Asen & Bunn, 2019) and the statutory tax rate as follows: $R^{ADJ} = R_{it} * \frac{(1-(CA_t)*\tau_t)}{(1-\tau_t)}$ with CA[65] and τ representing respectively the Belgian capital allowance and the statutory tax rate. Both measures are made available by the OECD (2021). In most countries, like in Belgium, depreciation schedules do not allow to take the time value of money into account. The time value of money consists of inflation and a normal return. Assume that a firm invests €1000 in a machine and it uses the straight-line depreciation method over a time horizon of five years. Further, assume an inflation rate of 2% and a normal return of 5%. In the first year, the firm depreciates €200. In the second year, again, the firm depreciates €200, however, the present value of this amount equals only €187. After five years, the firm is able to deduct only €877. The capital allowance, defined as the percentage of the initial investment which can be fully deducted, equals 87.7% in this case. The capital allowance becomes lower as the time horizon increases and/or the time value of money rises. A lower (than 100%) capital allowance increases the cost of capital. We use the adjusted cost of capital as our measure of cost of capital in the main text.

We plot the evolution of the nominal interest rate r in Figure 7, the evolution of inflation π in Figure 8, the evolution of the weighted depreciation rate δ in Figure 9, the evolution of the (adjusted) real rental cost of capital $(r_t - \pi_t + \delta_{it}) * \frac{(1-(CA)*\tau)}{(1-\tau)}$ in Figure 10, the evolution of the price index of investment goods P_I in Figure 11 and the evolution of the (adjusted) nominal rental cost of capital R^{ADJ} in Figure 12. Appendix Table 6 displays the values for the nominal interest rate, statutory tax rate and capital allowances.

A limitation of our Belgian data is that depreciation is only reported from 1996 onwards while we observe all other variables from 1985 onwards. Therefore, we assume that the depreciation rate in and before 1995 equals the depreciation rate in 1996 at the firm level.

---

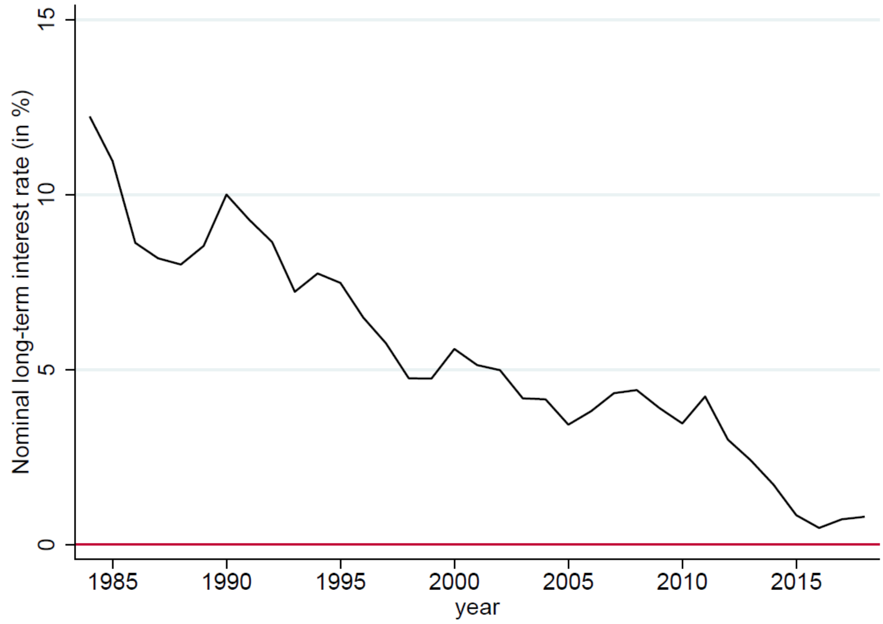
[63] We limit the depreciation rate at 100%.

[64] Inflation refers to the yearly growth rate of the consumer price index. The nominal interest rate refers to the long-term (10 years) government bond yield. The OECD (2021) reports these indices in a consistent manner since 1985.

[65] We calculate the capital allowance as the weighed sum of the capital allowance of each component, divided by tangible fixed assets. The weights are the corresponding shares of the component in tangible fixed assets.

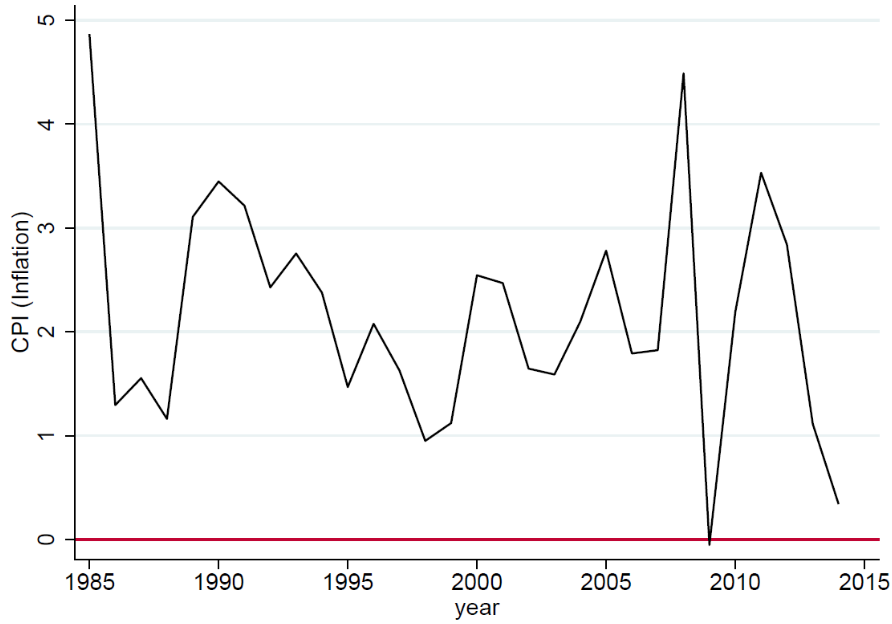
7.2 Figures appendix

Figure 8 Evolution of the nominal long-term interest rate



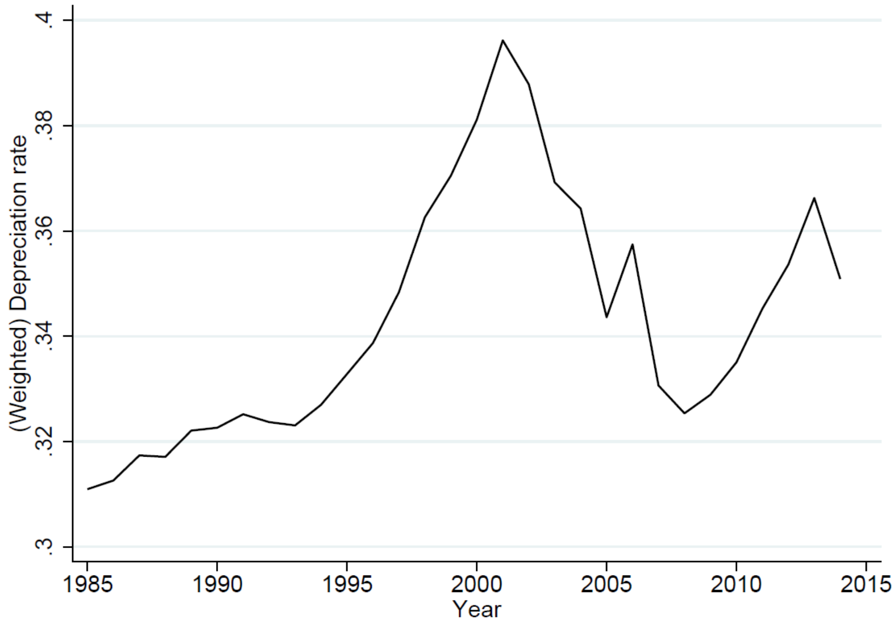
Notes: *This figure plots the long-term government bond yield (10 years). Data is obtained from the OECD (2021) and is consistently calculated throughout the sample period.*

