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PRICE-COST MARGINS, FIXED COSTS AND EXCESS PROFITS*

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This paper provides a new method to estimate price-cost margins in the presence of fixed costs of production. By exploiting properties of the primal and dual sales-based and cost-based Solow residuals, we are able to simultaneously estimate price-cost margins and the share of fixed costs in total costs for each input. Ignoring fixed costs in production underestimates price-cost margins and overestimates excess profit shares. Using a thirty-year panel of Belgian firms, we estimate price-cost margins, as a fraction of sales, of 25.4% on average, which can be decomposed between fixed costs of 22.9% and excess profits of 2.5%. Belgian price-cost margins have declined (−5.9%) in the past three decades due to a combination of falling fixed costs (−4.0%) and decreasing excess profits (−1.9%), suggesting that output markets have become even more competitive over time. While large firms have higher profit shares than small firms, they have lower fixed cost shares as well as lower price-cost margins.

The economic implications of institutional change, trade liberalisation and anti-trust policy on market power have been widely conjectured and researched. The long-term trend of the rise in US markups[1] has stirred concerns about the rise of superstar firms and the potential macroeconomic effects of rising market power (Diez *et al.*, 2018; Hall, 2018; De Loecker *et al.*, 2020). The documented rise in US markups has been accompanied by a fall in investment rates (Gutiérrez and Philippon, 2017), declining business dynamism (Decker *et al.*, 2017) and a fall in the labour share (Autor *et al.*, 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, industrial organisation economists especially stress that there can be diverse reasons for rising markups apart from increasing market power (Berry *et al.*, 2019). In particular, in the presence of (unobservable) fixed costs, markup estimates

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[1] The price-cost margin, $B \equiv (P - MC)/P$, corresponds one to one to the markup, $\mu = P/MC$, through the equation $\mu = 1/(1 - B)$, with product price P and marginal cost MC. Our approach estimates a price-cost margin. In this paper, we refer to a price-cost margin or a markup, depending on the respective underlying estimation approach.

may be biased. However, it is not straightforward to classify certain factors of production as fully fixed and others as fully variable. Capital is usually considered fully fixed, while labour and intermediate inputs are typically taken as flexible.[2] De Loecker *et al.* (2020) addressed this issue by using overhead costs as a proxy for fixed costs. In particular, the income statements of firms report selling, general and administrative costs (SG&A). While SG&A in total costs increased from 15% (1980) to 21% (2014), markups rose even more in the United States. Traina (2018) as well as Karabarbounis and Neiman (2018) argued, however, that accounting practices may have changed. Firms switched particular items originally booked under ‘costs of goods sold (COGS)’ to ‘SG&A’. When both COGS and SG&A are used as a measure for variable cost, the increase of the markup in the United States turns out to be far less pronounced.

In his survey of the recent literature, Basu (2019) recognised this issue of measuring variable cost and fixed costs, but remained sceptical that it can be resolved with existing methods, since they rely on a distinction between variable and fixed costs provided by accountants. He found that the Compustat data are not informative enough to allow such a distinction. Moreover, he was sceptical about the choice made by De Loecker *et al.* (2020) because of reclassification issues and economic changes such as outsourcing. This might have reduced COGS and increased SG&A. Also, this problem is not restricted to labour input, but similar problems arise for intermediate inputs as well. For instance, De Loecker *et al.* (2018) used Belgian firm-level accounts in which intermediate inputs are categorised as either materials or service inputs. They argued that service inputs should be considered as fixed costs similar to the US experience. Depending on whether service inputs are assumed to be fixed or variable in the markup estimation, they found different levels and trends of markups in Belgium.

This leaves the literature with a somewhat arbitrary classification into fixed and variable inputs, and often dictated by the limited availability of data on the disaggregation of input categories. In this paper we propose to overcome this problem and introduce a methodology to jointly estimate the price-cost margin, the share of fixed capital, the share of fixed labour and the share of fixed intermediate inputs, using standard yearly firm-level data on expenditures of inputs and sales. In order to do so, we generalise the framework introduced by Solow (1957) and Hall (1988) and further extended by Roeger (1995) to account for fixed costs.

Solow (1957) showed that, under perfect competition, the sales shares of the inputs measure the respective output elasticities, and the Solow residual equals the change in total factor productivity (TFP). Relaxing the assumption of perfect competition, Hall (1988) observed that the Solow residual differs from the change in TFP. The Solow residual becomes a weighted average of the growth rate of capital productivity and the growth rate of TFP with weights of the former equal to the price-cost margin. Since the growth in capital productivity is observable, a regression of the Solow residual on the growth in capital productivity yields an estimate of the price-cost margin.

We extend this approach by exploring how the Solow residual is affected by the presence of fixed factors of production. For this, we postulate that each factor of production can be divided into a variable and a fixed component, and only changes in variable components affect output in the current period, while variations of fixed factors do not affect output in the current period. Fixed factors, (e.g., a building) may affect output after a ‘time-to-build’ period or may not affect output at all (e.g., administrative staff), but is nevertheless a prerequisite for managing a firm.[3] Based on

[2] We provide evidence that fixed costs represent an important share of input outlays, even for inputs traditionally thought of as entirely variable, such as intermediate inputs (see Section 3.1). Recent studies following De Loecker and Warzynski (2012) rely on a variable input that does not contain fixed inputs.

[3] This paper does not deal with the issue of the timing assumption of a specific input.

this distinction between fixed and variable factors, we formulate a production technology that can be expressed as a function of variable factor inputs and a Hicks-neutral technological progress term. We can then ask the question of how the difference between the Solow residual and the TFP change does, not only depend on goods market imperfections, but also on the presence of fixed factors.

In particular, our approach makes use of four Solow residuals: the primal (quantity based) versus the dual (price based) as in Roeger (1995), as well as the sales-based versus the cost-based Solow residuals. By combining these four Solow residuals, we can difference out a number of unobservables, such as the change in TFP and the growth rate of variable input factors, which results in an equation of observables, allowing the joint estimation of the price-cost margin and the share of fixed costs as a fraction of sales for each input factor.[4]

To this end, we specify a general production function for variable factors of production where we allow a return-to-scale parameter that is not restricted to one, thus allowing for variable returns to scale. However, separating the scale parameter from the price-cost margin 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 price-cost margin. We show that this estimate together with the fixed cost estimate provides sufficient information about excess profits, defined as sales minus fixed costs and variable costs (including costs of capital). The comparison of US markup estimates with the (excess) profit share, defined as excess profits over sales, has also played a major role in the US debate on market power of large firms in recent years. We show how our price-cost margin and fixed cost estimates relate to estimates of the profit share as, for example, suggested by Barkai (2020).

Our approach has at least three main advantages. First, 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 labour and intermediate inputs. We do not have to classify costs as quasi-variable or quasi-fixed, nor do we have to assume that one or all inputs are entirely variable. Instead, our model jointly estimates the price-cost margin and the share of fixity for each input factor based on variation in the underlying firm-level data, thereby distinguishing marginal profitability (i.e., price-cost margins) from average profitability (i.e., excess profit share). Second, unlike most other approaches, we do not need to rely on unobserved product price data for deflating firm-level sales or deflating input factors. We make use of nominal values rather than price deflators and real values.[5] Third, our approach deals with the endogeneity problems caused by unobservable productivity shocks as in Roeger (1995) and Konings *et al.* (2001). These advantages come at the cost of not being able to estimate price-cost margins and the shares of fixity at the firm-year level;[6] however, our approach is equally able to estimate aggregate price-cost margins based on granular firm-year-level data. Moreover, our approach allows us to look into subsamples for large versus small and medium-sized enterprises (SMEs) and industry-level estimates, respectively, in Sections 3.3 and 4.5.

[4] The estimated *share* of fixity does not directly depend on the *level* of an input. In particular, fixed and variable costs are not directly linearly proportional to each other, but fixed and variable costs add up to total costs such that the *share* of 'variability' is, by definition, equal to one minus the estimated *share* of fixity.

[5] Deflated sales are used to proxy for physical output, but with firm heterogeneity and multi-product firms, this can introduce a bias (see Klette and Griliches, 1996; De Loecker, 2011; De Loecker and Warzynski, 2012).

[6] It has become standard practice to use firm-level (De Loecker and Waryznski, 2012) or even firm-product level data (De Loecker *et al.*, 2016) to obtain estimates of aggregate markups.

We illustrate our method using detailed longitudinal firm-level data for Belgium for the period 1985–2014. We study both the level and trend of the price-cost margins over time. Our main empirical findings can be summarised 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 fixed costs, while only a smaller part remains left as excess profits. In particular, the price-cost margin, fixed cost share and excess profit share are respectively estimated at 25.4%, 22.9% and 2.5% over the sample period. Third, Belgian price-cost margins declined by 5.9 percentage points between 1985 and 2014. The fixed cost share (FCS; −4.0 percentage points) as well as the excess profit share (EPS; −1.9 percentage points) have declined during this period, thereby reinforcing each other. These results indicate that output markets have become more competitive in the Belgian economy over time. Disentangling large firms versus SMEs, we find that large firms have smaller price-cost margins due to a lower fixed cost share; however, their excess profit share (3.0%) is larger than small and medium-sized firms' excess profit share (2.4%).

The remainder of the paper is structured as follows. In Section 1, we introduce the theoretical framework. In Section 2, we describe our data set, while Section 3 discusses the empirical results and compares them to other commonly used methods in the literature. Section 4 provides a more in-depth analysis of various aspects of our methodology ensuring the robustness of our estimation results. Finally, we conclude in Section 5.

1. Theoretical Framework

Our approach is an extension of Hall (1988), Roeger (1995) and Konings *et al.* (2011). In particular, we allow for the presence of fixed costs while also exploring the consequences of non-constant returns to scale on the variable inputs. Our methodology builds on the concept of the Solow residual, which is a measure of TFP growth under the assumptions of perfect competition, constant returns to scale (CRS) and no fixed costs. Violating these assumptions induces different wedges between the Solow residual and the change in TFP. We consider four variants of the Solow residual (primal versus dual; sales based versus cost based), which are all affected differently by the abovementioned wedges. Appropriately combining these four Solow residuals allows us to jointly estimate the price-cost margin and the share of fixed costs in sales for each input factor. Finally, we decompose the price-cost margin into a part that covers the fixed costs and another part representing excess profits.