Figure 9 Evolution of the consumer price index



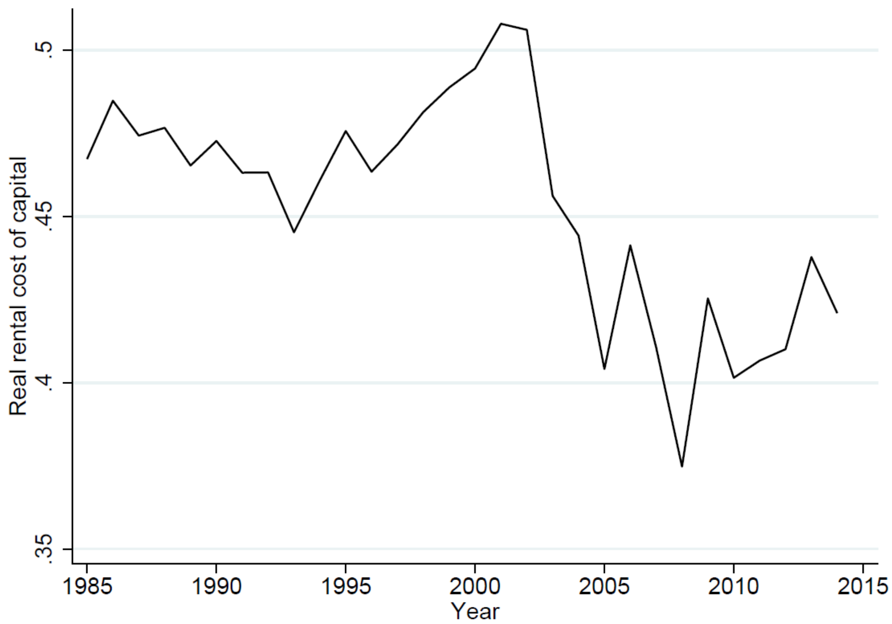
Notes: *This figure plots the yearly Belgian consumer price index (CPI) change. Data is obtained from the OECD (2021) and is consistently calculated throughout the sample period.*

Figure 10 Evolution of the weighted depreciation rate



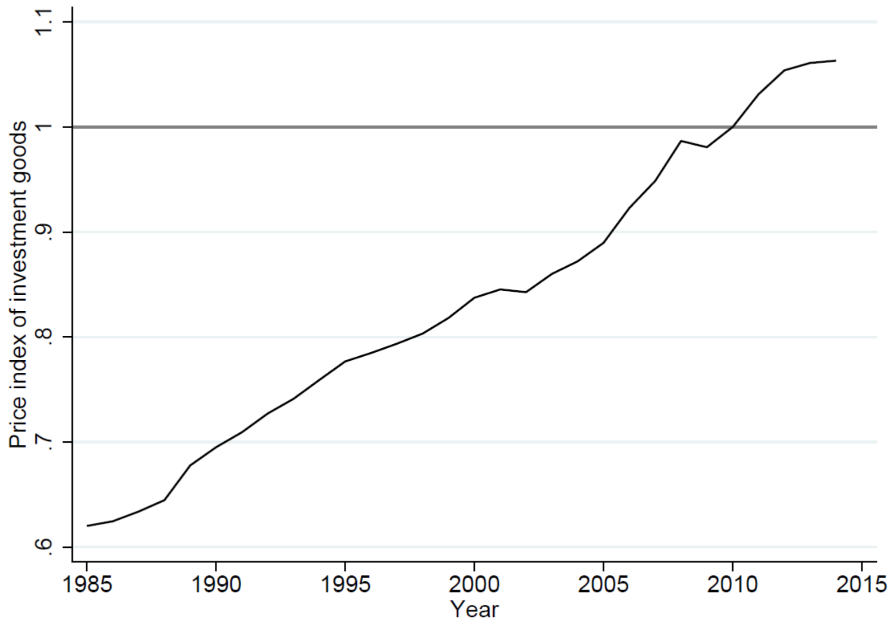
Notes: *This figure shows the weighted depreciation rate. We weigh the depreciation rate by operating revenue at the firm-year level.*

Figure 11 Evolution of the weighted real rental price of capital



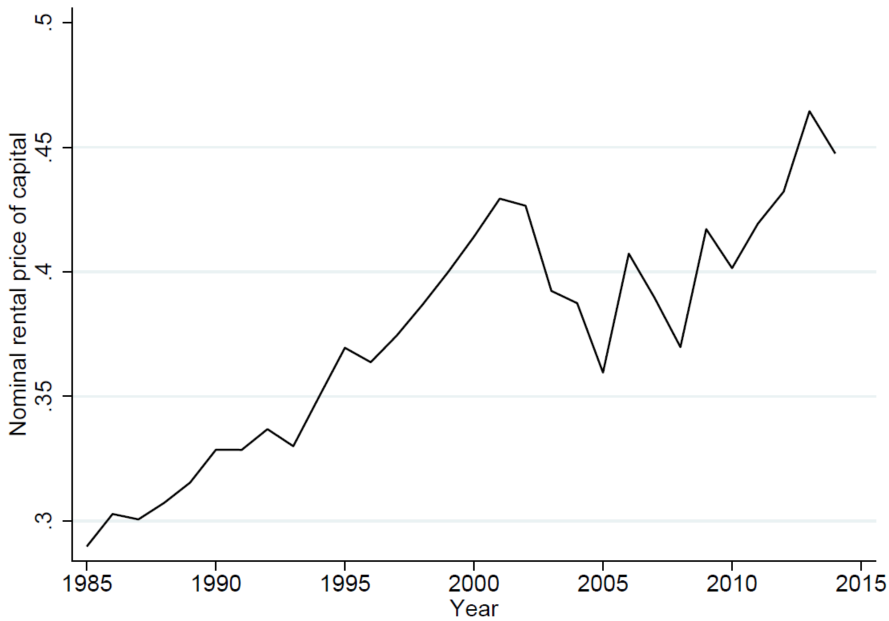
Notes: *This figure shows the weighted real rental price of capital. Depreciation is only available since 1996 for Belgian firms. We weigh the depreciation rate by operating revenue at the firm-year level.*

Figure 12 Evolution of the price index of investment goods



Notes: *This figure shows the Belgian price index of investment goods with 2010 as reference year. We source this data from the World Bank (2021).*

Figure 13 Evolution of the weighted nominal rental price of capital



Notes: *This figure shows the weighted nominal rental price of capital. Depreciation is only available since 1996 for Belgian firms. We weigh the depreciation rate by operating revenue at the firm-year level.*

7.3 Table appendix

Table 6 Raw data for robustness tests for the cost of capital

Year	Nominal Interest Rate	Tax Rate	Loan Rate	CA (Machines)	CA (Buildings)	CA (Patents)	Market Risk Premium
1985	10.97	45	-	83.8	62.2	-	-
1986	8.63	45	-	83.8	62.2	-	-
1987	8.18	43	-	83.8	62.2	-	-
1988	8.01	43	-	83.8	62.2	-	-
1989	8.54	43	-	83.8	62.2	-	-
1990	10.01	41	-	83.8	62.2	-	-
1991	9.29	39	-	83.8	62.2	-	-
1992	8.65	39	-	83.8	62.2	-	-
1993	7.23	40.2	-	83.8	62.2	-	-
1994	7.75	40.2	-	83.8	62.2	87	-
1995	7.48	40.2	-	83.8	62.2	87	-
1996	6.49	40.2	-	83.8	62.2	87	-
1997	5.75	40.2	-	83.8	62.2	87	-
1998	4.75	40.2	-	88.2	62.2	87	-
1999	4.75	40.2	-	88.2	62.2	87	-
2000	5.59	40.17	-	88.2	62.2	87	4.29
2001	5.13	40.17	-	88.2	62.2	87	5.63
2002	4.99	40.17	-	88.2	62.2	87	4.72
2003	4.18	33.99	3.78	88.2	62.2	87	6.87
2004	4.15	33.99	3.58	88.2	62.2	87	5.16
2005	3.43	33.99	3.43	88.2	62.2	87	5.27
2006	3.82	35.97	4.04	88.2	62.2	87	5.46
2007	4.33	33.99	5.15	88.2	62.2	87	4.72
2008	4.42	33.99	5.44	88.2	62.2	87	6.09
2009	3.90	33.99	2.62	88.2	62.2	87	6.97
2010	3.46	33.99	2.27	88.2	62.2	87	6.84
2011	4.23	33.99	2.83	88.2	62.2	87	7.26
2012	3.00	33.99	2.40	88.2	62.2	87	9.57
2013	2.41	33.99	2.28	88.2	62.2	86	7.33
2014	1.71	33.99	2.26	88.2	62.2	85	6.30

***Notes:** All values in this table are denoted in percentages.*

Table 7 Yearly estimates

Year	PCM	PCM (SE)		FCR	FCR (SE)		EPR	EPR (SE)	
1986	0.280	0.033	***	0.247	0.032	***	0.033	0.003	***
1987	0.294	0.040	***	0.260	0.039	***	0.034	0.004	***
1988	0.274	0.033	***	0.230	0.031	***	0.044	0.004	***
1989	0.289	0.044	***	0.255	0.044	***	0.034	0.003	***
1990	0.237	0.025	***	0.214	0.026	***	0.023	0.003	***
1991	0.263	0.025	***	0.237	0.025	***	0.026	0.003	***
1992	0.261	0.030	***	0.246	0.032	***	0.015	0.005	**
1993	0.313	0.041	***	0.300	0.041	***	0.013	0.005	*
1994	0.251	0.028	***	0.223	0.028	***	0.028	0.003	***
1995	0.251	0.035	***	0.220	0.036	***	0.031	0.004	***
1996	0.269	0.030	***	0.243	0.030	***	0.026	0.004	***
1997	0.277	0.027	***	0.249	0.027	***	0.029	0.004	***
1998	0.212	0.031	***	0.188	0.031	***	0.025	0.004	***
1999	0.276	0.027	***	0.251	0.028	***	0.025	0.003	***
2000	0.304	0.030	***	0.277	0.030	***	0.027	0.003	***
2001	0.297	0.023	***	0.278	0.023	***	0.020	0.002	***
2002	0.295	0.026	***	0.276	0.026	***	0.019	0.003	***
2003	0.301	0.024	***	0.277	0.024	***	0.024	0.002	***
2004	0.206	0.031	***	0.172	0.031	***	0.034	0.002	***
2005	0.276	0.030	***	0.242	0.030	***	0.034	0.002	***
2006	0.252	0.023	***	0.222	0.024	***	0.030	0.002	***
2007	0.228	0.026	***	0.200	0.027	***	0.029	0.002	***
2008	0.240	0.020	***	0.211	0.021	***	0.029	0.002	***
2009	0.264	0.028	***	0.256	0.028	***	0.008	0.002	***
2010	0.260	0.026	***	0.229	0.027	***	0.031	0.002	***
2011	0.264	0.019	***	0.242	0.020	***	0.023	0.002	***
2012	0.257	0.023	***	0.233	0.024	***	0.024	0.002	***
2013	0.259	0.017	***	0.239	0.017	***	0.020	0.002	***
2014	0.224	0.017	***	0.205	0.018	***	0.018	0.002	***

Notes: *This table shows the estimated Belgian price-cost margins, fixed costs ratio and excess profits ratio, with corresponding standard errors and significance level. Standard errors ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$). Standard errors are clustered by NACE 2 digits.*

Table 8 Yearly estimates (Robustness: Loan Rate)

Year	PCM	PCM (SE)		FCR	FCR (SE)		EPR	EPR (SE)	
2004	0.218	0.032	***	0.184	0.032	***	0.034	0.002	***
2005	0.291	0.029	***	0.257	0.029	***	0.034	0.002	***
2006	0.263	0.025	***	0.234	0.026	***	0.029	0.002	***
2007	0.226	0.029	***	0.200	0.029	***	0.027	0.002	***
2008	0.252	0.018	***	0.227	0.019	***	0.025	0.002	***
2009	0.296	0.022	***	0.285	0.022	***	0.011	0.003	***
2010	0.293	0.025	***	0.261	0.024	***	0.032	0.002	***
2011	0.265	0.020	***	0.239	0.021	***	0.026	0.003	***
2012	0.256	0.022	***	0.230	0.022	***	0.025	0.002	***
2013	0.262	0.020	***	0.242	0.021	***	0.020	0.003	***
2014	0.230	0.018	***	0.213	0.018	***	0.017	0.003	***

Notes: *This table shows the estimated Belgian price-cost margins, fixed costs ratio and excess profits ratio, with corresponding standard errors and significance level. Standard errors (+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$). Standard errors are clustered by NACE 2 digits.*

Table 9 Yearly estimates (Robustness: Capital Allowances)