1.1. *Primal and Dual Solow Residuals with Sales-Based Shares*

We start from a standard short-run production function $F(\cdot)^{\gamma}$ for firm *i* at period *t* with the variable production factors capital, labour and intermediate inputs (respectively K^v, L^v, M^v), where $F(\cdot)$ is homogeneous of degree one, γ is the scale parameter and there is Hicks-neutral technological progress θ. For now, we omit firm and time subscripts to simplify the notation:

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

Neutral technological progress implies that each production factor is multiplied by the same technology component, which means that we can write the production function as (1)

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

where Q, K, L and M are quantities of output, capital, labour and intermediate inputs, respectively. Variable capital input equals $K^v \equiv K - K^f$, variable labour input $L^v \equiv L - L^f$ and variable intermediate inputs $M^v = M - M^f$. Here $K^v(L^v;\ M^v)$ is the part of total capital (labour; intermediates) that 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 (labour; intermediates) that is fixed and does not adjust within a period to current demand and cost changes. Fixed capital can affect productivity, but must be subject to a time-to-build constraint of at least one period, while variable capital becomes productive within the period of installation (see, e.g., Boulhol, 2004 for models of investment with a time-to-build constraint). The specification of labour input is identical to models of production with variable and overhead labour (Eden and Griliches, 1993). Examples of fixed capital, labour and intermediate inputs include buildings, administration staff or the inventory costs of raw materials, respectively. Examples of variable capital, labour and intermediate inputs include printers, production workers or electricity, respectively.[7] 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 components of an input.

Often, it is assumed that intermediate inputs are variable. However, this view overlooks that intermediate inputs also contain service inputs or overhead, which are at least partly fixed (e.g., De Loecker *et al.*, 2018). Furthermore, we assume that firms are price takers in their input markets and that prices are uncorrelated with input choices at the firm level.[8,9]

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

In the following we generalise the approach of Hall (1988) and Roeger (1995). Hall looked at the implications of relaxing the condition that price equals marginal cost for the derivation of the (primal) Solow residual, while Roeger looked at the implications for the dual Solow residual and used both residuals for eliminating unobserved TFP growth. In this paper we generalise their 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 sales and cost shares. The latter is not sensitive to the presence of a price-cost margin, but it is sensitive to the presence of fixed factors. An appropriate combination of these four residuals eliminates unobserved growth of fixed factors and TFP growth such that we can estimate price-cost margins and shares of fixed factors of production. A key feature of our approach is that we do

[7] The international trade literature models the impact of entry costs on geographic market selection, export participation, sales, pricing, profits, intensive and extensive margins. (Sunk) Entry costs can be considered as fixed costs in our approach, e.g., building an export infrastructure in the exporting country (e.g., Castro *et al.*, 2016; using Chilean data) or market-specific marketing costs needed to enter the importing countries (Arkolakis, 2010). In the work of Roberts *et al.* (2018) on Chinese footwear producers, fixed costs are the primary determinant in selecting a specific export market, but the marginal costs are very important in explaining the variations in price, market share and sales across export destinations and time. Online Appendix B provides a dynamic decision problem where the investment decision could be interpreted as an entry decision.

[8] We assume perfectly competitive input markets, in line with the literature. De Loecker *et al.* (2016) relaxed this assumption and argued that the *level* of the markups will be underestimated if firms possess monopsony power. However, the *changes* in markups will be estimated correctly as long as monopsony power does not change over time. Recent papers have been trying to incorporate monopsony power in the labour market. For applications, see Dobbelaere (2004), Crépon *et al*. (2005), Abraham *et al.* (2009), Dobbelaere and Mairesse (2013), Amador and Soares (2017), Morlacco (2019) and Soares (2020).

[9] Our method assumes that inputs cannot influence demand (see Syverson, 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.

not have to make assumptions on the level of fixity of each input, rather, our approach estimates the share of fixed costs for each input in total sales. The main text provides the intuition for the wedges implied by the various Solow residuals. Online Appendices A.1–A.4 contain a detailed derivation, including an example using a CES production function.

1.1.1. *Deriving the primal sales-based Solow residual: SRQ^R*

The primal sales-based Solow residual is defined as in Hall (1988) and equals

$$SRQ^R \equiv \Delta q - \frac{WL}{PQ}\Delta l - \frac{P^M M}{PQ}\Delta m - \left(1 - \frac{WL}{PQ} - \frac{P^M M}{PQ}\right)\Delta k. \tag{2}$$

Define Δq, Δl, Δm and Δk as the growth rates of output, labour, intermediate inputs and capital, respectively. Here WL/PQ and $P^M M/PQ$ are the shares of labour cost and intermediate input cost in sales PQ, respectively; W and P^M are the wage rate and the price of intermediate inputs.

Solow (1957) showed that SRQ^R is an unbiased measure for TFP growth under the assumption of perfectly competitive product markets and the absence of fixed production factors (except capital). Hall (1988) showed how imperfect competition (i.e., a positive 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 Online Appendix A.2 for a detailed derivation to obtain Δq in (3) below. Using the FOCs of the profit maximisation problem of the firm, the growth rate of output becomes

$$\begin{aligned}\Delta q = {} & [1 - \gamma(1 - B)]\Delta q + \left(\frac{sv^K RK}{PQ}\Delta k^v + \frac{sv^l WL}{PQ}\Delta l^v + \frac{sv^M P^M M}{PQ}\Delta m^v\right) \\ & + \gamma^2(1 - B)\Delta\vartheta,\end{aligned} \tag{3}$$

where $B \equiv (P - MC)/P$ is the price-cost margin and $sv^k RK/PQ$, $sv^l WL/PQ$ and $sv^m P^M M/PQ$ are the shares of variable capital cost, variable labour cost and variable intermediate input cost in sales, respectively. We denote by $\Delta\vartheta$ the growth rate of total factor productivity.

Inserting (3) into (2) gives the primal Solow residual with sales-based shares:

$$\begin{aligned}SRQ^R = {} & (1 - \gamma(1 - B))(\Delta q - \Delta k) \\ & + \left(\frac{sv^K RK}{PQ}(\Delta k^v - \Delta k) + \frac{sv^l WL}{PQ}(\Delta l^v - \Delta l) + \frac{sv^M P^M M}{PQ}(\Delta m^v - \Delta m)\right) \\ & + \frac{(1 - sv^L)WL}{PQ}(\Delta k - \Delta l) + \frac{(1 - sv^M)P^M M}{PQ}(\Delta k - \Delta m) + \gamma^2(1 - B)\Delta\vartheta.\end{aligned} \tag{4}$$

Equation (4) shows that the presence of fixed factors and the scale parameter introduces additional wedges between SRQ^R and $\Delta\vartheta$ beyond the wedge imposed by a positive price-cost margin.[10] 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 labour underestimates the true increase of variable labour 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 (4); however, it remains in the

[10] This expression simplifies to $SRQ^R = B(\Delta q - \Delta k) + (1 - B)\Delta\vartheta$ under the assumptions of no fixed costs and a scale parameter of one, as shown by Hall (1988). We have $SRQ^R = \Delta\vartheta$ under the assumption of perfectly competitive output markets.

third term. Both the deviations from CRS and a positive price-cost margin drive a wedge between SRQ^R and efficiency growth.

1.1.2. *Deriving the dual sales-based Solow residual: SRP^R*

Similar to the approach introduced by Roeger (1995), we consider alternative representations of the Solow residual that are based on the cost function (see Online Appendix A.1)

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

corresponding to the production function in (1) with marginal cost

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

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

$$SRP^R \equiv \frac{WL}{PQ}\Delta w + \frac{P^M M}{PQ}\Delta p^M + \left(1 - \frac{WL}{PQ} - \frac{P^M M}{PQ}\right)\Delta r - \Delta p, \tag{5}$$

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.

Logarithmic differentiation of marginal costs and Shepard's lemma yields the following expression for the growth rate of the price (see Online Appendix A.3):

$$\begin{aligned}\Delta p = \Bigg[&(1-\gamma(1-B))\Delta p + \left(\frac{sv^K RK}{PQ}\Delta r + \frac{sv^l WL}{PQ}\Delta w + \frac{sv^M P^M M}{PQ}\Delta p^m\right)\\ &- \gamma(1-B)\Delta\vartheta + \gamma(1-B)\left(\frac{1}{\gamma}-1\right)\Delta q + \gamma\Delta B\Bigg].\end{aligned} \tag{6}$$

Substituting (6) into (5), we obtain

$$\begin{aligned}SRP^R = &-(1-\gamma(1-B))(\Delta p - \Delta r) + \frac{(1-sv^l)WL}{PQ}(\Delta w - \Delta r)\\ &+ \frac{(1-sv^M)P^M M}{PQ}(\Delta p^m - \Delta r) + \gamma(1-B)\Delta\vartheta\\ &- \gamma(1-B)\left(\frac{1}{\gamma}-1\right)\Delta q - \gamma\Delta B.\end{aligned} \tag{7}$$

Equation (7) shows that SRP^R corresponds to TFP growth, if labour and materials are variable factors of production, price-cost margins 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 that the fact that the difference between Δw and Δr matters for the bias follows from the fact that both factor prices are multiplied with the wage share (with opposite sign). This wage share is mismeasured in the case of partially fixed labour. In the case of increasing returns (and zero price-cost margin), SRP^R overestimates TFP growth, while in the CRS case, SRP^R is a weighted average of the price-cost margin component and TFP growth.