Year	PCM	PCM (SE)		FCR	FCR (SE)		EPR	EPR (SE)	
1995	0.255	0.031	***	0.223	0.032	***	0.031	0.004	***
1996	0.271	0.030	***	0.244	0.031	***	0.027	0.004	***
1997	0.295	0.030	***	0.265	0.030	***	0.030	0.004	***
1998	0.210	0.032	***	0.185	0.032	***	0.025	0.004	***
1999	0.268	0.031	***	0.242	0.031	***	0.026	0.004	***
2000	0.323	0.035	***	0.295	0.035	***	0.028	0.003	***
2001	0.295	0.024	***	0.275	0.025	***	0.020	0.002	***
2002	0.297	0.026	***	0.277	0.026	***	0.019	0.003	***
2003	0.320	0.027	***	0.295	0.028	***	0.025	0.002	***
2004	0.210	0.033	***	0.175	0.033	***	0.034	0.002	***
2005	0.276	0.030	***	0.240	0.030	***	0.035	0.002	***
2006	0.258	0.024	***	0.227	0.025	***	0.031	0.002	***
2007	0.226	0.029	***	0.196	0.029	***	0.030	0.002	***
2008	0.244	0.019	***	0.214	0.020	***	0.030	0.002	***
2009	0.268	0.028	***	0.260	0.028	***	0.008	0.003	***
2010	0.270	0.026	***	0.239	0.026	***	0.032	0.002	***
2011	0.264	0.020	***	0.241	0.020	***	0.024	0.002	***
2012	0.261	0.023	***	0.236	0.024	***	0.025	0.002	***
2013	0.261	0.019	***	0.240	0.019	***	0.020	0.002	***
2014	0.231	0.018	***	0.212	0.018	***	0.020	0.002	***

Notes: *This table shows the estimated Belgian price-cost margins, fixed costs ratio and excess profits ratio, with corresponding standard errors and significance level. Standard errors (+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$). Standard errors are clustered by NACE 2 digits.*

Table 10 Yearly estimates (Robustness: Risk Premium)

Year	PCM	PCM (SE)		FCR	FCR (SE)		EPR	EPR (SE)	
2001	0.310	0.026	***	0.302	0.027	***	0.008	0.002	***
2002	0.320	0.030	***	0.309	0.030	***	0.012	0.003	***
2003	0.316	0.031	***	0.306	0.031	***	0.009	0.003	***
2004	0.212	0.033	***	0.187	0.032	***	0.025	0.003	***
2005	0.285	0.030	***	0.258	0.031	***	0.027	0.003	***
2006	0.250	0.025	***	0.229	0.026	***	0.021	0.002	***
2007	0.230	0.030	***	0.206	0.030	***	0.024	0.002	***
2008	0.243	0.025	***	0.224	0.025	***	0.019	0.002	***
2009	0.254	0.022	***	0.264	0.022	***	-0.010	0.003	***
2010	0.260	0.024	***	0.244	0.024	***	0.016	0.003	***
2011	0.262	0.023	***	0.256	0.023	***	0.007	0.002	***
2012	0.207	0.027	***	0.206	0.026	***	0.002	0.002	.
2013	0.245	0.022	***	0.242	0.023	***	0.003	0.002	.
2014	0.238	0.023	***	0.234	0.023	***	0.005	0.002	*

Notes: *This table shows the estimated Belgian price-cost margins, fixed costs ratio and excess profits ratio, with corresponding standard errors and significance level. Standard errors ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$). Standard errors are clustered by NACE 2 digits.*

Table 11 Yearly estimates (Robustness: Consolidated accounts)

Year	PCM	PCM (SE)		FCR	FCR (SE)		EPR	EPR (SE)	
1986	0.364	0.051	***	0.336	0.052	***	0.028	0.004	***
1987	0.277	0.038	***	0.252	0.039	***	0.025	0.004	***
1988	0.245	0.053	***	0.209	0.052	***	0.036	0.003	***
1989	0.301	0.051	***	0.267	0.050	***	0.035	0.004	***
1990	0.254	0.032	***	0.233	0.033	***	0.021	0.003	***
1991	0.269	0.049	***	0.243	0.049	***	0.026	0.004	***
1992	0.236	0.030	***	0.226	0.031	***	0.010	0.005	+
1993	0.345	0.069	***	0.333	0.070	***	0.012	0.006	+
1994	0.254	0.035	***	0.229	0.037	***	0.025	0.004	***
1995	0.258	0.040	***	0.228	0.040	***	0.029	0.004	***
1996	0.279	0.033	***	0.254	0.034	***	0.025	0.004	***
1997	0.309	0.045	***	0.285	0.045	***	0.024	0.004	***
1998	0.224	0.036	***	0.205	0.036	***	0.019	0.004	***
1999	0.241	0.039	***	0.219	0.039	***	0.023	0.004	***
2000	0.308	0.028	***	0.285	0.029	***	0.024	0.003	***
2001	0.319	0.035	***	0.305	0.036	***	0.014	0.003	***
2002	0.310	0.028	***	0.295	0.029	***	0.015	0.004	***
2003	0.308	0.028	***	0.285	0.029	***	0.023	0.003	***
2004	0.212	0.028	***	0.182	0.029	***	0.030	0.002	***
2005	0.273	0.032	***	0.243	0.032	***	0.031	0.002	***
2006	0.251	0.031	***	0.223	0.032	***	0.027	0.003	***
2007	0.218	0.041	***	0.190	0.040	***	0.027	0.002	***
2008	0.244	0.023	***	0.220	0.024	***	0.024	0.003	***
2009	0.265	0.025	***	0.263	0.025	***	0.002	0.003	.
2010	0.251	0.023	***	0.224	0.023	***	0.027	0.003	***
2011	0.256	0.024	***	0.235	0.024	***	0.022	0.002	***
2012	0.253	0.033	***	0.232	0.034	***	0.021	0.003	***
2013	0.244	0.027	***	0.229	0.028	***	0.014	0.003	***
2014	0.252	0.022	***	0.238	0.023	***	0.013	0.003	***

Notes: *This table shows the estimated Belgian price-cost margins, fixed costs ratio and excess profits ratio, with corresponding standard errors and significance level. Standard errors ($^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$). Standard errors are clustered by NACE 2 digits.*