1.2. *Primal and Dual Solow Residuals with Cost-Based Shares*

Hall (1990) proposed a cost weighted measure as a way of avoiding the bias caused by imperfect competition. The cost weighted primal and dual Solow residuals are subject to wedges resulting from the fixity of the inputs as well as the scale parameter, but not from the price-cost margin. As in Roeger (1995), where combining the quantity-based (primal) and the price-based (dual) sales-based Solow residual could be used to eliminate the unobserved change in TFP, we can use a combination of four Solow residuals (primal versus dual; sales based versus cost based) to eliminate a number of unobservable terms like the change in TFP and the growth rate of variable input factors.

1.2.1. *Deriving the primal cost-based Solow residual: SRQ^C*

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

$$SRQ^C \equiv \Delta q - \frac{WL}{C}\Delta l - \frac{P^M M}{C}\Delta m - \frac{RK}{C}\Delta k. \tag{8}$$

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 Online Appendix A.2 for the derivation of (9)) as

$$\Delta q = \left(\frac{(1-sv^K)RK}{C} + \frac{(1-sv^L)WL}{C} + \frac{(1-sv^M)P^M M}{C}\right)\Delta q$$
$$+ \frac{sv^K RK}{C}\Delta k^v + \frac{sv^l WL}{C}\Delta l^v + \frac{sv^M P^M M}{C}\Delta m^v + \frac{C^v}{C}\gamma\Delta\vartheta. \tag{9}$$

Substituting (9) into (8), we get

$$SRQ^C = \frac{(1-sv^K)RK}{C}(\Delta q - \Delta k) + \frac{(1-sv^L)WL}{C}(\Delta q - \Delta l)$$
$$+ \frac{(1-sv^M)P^M M}{C}(\Delta q - \Delta m) + \frac{sv^K RK}{C}(\Delta k^v - \Delta k)$$
$$+ \frac{sv^l WL}{C}(\Delta l^v - \Delta l) + \frac{sv^M P^M M}{C}(\Delta m^v - \Delta m) + \frac{C^v}{C}\gamma\Delta\vartheta. \tag{10}$$

If all factors of production are variable and the scale parameter equals one, then TFP growth equals SRQ^C. If instead a particular production 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, SRQ^C underestimates $\Delta\theta$ by the factor $C^v\gamma/C$. Unlike the sales based measure, SRQ^C is not affected by B.

1.2.2. *Deriving the dual cost-based Solow residual: SRP^C*

The dual Solow residual with cost-based shares SRP^C is defined as

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

The dual cost minimisation 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 Online Appendix A.3):

$$\begin{aligned}\Delta p &= \frac{(1-sv^K)RK}{C}\Delta p + \frac{(1-sv^L)WL}{C}\Delta p + \frac{(1-sv^M)P^M M}{C}\Delta p \\ &\quad + \left(\frac{sv^K RK}{C}\Delta r + \frac{sv^l WL}{C}\Delta w + \frac{sv^M P^M M}{C}\Delta p^m\right) - \frac{C^v}{C}\Delta\vartheta \\ &\quad + \frac{C^v}{C}\left(\frac{1}{\gamma}-1\right)\Delta q + \frac{C^v}{C}\frac{\Delta B}{1-B}.\end{aligned}$$

The dual Solow residual with cost-based shares is then

$$\begin{aligned}SRP^C &= \frac{(1-sv^l)WL}{C}(\Delta w - \Delta p) + \frac{(1-sv^M)P^M M}{C}(\Delta p^m - \Delta p) \\ &\quad + \frac{(1-sv^K)RK}{C}(\Delta r - \Delta p) + \frac{C^v}{C}\Delta\vartheta - \frac{C^v}{C}\left(\frac{1}{\gamma}-1\right)\Delta q \\ &\quad - \frac{C^v}{C}\frac{\Delta B}{1-B}. \end{aligned} \tag{11}$$

Finally, (11) shows the equivalence between SRP^C and TFP growth under the assumptions of entirely variable input factors and CRS. Violating the assumption of an entirely variable input factor implies that a factor price increase is wrongly interpreted as an efficiency improvement by SRP^C. This is because the Solow residual assumes that total labour input enters marginal cost. Similar to the primal cost-based residual, when factors of production are partly fixed, SRP^C underestimates variations of TFP and also responds to variations in output in the case of deviations from CRS.

1.3. *Appropriately Combining the Four Solow Residuals*

As shown in Sections 1.1 and 1.2, the four alternative Solow residuals correspond to TFP changes in the absence of price-cost margins, factor fixity and under CRS. Equations (4), (7), (10) and (11) reveal the wedges inflicted. We can now exploit the differences between these variants of the Solow residual for eliminating the unobservable components. We multiply the difference of (4) and (7) by PQ on the one hand and multiply the difference of (10) and (11) by total costs C on the other hand. Finally, we take the difference of these two terms and obtain the following equation (see Online Appendix A.4):

$$\begin{aligned}&(SRQ^R - SRP^R)PQ - (SRQ^C - SRP^C)C \\ &\quad = [1-\gamma(1-B)][(\Delta p + \Delta q) - (\Delta k + \Delta r)]PQ \\ &\qquad - (sf^k)RK[(\Delta p + \Delta q) - (\Delta k + \Delta r)] - (sf^l)WL[(\Delta p + \Delta q) - (\Delta k + \Delta r)] \\ &\qquad - (sf^m)P^M M[(\Delta p + \Delta q) - (\Delta k + \Delta r)]. \end{aligned} \tag{12}$$

Equation (12) allows us to estimate the average shares of fixed labour, 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.[11] But the term B^{AVC} can itself be interpreted as the price-cost margin in terms of average variable cost (AVC). Given the assumed technology, the pricing rule of the (imperfectly competitive) firm can be written both in terms of a price-cost margin with prices comparing marginal cost and as a price-cost margin with prices comparing average variable cost. To show this, we consider the period profit maximisation problem of a firm that faces an imperfectly elastic demand schedule $P(Q)$, 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,

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

Profit maximisation yields the familiar price equation with prices as a price-cost margin in terms of marginal cost, where $B = 1/\varepsilon$:

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

There exists the following relationship between marginal and average variable costs:

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

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

$$(1 - B^{AVC})P = AVC.$$

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, but not sufficient, condition for a firm to be profitable since the price-cost margin must be large enough to cover fixed costs. We rewrite B^{AVC} in (13) as

$$B^{AVC} = 1 - \frac{C^{v}}{PQ}, \tag{13}$$

while we define the fixed costs C^{f} as a share of sales as

$$C^{f} = FCS \times PQ,$$

with FCS the share of fixed costs in sales. Subtracting the fixed cost share from the price-cost margin in terms of average variable costs gives the excess profit share EPS:

$$B^{AVC} - FCS = EPS \tag{14}$$

$$EPS = 1 - \frac{C^{v}}{PQ} - \frac{C^{f}}{PQ} = 1 - \frac{C}{PQ}. \tag{15}$$

Equations (14) and (15) show that the excess profit share, i.e., the difference between the price-cost margin and the fixed cost share, is equal to the profit share, which has been introduced by Barkai (2020) using information about sales and total cost. The profit share therefore serves as a plausibility check for our estimate of the price-cost margin and the fixed cost share, which cannot

[11] This equation also shows that the scale parameter γ does not affect sf^{k}, sf^{l} and sf^{m}. Furthermore, in the case of constant returns to scale $B^{AVC} = B$.

be inferred from the profit share. As shown in discussions of recent US estimates (Basu, 2019), it is often difficult to link the markup estimates to profit estimates, since information about fixed costs 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 to 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.

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 that in this case the sum of marginal products (multiplied by their respective factor inputs) exceeds the level of output. Paying production factors for their marginal product would result in losses for the firm. A price-cost margin is necessary for avoiding a loss. This makes it difficult to interpret the presence of a price-cost margin as a sign of imperfect competition. But a positive estimate of B^{AVC} provides unambiguous information about the difference between sales 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. This could include the limit case where factors of production are paid for their marginal product. Even in this limit case there is an extra return because the sum of marginal products (multiplied by their respective factor inputs) is smaller than output.

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 ($\gamma \langle 1$ or $B \rangle 0$). Moreover, since we know the share of fixed costs, our estimate indicates whether this extra return is sufficient to cover fixed costs.

We apply (12) to a firm panel dataset with firms $i \in (1, I)$ and $1 \leq t \leq T$, introducing firm i and time subscripts t again in the notation:

$$
\begin{aligned}
&(SRQ^R_{it} - SRP^R_{it})(PQ)_{it} - (SRQ^C_{it} - SRP^C_{it})C_{it} \\
&\quad = (B^{AVC} + \lambda^B_t)(PQ)_{it}[(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] \\
&\qquad - (sf^k + \lambda^k_t)(RK)_{it}[(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] \\
&\qquad - (sf^l + \lambda^l_t)(WL)_{it}[(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] \\
&\qquad - (sf^m + \lambda^m_t)(P^M M)_{it}[(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] + \epsilon_{it}. \qquad (16)
\end{aligned}
$$

Note, in particular, that the dependent variable and the explanatory variables can all be expressed in nominal terms. In particular, the differences between the primal and dual Solow residuals, which enter the left-hand side, can be expressed in terms of nominal variables and they are multiplied with nominal sales and nominal cost, respectively. The regressors are products of nominal variables and growth rates of nominal variables. This makes our approach especially suitable for firm panel applications where generally only nominal variables are observed. The parameters B^{AVC}, sf^k, sf^l *and* sf^m denote the means of the coefficients. We allow for time variation, via the terms λ^B_t, λ^k_t, λ^l_t and λ^m_t, in order to account for cyclical variation and time trends that are common across firms. We also allow for an additional error term ϵ_{it}, which captures pure measurement errors.

1.4. *Challenges and Limitations*

The main advantages of our approach are that (i) we do not have to classify inputs as variable or fixed, (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 (Roeger, 1995) and (iv) building on granular firm-level data, we obtain an aggregate price-cost margin estimate that can be decomposed into a fixed cost share and an excess profit share. 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.

However, these advantages come at a cost. First, we assume that all inputs are non-dynamic such that we rule out, for example, adjustment costs.[12] In Online Appendix B we embed the static decision problem for variable factors of production into a dynamic firm optimisation problem, where the firm makes an entry decision (in period $t = 0$) about the amount of fixed capital and period-by-period decisions about labour and variable capital afterwards.

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 measurement errors is limited because we can use nominal values rather than deflated input or output quantities, especially for labour or intermediate input costs. Unfortunately, the nominal cost of capital is not observed and estimating this variable remains challenging. Therefore, we consider various robustness checks in Section 4.1 below. Reassuringly, our main results are robust to alternative definitions of the cost of capital. There might also be measurement error due to multi-product firms. In Online Appendix C we argue why the bias is likely to be small.

Furthermore, we might worry about specification errors. 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 in Section 4.2 below.

Next, the derivative of the production function with respect to production factors (the marginal product) for period t can be equated to the corresponding factor price level (divided by the output price and adjusted for the price-cost margin level) for period t. This equality holds for any length of the period (Solow, 1957; Hall, 1988). Furthermore, Euler's theorem states that a function (which is homogeneous of degree γ) can be written as the sum of the products of the function arguments (in our case factor inputs) and the corresponding first derivatives (adjusted for γ). Here again we can make use of the equality between the derivative and the real (price-cost margin-level-adjusted) factor price level. The crucial step suggested by Solow and Hall is that derivatives can be equated to factor price levels. Calculating the Solow residual (adjusted for price-cost margins and shares of fixed factors) requires one to calculate the growth rate of the Euler decomposition of the level of output (or prices in the case of the dual) into the level of inputs (or input prices in the case of the dual) multiplied by their marginal products. This causes an approximation problem that is true for any such calculation that includes a sum of components. This problem is

[12] Ackerberg *et al.* (2007) and Asker *et al.* (2014) focused 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 often labour 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.

Table 1. *Summary Statistics.*

Variable	Mean	SD	P25	P50	P75	N
PQ	34.05	282.26	2.90	7.67	18.79	358,124
WL	4.44	29.81	0.39	1.07	2.59	358,124
$P^M M$	26.63	258.09	1.57	5.19	13.96	358,124
TFA	6.92	81.84	0.11	0.57	2.05	358,124
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%	10.4%	316,232
LS	0.126	0.137	0.022	0.085	0.179	358,124
MS	0.779	0.199	0.687	0.838	0.940	358,124
CS	0.096	0.119	0.029	0.052	0.115	358,124

Notes: The mean, SD, P25, P50 and P75 are shown in nominal million EUR for sales (PQ), wage costs (WL), intermediate input costs ($P^M M$), tangible fixed assets (TFAs) 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 sales at the firm-year level. The labour, intermediate input and capital shares (LS, MS, CS, respectively) are calculated as total labour, intermediate input and capital cost, respectively, divided by sales.

not related to the fact that marginal products appear on the right-hand side. The problem arises since the weights must be evaluated either in period t or in period $t-1$, or a combination of both. In our baseline approach, we use the latter approach. As an additional robustness test, we check whether the use of ln growth rates affects our estimation results in Online Appendix Table 1. The price-cost margin changes from 25.4 to 25.1, which can be decomposed into a change in the FCS from 22.9 to 22.8 and a change in the EPS from 2.5 to 2.3.

Finally, a shortcoming of our approach is that price-cost margins and the various shares of fixity are assumed to be constant for a cross section, or at least for a subset of firms for which we obtain estimates. An important avenue for future research should be to allow for firm-specific price-cost margins, fixed cost shares and excess profit shares.

2. Data

We illustrate our method by applying it to Belgian unconsolidated firm-level data, obtained from the National Bank of Belgium (National Bank of Belgium, 2015).[13] This dataset covers all for-profit firms from 1985 until 2014. Our sample uses all incorporated firms that report full company accounts. Small firms have to report abbreviated company accounts (see Online Appendix D). We use the following balance sheet variables in our analysis: sales, total labour costs, intermediate input costs, tangible fixed assets and depreciation. In order to compute the cost of capital, we follow Hall and Jorgenson (1967).

Table 1 provides summary statistics. The average firm in our sample has sales (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 (TFAs) of 6.92 million EUR. Nominal sales grow on average by 7.1% per year, labour costs by 4.8% and intermediate inputs by 7.3%.[14] Tangible fixed assets increase by 1.7% on average per year. Furthermore, note that the intermediate input

[13] Section 4.4 below exploits a proxy for consolidated accounts. The results remain robust.

[14] 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].

share (77.9%) is the most dominant input factor, followed by the labour share (12.6%) and the capital share (9.6%).

3. Results

We start by presenting pooled estimation results over the period 1985–2014. First, we show estimates of price-cost margins in the absence of fixed factors of production, after which we show estimates allowing for fixed cost shares for each input. We compare both estimation results and show that ignoring fixed input factors overestimates the excess profit share while it underestimates price-cost margins (Section 3.1). We then estimate yearly coefficients, which allows us to investigate secular trends (Section 3.2). Next, we compare our results to other common methods in the literature (Section 3.3). Finally, we consider results for a subsample of large firms and a subsample of SMEs (Section 3.4).

3.1. *Pooled Estimation Results: without and with Fixed Costs*

Assuming no fixed costs, then (16) simplifies to (Roeger, 1995)[15]

$$SRQ_{it}^{R} - SRP_{it}^{R} = B[(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] + \varepsilon_{it}. \tag{17}$$

We estimate the price-cost margin and pool over the period 1985–2014. Roeger (1995) assumed that capital, labour and intermediate inputs are fully flexible and adjusted immediately to their equilibrium values without any adjustment costs. We weigh the Roeger (1995) approach by firm-year sales to obtain a weighted aggregate price-cost margin for Belgium and include various year and firm fixed effects.

Next, we allow each input factor to have a variable and a fixed part. We make use of (16) to jointly estimate price-cost margins and the share of fixed costs for each input factor, and pool the data over the entire sample period to estimate pooled coefficients, i.e., B rather than B_t. Columns (1)–(4) of Table 2 show the results under the assumption of no fixed costs, while column (5) shows the results including fixed costs.

As long as inputs are fully variable, price-cost margins are equal to the excess profit share 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 represents firms' profitability. We include the fixed cost share and the excess profit share as additional rows in Table 2.[16]

Considering first the scenario without fixed costs in columns (1)–(4) irrespective of the specification, we find that price-cost margins are estimated at roughly 8%, which maps one to one into an excess profit share of 8% due to the fact that the fixed cost share equals zero by assumption. Column (5) shows the estimation results once we allow for fixed costs. Allowing for fixed costs increases the estimated price-cost margin from 8.1% to 25.4%. The largest part (22.9%) of this price-cost margin, however, is required to cover fixed costs, while only a smaller part remains

[15] The difference between the primal and dual cost-based Solow residuals (see Online Appendix A.4) becomes zero under the assumption of no fixed costs, as sv^K, sv^L and sv^M are equal to one, the growth rate of the variable input equals the growth rate of the input (e.g., $\Delta l^v = \Delta l$) and the assumption of a scale parameter of one.

[16] The aggregate fixed cost share FCS is defined as $FCS = \widehat{sf^l} \times WL/PQ + \widehat{sf^k} \times RK/PQ + \widehat{sf^m} \times P^M M/PQ$; hence, it is a sales-weighted combination of the share of fixed capital, share of fixed labour and the share of fixed intermediate inputs at the aggregate level. The aggregate excess profit share is defined as $EPS = \widehat{PCM} - \widehat{FCS}$.

Table 2. *Price-Cost Margins.*

	(1)	(2)	(3)	(4)	(5)
Price-cost margins	0.080***	0.079***	0.080***	0.080***	0.254***
	(0.010)	(0.010)	(0.011)	(0.011)	(0.017)
Share of fixed capital					0.625***
					(0.041)
Share of fixed labour					0.173***
					(0.029)
Share of fixed intermediates					0.232***
					(0.017)
Fixed cost share					0.229***
					(0.017)
Excess profit share	0.080***	0.079***	0.080***	0.080***	0.025***
	(0.010)	(0.010)	(0.011)	(0.011)	(0.002)
Year FEs	No	Yes	No	Yes	Yes
Firm FEs	No	No	Yes	Yes	Yes
N	280,252	280,252	278,353	278,353	278,353
R^2	0.27	0.28	0.31	0.32	0.54

Notes: Columns (1)–(4) show results from (17), assuming no fixed costs. Regressions are weighted by sales at the firm-year level. Column (5) shows pooled results from (16), allowing for fixed costs. SEs are reported in parentheses (*** $p < .001$) and clustered by NACE 2 digits.

as excess profits (2.5%). 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.

The estimated shares of fixed input factors are all highly statistically significantly different from zero, with the highest share of fixed costs being found for capital (62.5%), followed by intermediate inputs (23.2%) and labour (17.3%).[17]

We are now able to define the price-cost margin (PCM) 'bias' as the difference between the price-cost margin in the absence of fixed costs (column (4)) and the price-cost margin in the presence of fixed costs (column (5)). Likewise, we can define the excess profit share (EPS) 'bias' as the difference between the excess profit share in the absence of fixed costs (i.e., this equals the price-cost margin in the absence of fixed costs) and the excess profit share in the presence of fixed costs. More formally,

$$PCM\ bias = PCM^{NO\ FC} - PCM^{FC},$$

and

$$EPS\ bias = EPS^{NO\ FC} - EPS^{FC}.$$

The PCM bias and the EPS bias are respectively equal to −17.3% and 5.6%. The absolute total of these two types of bias is equal to the fixed cost share of 22.9%. Ignoring the presence of fixed costs would thus underestimate the price-cost margin and overestimate the excess profitability.

3.2. *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

[17] 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 times 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.