Table 12 Industry estimates

Industry	Description	PCM	PCM (SE)		FCR	FCR (SE)		EPR	EPR (SE)	
10	Manufacture of food products	0.29	0.05	***	0.27	0.05	***	0.02	0.00	***
11	Manufacture of beverages	0.46	0.07	***	0.37	0.07	***	0.09	0.00	***
12	Manufacture of tobacco products	0.25	0.08	**	0.23	0.09	*	0.02	0.01	*
13	Manufacture of textiles	0.68	0.07	***	0.65	0.06	***	0.03	0.00	***
15	Manufacture of leather and related products	0.89	0.08	***	0.84	0.08	***	0.06	0.00	***
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.67	0.06	***	0.62	0.06	***	0.05	0.01	***
17	Manufacture of paper and paper products	0.40	0.13	**	0.37	0.13	**	0.03	0.00	***
18	Printing and reproduction of recorded media	0.62	0.05	***	0.62	0.05	***	0.01	0.00	*
19	Manufacture of coke and refined petroleum products	0.14	0.04	***	0.11	0.04	**	0.03	0.01	**
20	Manufacture of chemicals and chemical products	0.36	0.03	***	0.33	0.03	***	0.03	0.00	***
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.25	0.03	***	0.23	0.03	***	0.03	0.01	**
22	Manufacture of rubber and plastic products	0.46	0.06	***	0.42	0.06	***	0.04	0.00	***
23	Manufacture of other non-metallic mineral products	0.59	0.05	***	0.58	0.05	***	0.01	0.00	**
24	Manufacture of basic metals	0.27	0.04	***	0.25	0.04	***	0.02	0.00	***
25	Manufacture of fabricated metal products, except machinery and equipment	0.51	0.07	***	0.49	0.06	***	0.02	0.00	***
26	Manufacture of computer, electronic and optical products	0.31	0.06	***	0.28	0.06	***	0.03	0.00	***
27	Manufacture of electrical equipment	0.34	0.06	***	0.30	0.06	***	0.03	0.00	***
28	Manufacture of machinery and equipment n.e.c.	0.35	0.04	***	0.31	0.04	***	0.04	0.00	***
29	Manufacture of motor vehicles, trailers and semi-trailers	0.18	0.04	***	0.16	0.05	***	0.03	0.00	***
30	Manufacture of other transport equipment	0.42	0.05	***	0.42	0.05	***	0.00	0.01	.
31	Manufacture of furniture	0.87	0.09	***	0.83	0.09	***	0.03	0.01	***
32	Other manufacturing	0.28	0.03	***	0.25	0.04	***	0.03	0.00	***
33	Repair and installation of machinery and equipment	0.22	0.07	***	0.21	0.07	**	0.01	0.00	***
35	Electricity, gas, steam and air conditioning supply	0.19	0.03	***	0.14	0.04	***	0.05	0.01	***
36	Water collection, treatment and supply	0.26	0.03	***	0.34	0.04	***	-0.09	0.01	.
37	Sewerage	0.24	0.06	***	0.24	0.08	**	0.00	0.03	.

38	Waste collection, treatment and disposal activities; materials recovery	0.33	0.04	***	0.31	0.03	***	0.03	0.01	***
39	Remediation activities and other waste management services	1.00	0.04	***	0.95	0.04	***	0.04	0.00	***
41	Construction of buildings	0.43	0.03	***	0.40	0.03	***	0.02	0.00	***
42	Civil engineering	0.57	0.03	***	0.52	0.03	***	0.05	0.00	***
43	Specialised construction activities	0.26	0.03	***	0.25	0.03	***	0.01	0.00	***
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	0.38	0.05	***	0.36	0.05	***	0.02	0.00	***
46	Wholesale trade, except of motor vehicles and motorcycles	0.23	0.02	***	0.20	0.02	***	0.03	0.00	***
47	Retail trade, except of motor vehicles and motorcycles	0.37	0.02	***	0.35	0.02	***	0.02	0.00	***
49	Land transport and transport via pipelines	0.08	0.02	***	0.13	0.02	***	-0.05	0.00	.
50	Water transport	0.28	0.06	***	0.32	0.06	***	-0.05	0.01	.
51	Air transport	0.16	0.05	**	0.16	0.06	**	0.01	0.01	.
52	Warehousing and support activities for transportation	0.24	0.01	***	0.25	0.01	***	-0.01	0.00	.
53	Postal and courier activities	0.27	0.05	***	0.31	0.09	**	-0.04	0.06	.
55	Accommodation	0.38	0.07	***	0.42	0.07	***	-0.04	0.01	.
56	Food and beverage service activities	0.34	0.05	***	0.33	0.05	***	0.02	0.00	***
58	Publishing activities	0.50	0.05	***	0.43	0.05	***	0.07	0.00	***
59	Motion picture, video and television programme production, sound recording and music publishing activities	0.63	0.10	***	0.58	0.09	***	0.05	0.01	***
60	Programming and broadcasting activities	0.64	0.07	***	0.64	0.08	***	0.00	0.01	.
61	Telecommunications	0.39	0.03	***	0.39	0.04	***	0.00	0.02	.
62	Computer programming, consultancy and related activities	0.36	0.02	***	0.33	0.02	***	0.03	0.00	***
63	Information service activities	0.24	0.22	.	0.23	0.23	.	0.01	0.02	.
64	Financial service activities, except insurance and pension funding	0.26	0.02	***	0.23	0.02	***	0.03	0.00	***
65	Insurance, reinsurance and pension funding, except compulsory social security	0.84	0.05	***	0.75	0.05	***	0.09	0.00	***
66	Activities auxiliary to financial services and insurance activities	0.27	0.04	***	0.17	0.04	***	0.10	0.00	***
68	Real estate activities	0.31	0.03	***	0.31	0.03	***	0.00	0.02	.
69	Legal and accounting activities	0.24	0.03	***	0.19	0.03	***	0.06	0.00	***
70	Activities of head offices; management consultancy activities	0.29	0.02	***	0.26	0.02	***	0.03	0.00	***

71	Architectural and engineering activities; technical testing and analysis	0.31	0.05	***	0.28	0.05	***	0.03	0.00	***
72	Scientific research and development	0.32	0.05	***	0.31	0.04	***	0.01	0.01	.
73	Advertising and market research	0.11	0.01	***	0.09	0.01	***	0.02	0.00	***
74	Other professional, scientific and technical activities	0.40	0.09	***	0.37	0.09	***	0.03	0.01	**
77	Rental and leasing activities	0.27	0.01	***	0.32	0.02	***	-0.05	0.01	.
78	Employment activities	0.07	0.01	***	-0.24	0.01	.	0.31	0.01	***
79	Travel agency, tour operator and other reservation service and related activities	0.13	0.02	***	0.12	0.03	***	0.01	0.00	**
80	Security and investigation activities	0.13	0.01	***	-0.07	0.01	.	0.20	0.01	***
81	Services to buildings and landscape activities	0.18	0.02	***	0.04	0.03	.	0.14	0.01	***
82	Office administrative, office support and other business support activities	0.29	0.02	***	0.28	0.02	***	0.01	0.00	**

Notes: *Standard errors are clustered by year. Standard errors in parentheses (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$). An industry is defined as a two-digit category. We estimate equation (20) by industry (NACE two-digit categories). Fixed effects include year fixed effects.*

7.4 Methodology appendix

7.4.1 Deriving the cost function for a production function with scale elasticity γ and neutral technical progress

Corresponding to the (homogenous) production function in equation (1) with scale elasticity γ, there exists a variable cost function:

$$C^v = C^v(W,R,P^M,Q,\theta) = G(W,R,P^M)\theta^{-1}Q^{\frac{1}{\gamma}}$$

which is defined as

$$C^v(W,R,P^M,Q,\theta) = \min_{L,K,M}(WL^v + RK^v + P^M M^v)\ s.t. F(K^v,L^v,M^v)^\gamma\theta^\gamma \geq Q)$$

Consider the problem with θ initially normalised to 1

$$C^v(W,R,P^M,Q,1) = \min_{L,K,M}(WL^v + RK^v + P^M M^v)\ s.t.\ F(K^v,L^v,M^v)^\gamma 1^\gamma \geq Q)$$

For homogenous production functions we can also write the cost function as follows (see Diewert 2020)

$$C^v(W,R,P^M)Q^{\frac{1}{\gamma}} = \min_{L,K,M}(WL^v + RK^v + P^M M^v)\ s.t.\ F(K^v,L^v,M^v)^\gamma 1^\gamma \geq Q)$$

Now consider the RHS of this equation and multiply 1 with $\theta > 1$, i. e. increase the efficiency of production in a neutral way, and keep all factor prices constant. Now the minimisation problem of producing at least an output level Q with the new technology level θ

$$\min_{L,K,M}\left(WL^{v^*} + RK^{v^*} + P^M M^{v^*}\right)\ s.t.\ F\left(K^{v^*},L^{v^*},M^{v^*}\right)^\gamma\theta^\gamma \geq Q)$$

What are the new cost minimizing factor levels K^{v^*},L^{v^*},M^{v^*}?

First, notice that by taking the derivatives w. r. t. K^v,L^v,M^v and factor prices constant, the factor proportions are invariant to θ. Therefore the question becomes, by which common factor K^v,L^v,M^v must be reduced in order to meet the production level Q?

Since

$$F(K^v, L^v, M^v)^\gamma = F(K^v, L^v, M^v)^\gamma \theta^\gamma \left(\frac{1}{\theta}\right)^\gamma = Q$$

and by using the property that $F(K^v, L^v, M^v)^\gamma$ is homogenous of degree γ this can also be written as

$$F\left(\frac{K^v}{\theta}, \frac{L^v}{\theta}, \frac{M^v}{\theta}\right)^\gamma \theta^\gamma = Q$$

Thus with $K^{v^*} = \frac{K^v}{\theta}; L^{v^*} = \frac{L^v}{\theta}; M^{v^*} = \frac{M^v}{\theta}$ the same level of output can be produced.

That in turn implies that if K^v, L^v, M^v have been cost minimising factor inputs for $\theta = 1$ and cost

$$C^v(W, R, P^M)Q^{\frac{1}{\gamma}} = \min_{L,K,M}(WL^v + RK^v + P^M M^v))$$

With $\theta > 1$ we get

$$\frac{C^v(W, R, P^M)Q^{\frac{1}{\gamma}}}{\theta} = \min_{L,K,M}\left(W\frac{L^v}{\theta} + R\frac{K^v}{\theta} + P^M\frac{M^v}{\theta}\right)$$

Thus for a homogenous production function with scale parameter γ, and neutral technology shock θ the corresponding cost function is given by

$$C^v(W, R, P^M)\theta^{-1}Q^{\frac{1}{\gamma}}$$

A CES example:

Consider a perfectly competitive firm with CES production function with neutral technical progress and scale elasticity γ, and substitution elasticity σ for the two inputs, capital (K) and labor (L):

$$Q_t = \left[s^{K\frac{1}{\sigma}}(\theta_t K_t)^{\frac{\sigma-1}{\sigma}} + s^{L\frac{1}{\sigma}}(\theta_t L_t)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma\gamma}{\sigma-1}} = \left[\left(s^{K\frac{1}{\sigma}}K_t^{\frac{\sigma-1}{\sigma}} + s^{L\frac{1}{\sigma}}L_t^{\frac{\sigma-1}{\sigma}}\right)\right]^{\frac{\sigma\gamma}{\sigma-1}}\theta_t^\gamma$$

Cost minimisation gives the two factor demand functions

$$K_t = \gamma^\sigma s^K \left(\frac{P}{R_t^c}\right)^\sigma \theta^{\sigma-1}(Q)^{\frac{\sigma(\gamma-1)+1}{\gamma}}$$

$$L_t = \gamma^\sigma s^L \left(\frac{P}{W_t^c}\right)^\sigma \theta^{\sigma-1}(Q)^{\frac{\sigma(\gamma-1)+1}{\gamma}}$$

Substituting the demand function into the production function yields the CES cost function,

$$C = PQ = \left[s^K \left(\left(\frac{1}{R_t^c} \right)^{\sigma} \right)^{\frac{\sigma-1}{\sigma}} + s^L \left(\left(\frac{1}{W_t} \right)^{\sigma} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{1}{1-\sigma}} \theta^{-1} Q_t^{\frac{1}{\gamma}}$$

Then, the cost function is homogenous of degree one w.r.t. R, W, while homogenous of degree minus one w.r.t. θ and homogenous of degree $\frac{1}{\gamma}$ w. r. t. Q.

7.4.2 Deriving Δq: wedges in the presence of fixed costs and a scale parameter

Our approach uses properties of various Solow residuals. Solow decomposed output growth into TFP growth and a weighted average of factor input growth, with weights equal to their respective revenue shares. This is the correct decomposition under the assumption of perfectly competitive product markets and the absence of fixed factors. Hall (1988) has shown how the presence of a price cost margin drives a wedge between the Solow residual and TFP growth, which can be used to estimate the price cost margin. Here we show that the presence of fixed factors as well as a scale parameter adds additional wedges.

We further assume that the firm faces a demand function with price elasticity equal to ε. We start from a production function which is homogeneous of degree one with respect to the variable inputs of production. θ denotes neutral technological progress as each production factor is multiplied with the same technology component. Hence, we have:

$$Q = F(K^v, L^v, M^v)^{\gamma} \theta^{\gamma} \quad (4)$$

The Lagrangian of the static profit maximization problem of firm *i* in year *t* becomes,

$$Max\ P(Q_t)Q_t - (WL^v + RK^v + P^M M^v) - \lambda(Q - F(K^v, L^v, M^v)^{\gamma} \theta^{\gamma})$$

which yields the following first-order-conditions,

$$(1-B)\gamma F(.)^{\gamma-1} F_{L^v} \theta^{\gamma} = (1-B)\gamma \left(\frac{Q}{F}\right) F_{L^v} = \frac{W}{P}$$

$$(1-B)\gamma F(.)^{\gamma-1} F_{K^v} \theta^{\gamma} = (1-B)\gamma \left(\frac{Q}{F}\right) F_{K^v} = \frac{R}{P}$$

$$(1-B)\gamma F(.)^{\gamma-1} F_{M^v} \theta^{\gamma} = (1-B)\gamma \left(\frac{Q}{F}\right) F_{M^v} = \frac{P^M}{P}$$

$F(.)$ Is homogenous of degree one, therefore Euler's law states that,

$$F_{K^v} K^v + F_{L^v} L^v + F_{M^v} M^v = Y = \left(\frac{Q}{\theta^{\gamma}}\right)^{\frac{1}{\gamma}}$$

And can be rewritten, using the first-order conditions as,

$\left(\frac{Q}{F}\right)(F_{K^v}K^v + F_{L^v}L^v + F_{M^v}M^v) = Q = \frac{RK^v}{(1-B)\gamma P} + \frac{WL^v}{(1-B)\gamma P} + \frac{P^M M^v}{(1-B)\gamma P}$

Logarithmic differentiation of the production function leads to,

$\Delta q = \frac{sv^K RK}{\gamma(1-B)PQ}\Delta k^v + \frac{sv^l WL}{\gamma(1-B)PQ}\Delta l^v + \frac{sv^M P^M M}{\gamma(1-B)PQ}\Delta m^v + \gamma\Delta\theta$.