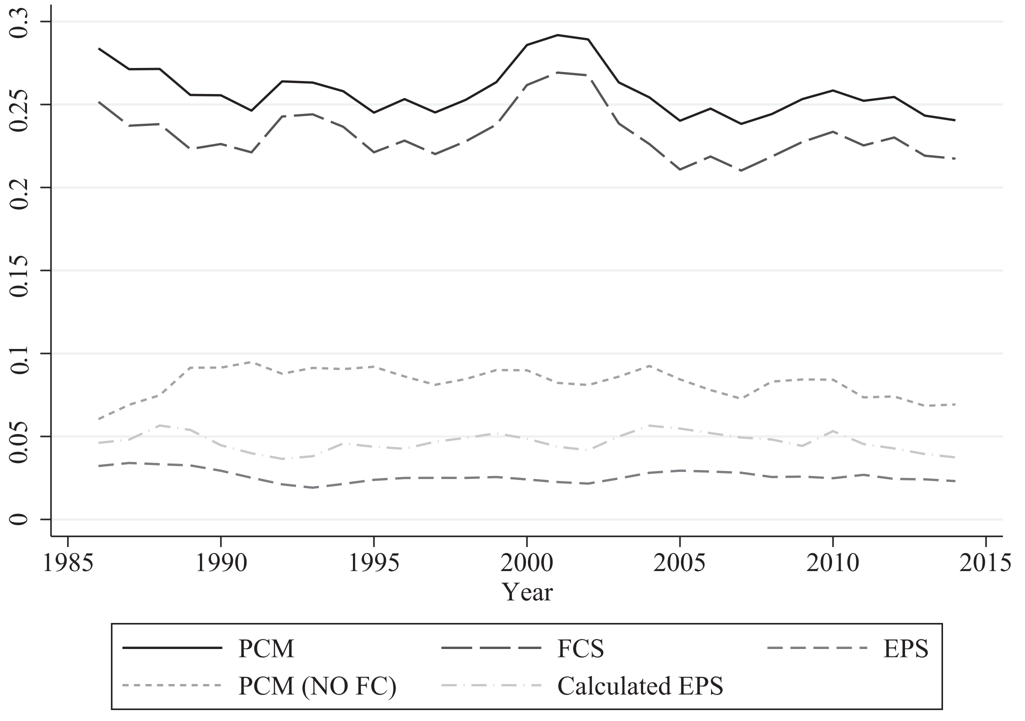


Fig. 1. *Evolution of Price-Cost Margins.*
Notes: This figure shows the evolution of the price-cost margins, fixed cost share and the excess profit share (see (16)), the evolution of price-cost margins without fixed costs (see (17)) and the accounting profits (see (15)) at the yearly level. The evolution of the variables has been smoothed. Each observation is the simple average of its current observations and one observation before and after its observation.

price-cost margin as well as their mix of variable and fixed input factors in response to changing economic circumstances over time. We use (16) and estimate yearly coefficients such that we obtain an annual price-cost margin estimate and annual estimates for the shares of fixed input factors. We refer to these results as our baseline results.

Figure 1 plots the evolution of the aggregate price-cost margin, the fixed cost share and the excess profit share. In Online Appendix Table 4 we show the corresponding estimates for the PCM, FCS and EPS. As a comparison, we add the calculated excess profit share (see (15)). It can be computed directly as the difference between sales and labour and intermediate input costs and capital costs, divided by sales (Barkai, 2020). We also show the evolution of the price-cost margin in the absence of fixed costs based on (17).[18] Various interesting patterns can be observed. Overall, the price-cost margin displays a moderately decreasing trend, from 28.4% in 1986 to 24.1% in 2014. This evolution seems to be driven by the fixed cost share that drops from 25.2% in 1986 to 21.8% in 2014. Both components experience some fluctuations from one year to the other and seem to be correlated to the business cycle. The PCM and the FCS reach a peak around the early 1990s, again in the early 2000s and in 2010. Interestingly, the excess profit share has

[18] We omit confidence intervals in the figures for readability. All yearly coefficients are always highly significant in Figure 1.

been rather stable, especially during the past two decades. It falls from 3.2% in 1986 to 2.0% in 1993, after which it increases again to 2.9% in 2006. Note in particular that the co-movement of the FCS and PCM on the one hand and the implied flat excess profit share on the other hand is consistent with the calculated excess profit share. The latter moves closely with our estimated EPS, as expected from (15).

Looking at price-cost margins when fixed costs are ignored, we find that they first increase and then decrease moderately at the beginning and the end of the sample period, respectively, while they barely move between 1990 and 2009. This evolution is very different from the price-cost margins and the excess profit share when fixed costs are accounted for. In fact, the correlation between the price-cost margin with and without fixed costs is negative (−0.13), and the correlation between the price-cost margin without fixed costs and the excess profit share is negative (−0.19), illustrating the relevance of taking into account the role of fixed factor shares for analysing the evolution of price cost margins.

3.3. *Comparison with Standard Supply-Side Estimates of Price-Cost Margins*

This section compares our estimation results to other price-cost margin estimation methods. First of all, we compare our estimates to the supply-side framework (Section 3.3.1). Next, we look at the difference between these other methodologies and our baseline estimate over time (Section 3.3.2). Finally, we study how the shares of fixed costs for each input factor evolve over time (Section 3.3.3).

3.3.1. *The supply-side framework*

We compare our estimation results to the markups obtained by De Loecker *et al.* (DLFVB) (2018) based on Belgian firm-level data as well. Their markup can be obtained as

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

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

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

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

The method requires one input that is fully flexible, for which usually intermediate inputs are used. However, De Loecker *et al.* (2018) discussed that intermediate inputs might still contain various quasi-fixed categories. They exploited a unique feature of the Belgian firm-level data: since 1996, firms have to break down their intermediate inputs into materials and services inputs. They argued 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 service 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 De Loecker *et al.* (2018)[19] and estimate markups, one based on material inputs only and one based on total intermediate inputs. We convert these aggregate markups into aggregate price-cost

[19] We follow De Loecker *et al.* (2018) and compute a normalised aggregate markup in which we normalise the output elasticity such that the median firm markup equals 1.1 over the sample.

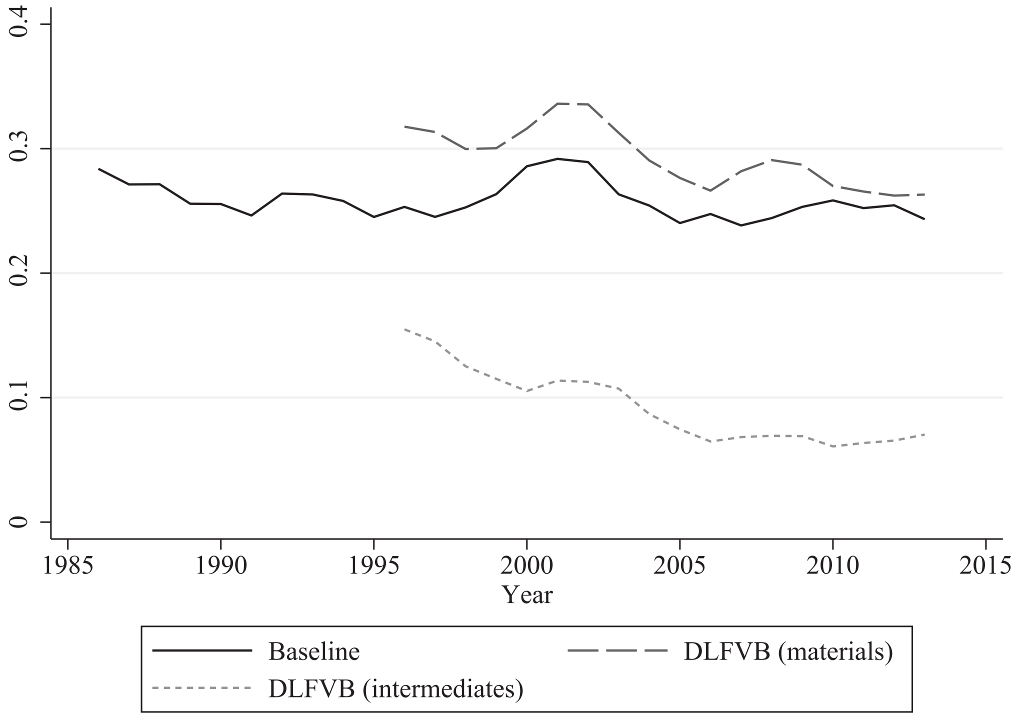


Fig. 2. *Evolution of Price-Cost Margins: Baseline and DLFVB Estimates.*
Notes: This figure shows the evolution of our baseline price-cost margins, and the price-cost margins based on DLFVB estimates (one based on materials as a variable input and one based on intermediate inputs as a variable input) at the yearly level. 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 observation. DLFVB refers to the estimation procedure applied by De Loecker *et al.* (2018).

margins. Figure 2 shows the evolution of these estimates as well as the evolution of our baseline results, allowing for fixed costs.

The DLFVB (aggregate) 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 25.3% 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. 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.

However, 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.