Which can be rewritten, due to the first-order conditions and Euler's law, as,

$\Delta q = (1-\gamma(1-B))\Delta q + (\frac{sv^K RK}{PQ}\Delta k^v + \frac{sv^l WL}{PQ}\Delta l^v + \frac{sv^M P^M M}{PQ}\Delta m^v) + \gamma^2(1-B)\Delta\theta$

Since variable cost equals (see section 7.4.1.),

$C^v = C^v(W, R, P^M, Q, \theta) = G\left(W, R, P^M\right)\theta^{-1}(Q)^{\frac{1}{\gamma}} = WL^v + RK^v + P^M M^v$

And marginal costs equals

$MC_Q = \frac{\partial C^v}{\partial Q} = \frac{1}{\gamma}G\left(W, R, P^M\right)\theta^{-1}(Q)^{\frac{1}{\gamma}}\left(\frac{1}{Q}\right)$

We can write the relationship between variable and cost marginal costs as,

$\frac{1}{\gamma}C^v\left(\frac{1}{Q}\right) = MC_Q$

Or,

$\frac{1}{\gamma}C^v = MC_Q Q = \frac{1}{\gamma}(sv^K RK + sv^L WL + sv^M P^M M)$

And since,

$(1-B)PQ = MC_Q Q = \frac{1}{\gamma}C^V$

We can rewrite Δq also in terms of variable costs rather than operating revenue,

$\Delta q = \frac{sv^K RK}{C^v}\Delta k^v + \frac{sv^l WL}{C^v}\Delta l^v + \frac{sv^M P^M M}{C^v}\Delta m^v + \gamma\Delta\vartheta$.

7.4.3 Deriving Δp: wedges in the presence of fixed costs and a scale parameter

As shown above, corresponding to the production function with scale elasticity γ there exists a variable cost function.

$$C^v = C^v(W, R, P^M, Q, \theta) = G(W, R, P^M)\theta^{-1}(Q)^{1/\gamma}$$

Marginal Cost are,

$$MC_Q = \frac{dC^v}{dQ} = G(W, R, P^M)\frac{1}{\gamma}(Q)^{\frac{1}{\gamma}-1}\left(\frac{1}{\theta}\right)$$

Which can be rewritten as,

$$\frac{\Delta MC_Q}{MC_Q} = \left(\frac{G_W W}{G}\left(\frac{\Delta W}{W}\right) + \frac{G_R R}{G}\left(\frac{\Delta R}{R}\right) + \frac{G_{P^M} P^M}{G}\left(\frac{\Delta P^M}{P^M}\right)\right) + \left(\frac{1}{\gamma} - 1\right)\left(\frac{\Delta Q}{Q}\right) - \left(\frac{\Delta \theta}{\theta}\right)$$

Using Shepard's lemma and the derivatives of the cost function w. r. t. factor prices is equal to factor input

$$L^v = \frac{\partial C^v}{\partial W} = G_W \frac{1}{\theta}(Q)^{\frac{1}{\gamma}}$$

$$K^v = \frac{\partial C^v}{\partial R} = G_R \frac{1}{\theta}(Q)^{\frac{1}{\gamma}}$$

$$M^v = \frac{\partial C^v}{\partial P^M} = G_{P^M} \frac{1}{\theta}(Q)^{\frac{1}{\gamma}}$$

Therefore, we can write terms like

$$\frac{G_W W}{G} = \frac{WL^v}{G\frac{1}{\theta}(Q)^{\frac{1}{\gamma}}} = \frac{WL^v}{C^v(.)} = \frac{WL^v}{WL^v + RK^v + P^M M^v}$$

This allows us to write the growth rate of marginal cost as a weighted average of the growth rate of factor prices weighed with their respective cost shares.

With constant markup this allows us to decompose the growth rate of prices

$$\frac{\Delta P}{P} = \frac{\Delta MC_Q}{MC_Q} + \frac{\Delta B}{1-B}$$

$$\Delta p = \Delta mc_q = \left(\frac{G_W W}{G}\Delta w + \frac{G_R R}{G}\Delta r + \frac{G_{P^M} P^M}{G}\Delta p^M\right) - \Delta\theta + \left(\frac{1}{\gamma} - 1\right)\Delta q$$

$$\Delta p = \Delta mc_q = \left(\frac{WL^v}{C^v}\Delta w + \frac{RK^v}{C^v}\Delta r + \frac{P^M M^v}{C^v}\Delta p^M\right) - \Delta\theta + \left(\frac{1}{\gamma} - 1\right)\Delta q$$

Which we can rewrite due to $PQ * \gamma(1 - B) = C^v$ as,

$$\Delta p = \frac{1}{\gamma(1-B)}\left(\frac{WL^v}{PQ}\Delta w + \frac{RK^v}{PQ}\Delta r + \frac{P^M M^v}{PQ}\Delta p^M\right) - \Delta\theta + \left(\frac{1}{\gamma} - 1\right)\Delta q$$

Or as,

$$\Delta p = (1-\gamma(1-B))\Delta p + \left(\frac{sv^K RK}{PQ}\Delta r + \frac{sv^l WL}{PQ}\Delta w + \frac{sv^M P^M M}{PQ}\Delta p^m\right) - \gamma(1-B)\Delta\theta + \gamma(1-B)\left(\frac{1}{\gamma}-1\right)\Delta q\ .$$

8. References

Ackerberg, D., Benkard, C. L., Berry, S., & Pakes, A. (2007). Chapter 63 Econometric Tools for Analyzing Market Outcomes. In J. Heckman, & E. Leamer, *Handbook of Econometrics* (pp. 4171-4276). Amsterdam: Elsevier.

Amit, R., Domowitz, I., & Fershtman, C. (1988). Thinking one step ahead: The use of conjectures in competitor analysis. *Strategic Management Journal*, 9(5), 431-442.

Asen, E., & Bunn, D. (2019). *Capital Cost Recovery across the OECD, 2019.* Washington, DC: OECD.

Asker, J., Collard-Wexler, A., & De Loecker, J. (2014). Dynamic Inputs and Resource (Mis)Allocation. *Journal of Political Economy*, 122, 1013-1063.

Autor, D., Dorn, D., Katz, L. F., Patterson, C., & Van Reenen, J. (2020). The Fall of the Labor Share and the Rise of Superstar Firms. *Quarterly Journal of Economics*, 135(2), 645-709.

Barkai, S. (2020). Declining labor shares and capital shares. *The Journal of Finance*, 75(5), 2421-2463.

Basu, S. (2019). Are price-cost markups rising in the united states? a discussion of the evidence. *Journal of Economic Perspectives*, 33(3), 3-22.

Basu, S., & Fernald, J. (1994). *Constant returns and small markups in U.S. manufacturing.* Washington: International Finance Discussion Papers (IFDP) Discussion Paper 483.

Berry, S., Gaynor, M., & Morton, F. S. (2019). Do increasing markups matter? Lessons from empirical industrial organization. *Journal of Economic Perspectives*, 33(3), 44-68.