3.3.2. *Implied bias over time*

Section 3.2 showed that the price-cost margin and excess profit share are respectively under- and overestimated if fixed costs are not taken into account. This PCM and EPS bias does, not only

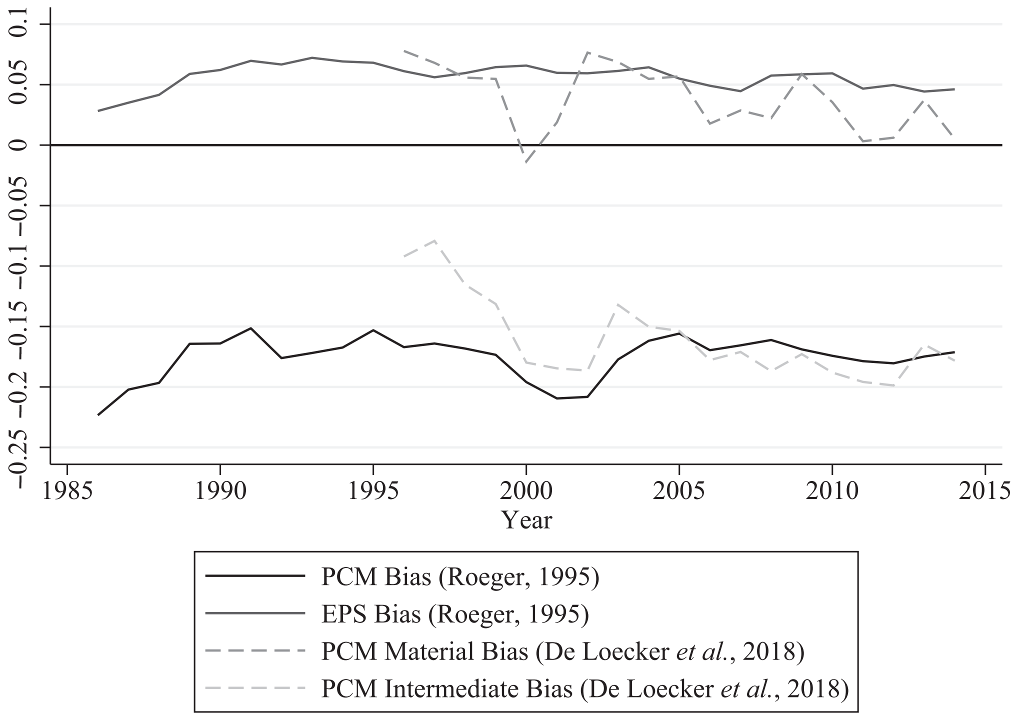


Fig. 3. *Comparison between the Results of Roeger (1995) and De Loecker et al. (2018) and Our Baseline Results.*

Notes: This figure shows the difference between our baseline estimates on the one hand and the Roeger (1995) and De Loecker *et al*. (2018) estimates on the other hand. A positive (negative) value shows that the alternative measure is larger (smaller) than our baseline estimate.

exist in levels, but also in *changes* as it evolves over time. Figure 3 shows that the PCM bias goes from −22.3% (1986) to −17.1% (2014). The EPS bias ranges from 2.8% (1986) to 7.2% (1993), relative to an estimated EPS of 2.5% over the pooled sample.

The empirical results in Figure 1 show that both the fixed cost share and the excess profit share decreased between 1985 and 2014, thus reinforcing each other. However, empirical results for another country might lead to divergent trends. Consider, for example, an economy in which the FCS goes from 0.20 to 0.25, while the EPS goes from 0.05 to 0.02. In this example the PCM goes from 0.25 to 0.27. The increase in the price-cost margin would suggest that firms gain more market power over time; however, their excess profit share falls from 0.05 to 0.02 due to the fact that fixed costs increase disproportionally more. The policy conclusions would change in the opposite direction, i.e., firms having less rather than more market power over time. Although they generate a larger margin over time, this is being more than offset by a shift from variable to fixed costs. A similar reasoning holds for changes over time.

Our price-cost margin is reasonably similar to the markup estimated following De Loecker *et al*. (2018) based on materials as a variable input rather than services, as discussed in Section 3.3.1. Nevertheless, the difference between the material-based De Loecker *et al*. (2018) estimate fluctuates from 7.8% (1996) to 0.01% (2014), suggesting that there is a difference which changes even over time.

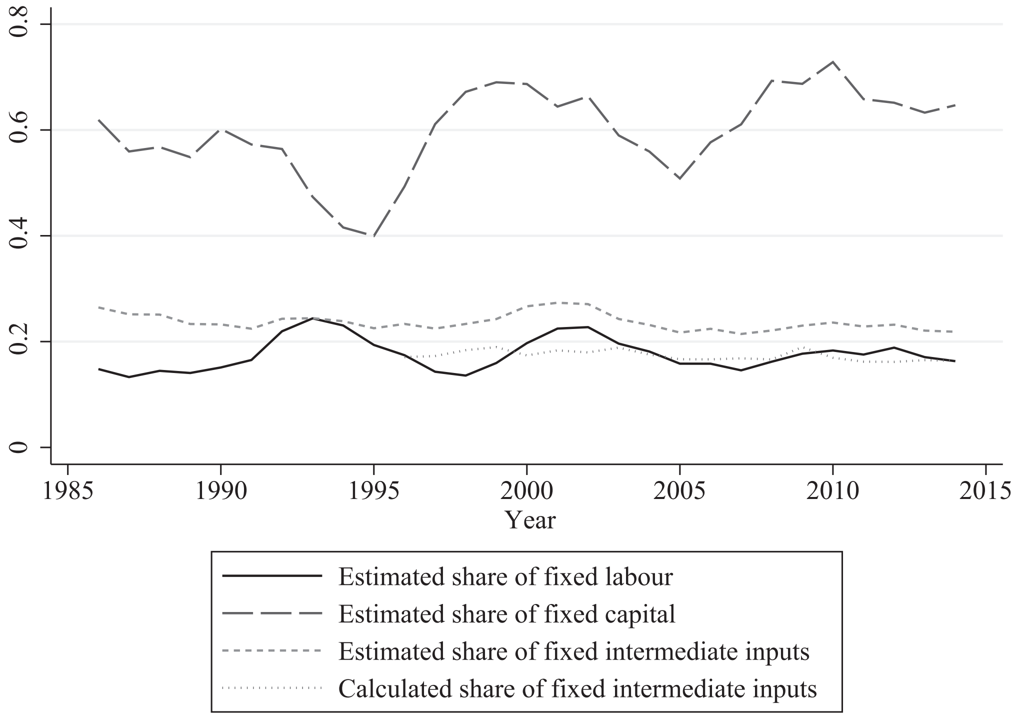


Fig. 4. *Estimated and Calculated Share of Fixed Intermediate Inputs.*
Notes: This figure shows the evolution of the estimated share of fixed intermediate inputs (see (16)) and the calculated share of fixed intermediate inputs for the Belgian economy.

3.3.3. *The estimated shares of fixed costs*

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 the calculated share of fixed intermediate inputs.[20] The calculated share of fixed intermediate inputs is defined as service inputs over intermediate inputs and can be used as a proxy for sf^m.

Figure 4 shows the evolution of the estimated share of fixed inputs using our approach and the calculated share of fixed intermediates, based on the component of service inputs reported in the account data for Belgium as in De Loecker *et al.* (2018). This detail of reporting in accounts depends on the local accounting rules and legislation and is not available in many countries. We can note that both series, the estimated and the computed fixed shares of inputs, evolve in parallel over time. The estimated share of fixed inputs equals 23.2% in 1996 and drops to 20.0% in 2014,

[20] De Loecker *et al.* (2018) argued that materials (60) consists of *predominantly* variable input costs. For example, firms that increase their output in the short run need more raw materials (600). On the other hand, services contain *mainly* quasi-fixed input costs. Although we agree that materials and service inputs might respectively display mostly variable and fixed inputs, we argue that it is not plausible that each subcomponent is respectively entirely variable and fixed. For example, looking at the detailed subcomponents, we worry that insurances (610) and rent (615) are not variable input costs. These costs do not depend one to one on changes in production as firms might rent buildings for a time period of multiple years (e.g., empty buildings during COVID-19). Even if firms would report data on all these specific subcomponents, it would still not be straightforward to argue that a subcomponent is quasi-fixed or quasi-variable, driving a bias in both the level and the trend of the markup estimate (see Section 3.3.2).

whereas the calculated share of fixed inputs equals 17.1% in 1996 and drops to 16.4% in 2014. Our estimate finds a higher share for fixed inputs, which could be explained by the fact that the computed share of fixed inputs assumes that materials and services are fully variable and fixed, respectively. Our approach does not require to make ex ante assumptions on whether a specific input is fixed or variable or which fraction of the input is fixed.

3.4. *SMEs versus Large Firms*

Autor *et al.* (2020) included a model of superstar firms, finding that large firms typically have high markups (and low labour shares). This follows from the fact that these large firms are characterised by low marginal costs, allowing them to have lower prices and higher demand for their products. A key finding is that value added has reallocated substantially towards these high-markup firms in the past decades (Autor *et al.*, 2020; De Loecker *et al.*, 2020; Kehrig and Vincent, 2021), affecting key macroeconomic outcomes. For example, the reallocation effect pushes down the aggregate labour share and has increased the aggregate markup in the United States.

In this subsection we consider differences among the firm size distribution and split our sample into SMEs ($<$ 250 FTE) versus large firms ($\geq$ 250 FTE).[21] Panels (a) and (b) of Figure 5 respectively show results for SMEs and large firms. We show the evolution of the price-cost margin, fixed cost share, excess profit share as well as the calculated profit share observed from the income statements, i.e., $(PQ - TC)/PQ$. The estimated excess profitability should be closely aligned, as predicted by (14) and (15).

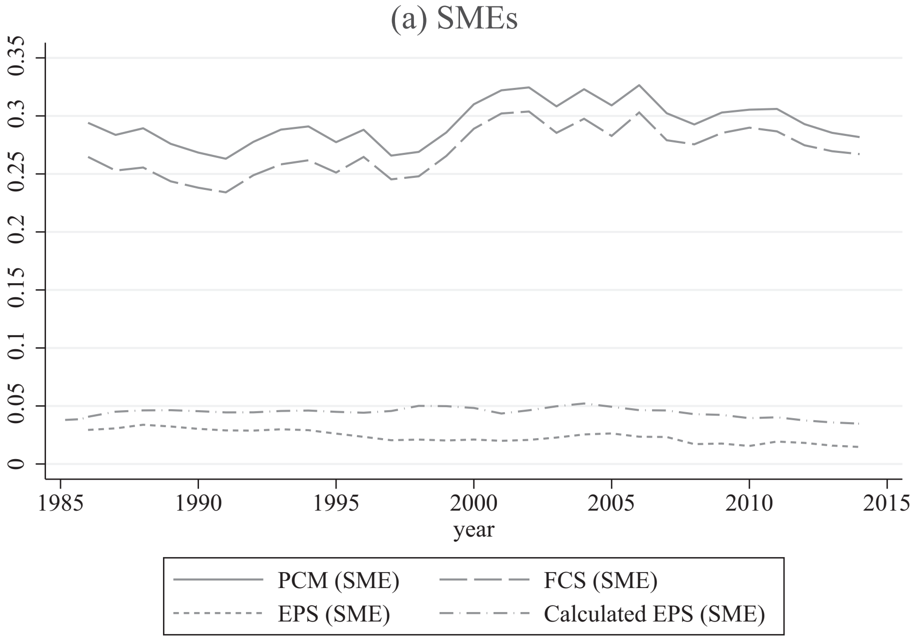
This leads to three main results. First, we compare the estimated and calculated EPSs within the subsamples of SMEs and large firms. We find that the estimated and calculated EPSs move in parallel over time for both subsamples. Second, the estimated EPS of large firms is larger than the EPS of SMEs in the vast majority of the years (see also Online Appendix Figure 7). On average, the EPS equals 2.4% and 3.0% for SMEs and large firms, respectively. Given that the EPS is defined as a percentage of the sales, the amount of *absolute* (rather than relative) profits is even more skewed towards large firms. Third, both PCM and FCS are smaller rather than larger for large firms; an empirical finding at odds with most of the estimates in the literature. In particular, ignoring fixed costs, Online Appendix Table 2 shows that the price-cost margin for large firms (0.087) is larger than the price-cost margin for small firms (0.077), as is usually found in the literature. However, accounting for fixed costs breaks down the one-to-one relationship between the price-cost margin and excess profits as fixed costs drive a wedge between these.

4. Robustness

4.1. *Robustness I: Cost of Capital*

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

[21] The subsamples of small and large firms respectively contain 94% and 6% of the number of observations. The mean and median employment respectively equals 92 and 25 FTE.



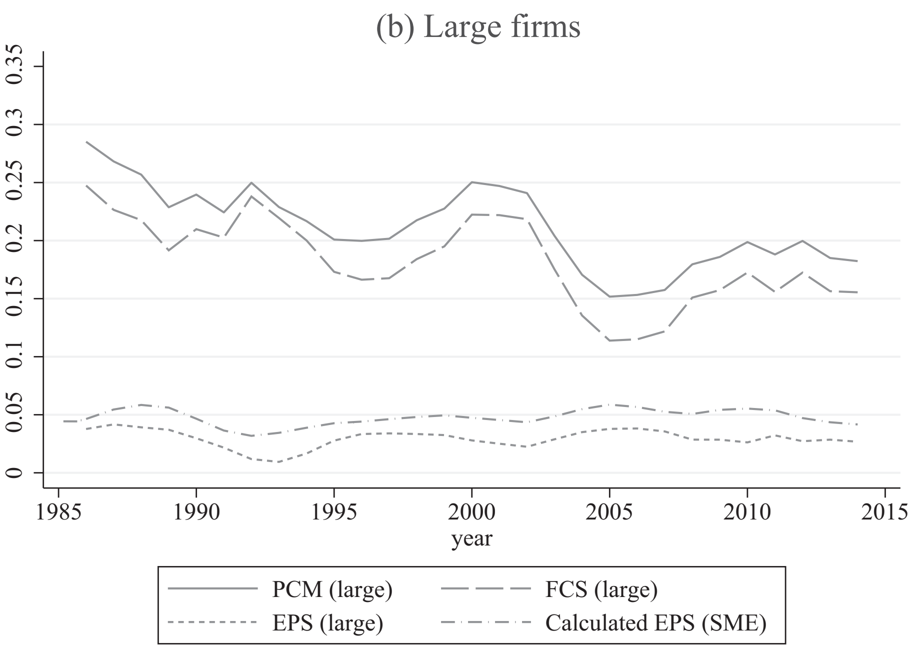


Fig. 5. *Subsample Results: Small versus Large Firms.*
Notes: Panels (a) and (b) show the evolution of the price-cost margin, fixed cost share, excess profit share and the calculated excess profit share for the subsamples of SMEs ($<$ 250 employees) and large firms ($\geq$ 250 employees), respectively. 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.

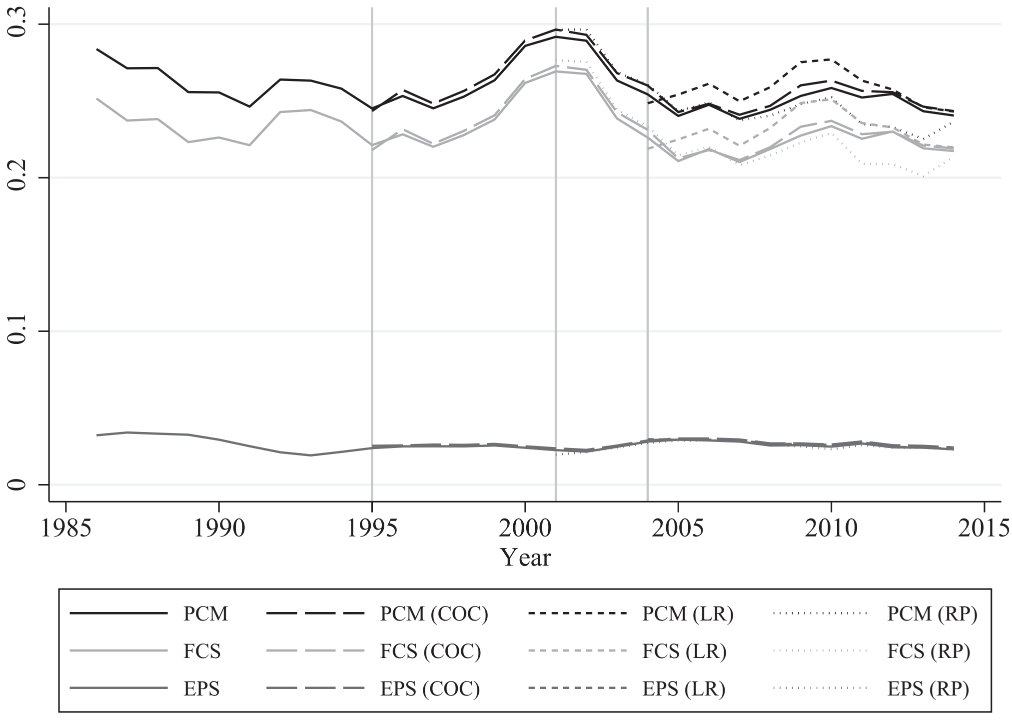


Fig. 6. *Evolution of PCM, FCS and EPS: Cost of Capital, Loan Rate and Risk Premium.*
Notes: This figure shows the evolution of the excess profit share (see (16)) under various robustness tests for the Belgian economy. The evolution of Belgian variables has been smoothed. Each observation is the simple average of its current observations and one observation before and after its observation. COC, LR and RP, respectively, refer to the cost-of-capital (Section 4.1.1), loan rate (Section 4.1.2) and risk premium (Section 4.1.3) adjustments.

4.1.1. *Capital allowances*

The first robustness test considers another adjustment of the cost of capital. Our baseline cost of capital considers capital allowances for machines and buildings. Additionally, we also take patents into account, made available by OECD (2021). Note that these data are only available from 1994 onwards. We show the results (labelled COC) in Figure 6 and Online Appendix Table 6 demonstrate that our main findings still hold. The price-cost margins, fixed cost share and excess profit share are very similar to our baseline results.

4.1.2. *Loan rate*

Next, we replace the Belgian long-term interest rate with the cost of borrowing for firms, which we call the loan rate. This loan rate is closely related to the real borrowing cost for corporations rather than the Belgian long-term interest rate; however, data are only available from 2003 onwards. The loan rate is made available by OECD (2021). During the financial crisis, the loan 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 6 and Online Appendix Table 5. The new results (labelled LR) are consistent with our main findings: the excess profit share remains basically unchanged, while the fixed cost share and the price-cost margins are close to the baseline results, i.e., they are slightly higher, especially during the financial crisis.

4.1.3. *Risk premium*

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). Figure 6 and Online Appendix Table 7 show the results (labelled RP). Note that the excess profit share follows the same trend, but at a slightly lower level. The aggregate risk premium increases the cost of capital, which decreases the excess profit share slightly. The price-cost margin and the fixed cost share follow a similar pattern as the baseline results.

4.2. *Robustness II: Firm Size*

Our approach comes up with an estimate of one price cost margin and shares of fixed costs for all firms; however, clearly different firms may have different market power and therefore we analyse how our approach can be used to analyse price cost margins by firm size. We build on (16), 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

$$B_i = B + \beta_1 \times [PQ_{it} - \text{mean}(PQ_{it})], \qquad sf_i^k = sf^k + \beta_2 \times [PQ_{it} - \text{mean}(PQ_{it})_t],$$
$$sf_i^l = sf^l + \beta_3 \times [PQ_{it} - \text{mean}(PQ_{it})_t], \qquad sf_i^m = sf^m + \beta_4 \times [PQ_{it} - \text{mean}(PQ_{it})_t],$$

and introduce this into (16) such that we obtain

$$\begin{aligned}
&(SRQ_{it}^R - SRP_{it}^R)PQ_{it} - (SRQ_{it}^C - SRP_{it}^C)C_{it} \\
&= B \times PQ_{it} \times [(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] \\
&\quad - sf^k \times RK_{it} \times [(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] \\
&\quad - sf^l \times WL_{it} \times [(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] \\
&\quad - sf^m \times P^M M_{it} \times [(\Delta p + \Delta q)_{it} - (\Delta k + \Delta r)_{it}] \\
&\quad + \beta_1 \times PQ_{it}[PQ_{it} - \text{mean}(PQ_{it})_t] - \beta_2 \times RK_{it} \times [PQ_{it} - \text{mean}(PQ_{it})_t] \\
&\quad - \beta_3 \times WL_{it} \times [PQ_{it} - \text{mean}(PQ_{it})_t] - \beta_4 \times P^M M_{it} \times [PQ_{it} - \text{mean}(PQ_{it})_t] \\
&\quad + FE + \varepsilon_{it}.
\end{aligned} \tag{18}$$

Assuming that fixed costs are not present and dividing again by PQ_{it}, this collapses to

$$\begin{aligned}
SRQ_{it}^R - SRP_{it}^R = {} & B[(\Delta q + \Delta p)_{it} - (\Delta k + \Delta r)_{it}] \\
& + \beta_1 \times [PQ_{it} - \text{mean}(PQ_{it})_t][(\Delta q + \Delta p)_{it} - (\Delta k + \Delta r)_{it}] \\
& + FE + \varepsilon_{it}.
\end{aligned} \tag{19}$$

We show the results in Table 3. This repeats the unweighted results 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 (19) and (18), 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

Table 3. *Price-Cost Margins and Shares of Fixed Input Factors: Control for Firm Size.*

	(1)	(2)	(3)	(4)
Price-cost margins	0.117***	0.117***	0.411***	0.411***
	(0.017)	(0.017)	(0.047)	(0.047)
Share of fixed capital			0.871***	0.867***
			(0.062)	(0.060)
Share of fixed labour			0.330***	0.327***
			(0.041)	(0.041)
Share of fixed intermediates			0.414***	0.413***
			(0.055)	(0.054)
Size × price-cost margins (β_1)		−0.014**		−0.044*
		(0.004)		(0.017)
Size × share of fixed capital (β_2)				−0.198
				(0.135)
Size × share of fixed labour (β_3)				−0.166*
				(0.069)
Size × share of fixed intermediates (β_4)				−0.046*
				(0.019)
Year FEs	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes
N	278,353	278,353	278,353	278,353
R^2	0.36	0.36	0.56	0.56

Notes: SEs are reported in parentheses ($^+$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$) and clustered by NACE 2 digits. Columns (1) and (2) show unweighted results based on (17). Columns (3) and (4) show unweighted results based on (16).