Bijnens, G., & Konings, J. (2018). Declining business dynamism in Belgium. *Small Business Economics*, 51(4), 1-39.

Crépon, B., Desplatz, R., & Mairesse, J. (2005). Price-cost margins and rent sharing: Evidence from a panel of french manufacturing firms. *Annales d'économie et de statistique*, 79-80, 583-610.

Curry Raper, K., Love, A. H., & Shumway, R. C. (2007). Distinguishing the Source of Market Power. *American Journal of Agricultural Economics*, Vol. 89, No. 1, pp. 78-90.

De Loecker, J. (2011). Product differentiation, multiproduct firms, and estimating the impact of trade liberalization on productivity. *Econometrica*, 79(5), 1407-1451.

De Loecker, J., & Warzynski, F. (2012). Markups and Firm-Level Export Status. *American Economic Review*, 102(6), 2437-2471.

De Loecker, J., Eeckhout, J., & Unger, G. (2020). The Rise of Market Power and the Macroeconomic Implications. *Quarterly Journal of Economics*, 135(2), 561-644.

De Loecker, J., Fuss, C., & Van Biesebroeck, J. (2018). *Markup and price dynamics: linking micro to macro.* Brussels: National Bank of Belgium, Working Paper No 357.

Decker, R. A., Haltiwanger, J., Jarmin, R. J., & Miranda, J. (2017). Declining Dynamism, Allocative Efficiency, and the Productivity Slowdown. *American Economic Review: Papers & Proceedings*, 107(5), 322-326.

Diewert, E. W. (2020). *Handbook of Production Economics: Duality in production.* Singapore: Springer.

Diez, F. J., Leigh, D., & Tambunlertchai, S. (2018). *Global Market Power and its Macroeconomic Implications.* Washington: IMF Working Paper, WP/18/137.

Dobbelaere, S. (2004). Estimation of price-cost margins and union bargaining power for Belgian manufacturing. *International Journal of Industrial Organization*, 22, 1381-1398.

Dobbelaere, S., & Mairesse, J. (2013). Panel data estimaets of the production function and product and labor market imperfections. *Journal of Applied Econometrics*, 28(1), 1-46.

Flynn, Z., Gandhi, A., & Traina, J. (2019). *Measuring Markups with Production Data.*

Goutsmet, D., Lecocq, C., & Volckaert, A. (2017). *Methodologie voor het beschrijven van speerpuntclusters in Vlaanderen.* Leuven (Belgium): Steunpunt Economie & Ondernemen.

Griliches, Z., & Hausman, J. (1986). Errors in variables in panel data. *Journal of Econometrics*, 31(1), 93-118.

Griliches, Z., & Mairesse, J. (1995). *Production functions: The search for identification.* Cambridge: NBER Working Paper No. 5067.

Gutiérrez, G., & Philippon, T. (2017). *Declining Competition and Investment in the U.S.* Cambridge: NBER Working Paper No. 23583.

Hall, R. E. (1988). The Relation between Price and Marginal Cost in U.S. Industry. *Journal of Political Economy*, 96(6), 921-947.

Hall, R. E. (1990). *Invariance Properties of Solow's Productivity Residual.* Cambridge: MIT Press.

Hall, R. E. (2018). *New Evidence on the Markup of Prices over Marginal Costs and the Role of Mega-Firms in the US Economy.* Cambridge: NBER Working Paper No. 24574.

Hall, R. E., & Jorgenson, D. W. (1967). Tax Policy and Investment Behavior. *The American Economic Review*, 57(3), 391-414.

Harrison, A. (1994). Productivity, imperfect competition and trade reform: Theory and evidence. *Journal of International Economics*, 36(1-2), 53-73.

Hsiao, C., Li, Q., Liang, Z., & Xie, W. (2019). Panel Data Estimation for Correlated Random Coefficietns Models. *Econometrics*, 7(1), 1-18.

Klette, T. (1999). Market power, scale economies and productivity: Estimates from a panel of establishment data. *Journal of Industrial Economics*, 47(4), 451-476.

Klette, T. J., & Giliches, Z. (1996). The inconsistency of common scale estimators when output prices are unobserved and endogenous. *Journal of Applied Econometrics*, 11, 343-361.

Konings, J., Roeger, W., & Zhao, L. (2011). *Price-cost margins and shares of fixed factors.* London: Centre for Economic Policy Research (CEPR) Discussion Papers 8290.

Konings, J., Van Cayseele, P., & Warzynski, F. (2001). The dynamics of industrial mark-ups in two small open economies: does national competition policy matter? *International Journal of Industrial Organization*, 19(5), 841-859.

Konings, J., Van Cayseele, P., & Warzynski, F. (2005). The effects of privatization and competitive pressure on firms' price-cost marings: micro evidence from emerging economies. *The Review of Economics and Statistics*, 87(1), 124-134.

Levinsohn, J. (1993). Testing the imports-as-market-discipline hypothesis. *Journal of International Economics*, 35(1-2), 1-22.

Morlacco, M. (2019). *Market Power in Input Markets: Theory and Evidence from French Manufacturing.* Los Angelos: University of Southern California.

Morrison, C. J. (1992). Unraveling the productivity growth slowdown in the United States, Canada and Japan: The effects of subequilibrium, scale economies and markups. *The Review of Economics and Statistics*, 74(3), 381-393.

Norrbin, S. (1993). The relation between price and marginal costs in U.S. industry: a contradiction. *Journal of Political Economy*, 101(6), 1149-1164.

OECD. (2020). *OECD Economic Outlook, Issue 1.* Paris: OECD.

Roeger, W. (1995). Can Imperfect Competition Explain the Difference between the Primal and Dual Productivity Measures? Estimates for U.S. Manufacturing. *Journal of Political Economy*, 103(2), 316-330.

Roeger, W., & Warzynski, F. (2004). *A Joint Estimation of Price-Cost Margins and Sunk Capital - Theory and Evidence from the European Electricity Industry.* Aarhus: Department of Economics, Aarhus School of Business, Working Paper 04-17.

Rubens, M. (2021). *Market Structure, Oligopsony Power, and Productivity.* Leuven: KU Leuven.

Shapiro, M. D. (1987). Are cyclical fluctuations in productivity due more to supply shocks or demand schocks. *American Economic Review: Papers and Proceedings*, 77: 118-124.

Solow, R. M. (1957). Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*, 39(3), 312-320.

Syverson, C. (2019). Macroeconomics and Market Power: Facts, Potentional Explanations and Open Questions. *Journal of Economic Perspectives*, 33(3), 23-43.

Traina, J. (2018). *Is aggregate market power increasing? Production trends using financial statements.* Chicago: Booth School of Business, University of Chicago.

Waldmann, R. J. (1991). Implausible results of implausible data? Anomalies in the construction of value-added data and implications for estimates of price-cost markups. *Journal of Political Economy*, 99(6), 1315-1328.

Wooldridge, J. (2002). *Econometric Analysis of Cross Section and Panel Data.* Massachusetts: MIT Press.

World Bank. (2021, August 6). *GDP (current US$) - Belgium*. Retrieved from https://data.worldbank.org: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=BE