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 sales of one billion euros above the mean value to lower the average price-cost margins by 1.38 percentage points.[22] Next, column (4) shows that β_1 is significant and negative. Firms with sales of one billion euros above the mean value have a price-cost margin that is 4.4 percentage points lower. Larger firms also have a lower share of fixed capital, fixed labour and fixed intermediate input. So, large firms tend to have lower PCM and a lower FCS. Nevertheless, Section 3.4 already showed that they display a higher EPS.

4.3. *Robustness III: 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 that the share of fixity decreases for each input factor such that the fixed cost share falls. Table 4 summarises these estimation results based on five-year and ten-year differences.

Looking at columns (2) and (3), we find that the fixed cost share decreases to 20.6% and 17.1%, respectively, in comparison with the baseline value of 22.9% of column (1). This fall is driven by the decrease in the share of fixed capital shrinking from 62.5% to 47.8%. This is in line with the idea that capital is quasi-fixed in the short run, whereas it becomes more flexible over longer time periods. Additionally, comparing columns (1) and (3), we find that the share of fixed intermediate inputs falls moderately from 23.2% to 17.7%, while the share of fixed labour decreases from 17.3% to 10.7%.

[22] Firm-specific sales are divided by one billion in order to be able to interpret the estimated coefficients.

Table 4. *Price-Cost Margins and Shares of Fixed Input Factors: Longer horizon differences.*

	(1) Baseline	(2) Δ5 yr	(3) Δ10 yr
Price-cost margins	0.254***	0.236***	0.200***
	(0.017)	(0.021)	(0.045)
Share of fixed capital	0.625***	0.478***	0.449**
	(0.041)	(0.069)	(0.110)
Share of fixed labour	0.173***	0.155***	0.107
	(0.029)	(0.040)	(0.069)
Share of fixed intermediate inputs	0.232***	0.214***	0.177***
	(0.017)	(0.021)	(0.047)
Fixed cost share	0.229***	0.206***	0.171***
	(0.017)	(0.021)	(0.046)
Excess profit share	0.025***	0.030***	0.029***
	(0.002)	(0.002)	(0.003)
Year FEs	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes
N	278,353	42,367	13,006
R^2	0.54	0.65	0.71

Notes: SEs are reported in parentheses (** $p < .01$, *** $p < .001$) and 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.

4.4. *Robustness IV: Consolidated Accounts versus Unconsolidated Accounts*

The unit of analysis is the unconsolidated firm-level account, as this is how firms report their 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 *et al.* (2017) used 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 that are owned by the same parent company. We use this as a proxy for consolidated firm-level accounts at the Belgian level.[23]

We show the evolution of the price-cost margins, fixed cost share and excess profit share for both unconsolidated accounts and our proxy for consolidated accounts in Figure 7 and Online Appendix Table 8. Our results are robust to this alternative boundary definition of a firm. We find that price-cost margins and the fixed cost share 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 profit share displays the same evolution over time, albeit being slightly smaller.

4.5. *Robustness V: Industry-Level Estimates*

Another dimension we can slice our data is by estimating price cost margins at the sector level. In particular, we can estimate industry-year-level price-cost margins or firm-level (but not firm-year-level) price-cost margins.[24]

[23] Note that this alternative definition of the frontier of a firm is a technical one and does not exist in reality.
[24] 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.

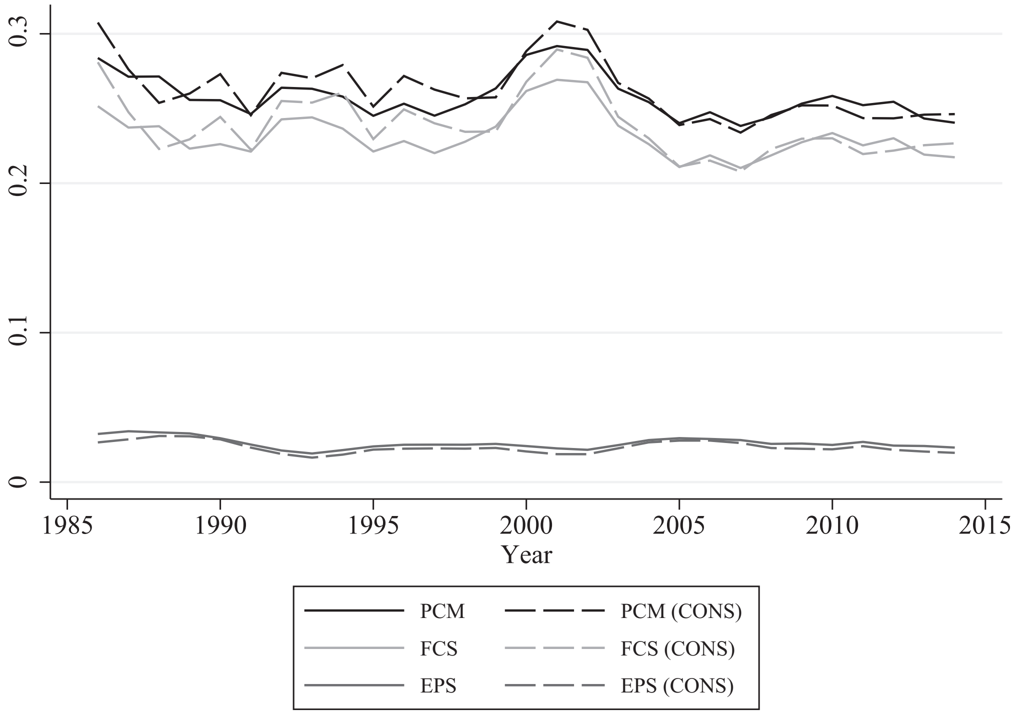


Fig. 7. *Evolution of PCM, FCS and EPS: Consolidated Accounts.*
Notes: This figure shows the evolution of the price-cost margin, fixed cost share and excess profit share for unconsolidated and consolidated accounts based on (16). The evolution of the variables has been smoothed. Each observation is the simple average of its current observations and one observation before and after its observation.

We illustrate this by estimating price-cost margins, fixed cost shares and excess profit shares at the NACE two-digit category level for the period 1985–2014. Online Appendix Table 9 summarises the results and shows (1) that fixed costs are sizeable and significant in nearly all industries and (2) that industry-level heterogeneity matters.

5. Conclusion

In this paper, we introduce and illustrate a new method that estimates aggregate price-cost margins in the presence of fixed factors of production. We distinguish marginal profitability (i.e., the price-cost margin) from average profitability (i.e., the excess profit share). The main idea of our methodology is that, under the assumptions of perfectly variable inputs on the one hand and perfect competition and constant returns to scale on the other hand, the sales- and cost-based Solow residuals represent an unbiased measure of productivity growth. Violating both assumptions implies that these Solow residuals deviate from productivity growth due to a positive price-cost margin, scale parameter and/or a degree of fixity of the input factors; each of the four Solow residuals (sales versus cost based; primal versus dual) experience a different impact from these violations. Appropriately combining these four Solow residuals cancels out various unobservable terms (e.g., productivity growth, growth in unobservable variable inputs), while the price-cost margin and the share of fixed costs for each input can be estimated in a joint regression framework.

The main advantage of our approach is that it allows for a flexible treatment of all input factors: labour, capital and intermediate inputs. Ex ante, each input can be variable, fixed or a combination of both. However, we show that fixed costs represent an important share of input costs in total sales for capital (62.5%), labour (17.3%) and even intermediate inputs (23.2%).

We apply our method to Belgian firm-level data from 1985 until 2014. Our main findings can be summarised 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 are estimated higher, 25.4% instead of 8.1%. However, this does not necessarily imply that firms' profitability has been underestimated so far. In contrast, high price-cost margins are predominantly used to recover fixed costs (22.9%), whereas only a small fraction remains left as excess profits (2.5%). Second, the evolution of price-cost margins consists of the evolution of the fixed cost share and the evolution of the excess profit share. These components can reinforce or offset each other. We find that both the fixed cost share (−4.0%) and the excess profit share (−1.9%) have fallen between 1985 and 2014 such that price-cost margins decreased by 5.9% in Belgium, pushing excess profit margins closer to zero, suggesting that output markets became more competitive over time. Moreover, our results show that ignoring fixed costs leads to a bias in the level (i.e., underestimates price-cost margins and overestimates the excess profit share) as well as to a bias in the evolution of the price-cost margin due to changes in the shares of fixed costs for capital, labour and intermediate inputs over time.

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 due to a combination of both.

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Additional Supporting Information may be found in the online version of this article:

Online Appendix
Replication Package

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