Cost Plus Markups for Manufacturing Entities: The Effect of Size on Fully Loaded Versus Variable Costs

The authors analyze the statistical and economic significance of economies of scale for production entities and find that the effect of size—given significant revenue turnover differences— is more pronounced for fully loaded than for variable costs. The results of their analysis suggest that the cost plus markup based on variable costs compared to the markup on fully loaded costs is a more suitable profit-level indicator to set and test the arm's-length nature of transfer prices for production entities.




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Arm's-length transfer prices for the remuneration of production entities are commonly set ex post—that is, after the transaction takes place—based on the cost plus method. Also for ex ante arm's-length testing purposes, the transactional net margin method (TNMM) with a cost plus profit-level indicator is commonly chosen as the standard approach for production entities.

Cost plus markups can either be based on fully loaded total costs (that is, the quotient of earnings before interest and taxes, or EBIT, and total costs) or on a variable cost basis (the quotient of EBIT and variable costs). Publicly available databases are used in ''benchmark studies'' for the determination and testing of the cost plus markups both on fully loaded as well as variable costs.[1] Despite criticism regarding data availability and quality in these databases, benchmark analysis established itself as a tool for documenting and planning transfer prices.

[1] OECD *Transfer Pricing Guidelines for Multinational Enterprises and Tax Administrations* (OECD guidelines) para. 3.30 and following, concerning the use of databases.

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Related to this tool, the OECD guidelines define comparability factors.[2] Regarding these factors, it should be noted that comparable companies included in a benchmark analysis are generally not fully comparable to the tested party in all dimensions. Because relevant information is often not available, not all ''comparability factors'' (for example, contract details of a comparable transaction or the business strategy of a comparable company) can be considered in principle. To address this issue, the range of results is usually narrowed to the interquartile range—the middle 50 percent of values, excluding the upper 25 percent and lower 25 percent.[3]

However, even after narrowing the bandwidth with the help of the interquartile range it is not clear how differences in size (measured by revenue turnover) shall be considered. Thus, significant size differences within the set of unrelated companies as well as in comparison to the tested party regularly exist in standard benchmark sets.

From an economic point of view, size differences between companies can however imply relative profitability differences (for example, in terms of cost plus markups) if economies of scale are at work. For example, positive economies of scale due to lower direct costs caused by production synergies should have a positive effect on the overall profitability. In contrast, a disproportionate increase in overhead expenses could imply negative economics of scale. Constant economies of scale can be assumed if there is no change in the relative profitability if the company size varies.

[2] OECD guidelines para. 1.36 and following.
[3] OECD guidelines para. 3.57.

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Hence, given the considerable size heterogeneity typically present in benchmark studies, the decisive question is whether production companies are characterized by positive, negative or constant economics of scales and how these economies of scale impact the cost plus markups based on fully loaded and variable costs.

To investigate this question the authors explore the statistical and economic significance of scale effects by deriving arm's-length cost plus markups based on fully loaded or variable costs in a large set of independent production companies.

This analysis suggests that negative economies of scale can be found both in terms of fully loaded as well as variable costs. Scale effects, however, differ between fully loaded and variable costs. Stronger negative economies of scale are found based on fully loaded costs. From an operational point of view, this indicates that increasing the size of a production entity not only increases the marginal direct costs, but also marginal overheads, which in turn increase over proportionally.

The results suggest that the markup based on variable costs compared to the a markup on fully loaded costs is—given significant revenue turnover differences before applying any adjustment calculations—a more suitable profit-level indicator to set and test the arm's-length nature of transfer prices for production entities.

Cost Plus Basis

The cost basis on which the markup is applied can either be actual costs or budgeted costs and it can incorporate fully loaded costs as well as variable costs. In both cases, well-established accounting methods shall be applied. Whether the cost basis is fully loaded or variable costs is case depended and the OECD have no strict rules for the choice.[4] The general principle is that the cost basis has to be comparable to the cost basis of the comparable uncontrolled transaction.

However, the OECD argues that the costs incorporated in the cost basis shall be limited to such extent that they include only the companies own production costs. This implies that the cost plus markup shall only refer to the basis of the company's own value contribution.[5] Also from a controlling perspective, fully loaded costs are often considered critical, since that might dilute incentive with regard to the use of efficient and cost saving production techniques. Instead, directly attributable production costs—that is, variable costs—are often favorable. Whether fully loaded costs or variable costs represent the more appropriate cost basis has to be analyzed in each case individually.

Cost Plus Markups

A first glance at the data

Financial data for the following analysis is based on the Amadeus Neo database.[6] The data set includes up to 31.629 unrelated[7] manufacturing companies from 28 European Union countries[8] as well as Norway and Switzerland. For each company an industry classification—that is, NACE Code[9]—is assigned. Financial figures for these manufacturing companies are analyzed for the period 2011 to 2013.

In contrast to the usually small number of comparable companies in final sets of a ''standard'' benchmark study, the large number of comparable companies analyzed here provides an indicative cross-section analyses for production companies across sectors and European countries over a period of three years.

This broadly defined set is in particular robust against the exclusion of single companies. Table 1 provides the markups on fully loaded costs[10] and Table 2 the markups on variable costs[11] as an interquartile range from 2011 to 2013 as well as the weighted average[12] over the years.

Table 1: Cost plus markups (fully loaded costs)

Quartile	2011	2012	2013	Average
1st quartile	1.2%	0.8%	1.1%	1.1%
Median	3.7%	3.3%	3.5%	3.5%
3rd quartile	7.9%	7.4%	7.6%	7.3%

Source: Calculations based on the data of Amadeus Neo Database

Table 2: Cost plus markups (variable costs)

Quartile	2011	2012	2013	Average
1st quartile	2.5%	1.7%	2.2%	2.3%
Median	7.2%	6.5%	6.8%	6.9%
3rd quartile	15.1%	14.0%	14.4%	14.0%

Source: Calculations based on the data of Amadeus Neo Database

The comparison of the different quartiles shows that the markup based on variable costs is approximately twice as high as the cost plus based on fully loaded costs. This implies that the relation between fully loaded and variable costs is approximately two to one.

As motivated in the introduction, the analysis of economies of scale shall be the heart of the following analysis. Figures 1 and 2 give a first impression of the relation between cost plus markups based on fully loaded as well as variable costs to revenue turnover,

[4] Alexander Vogele and Juergen Raab Chapter D, *Transfer Prices*, C.H. Beck, 4th Ed., 2015, textnote 282-323.

[5] OECD guidelines para. 2.50.

[6] Amadeus Neo Datenbank in der Version 8.08, Update 228 by Bureau van Dijk.

[7] Companies with the following independence indicators are used: A+, A, A-, B+, B, B-.

[8] The following countries of the EU are taken into account: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Sweden, Slovakia, Spain and the U.K.

[9] The included industries according to the NACE Code Classification (Rev. 2) are 1000 to 1920, 2000 to 2932 and 3000 to 3299.

[10] The cost plus based on fully loaded costs can be determined using the operative margin (this was taken directly from Amadeus database as the quotient of EBIT and turnover).

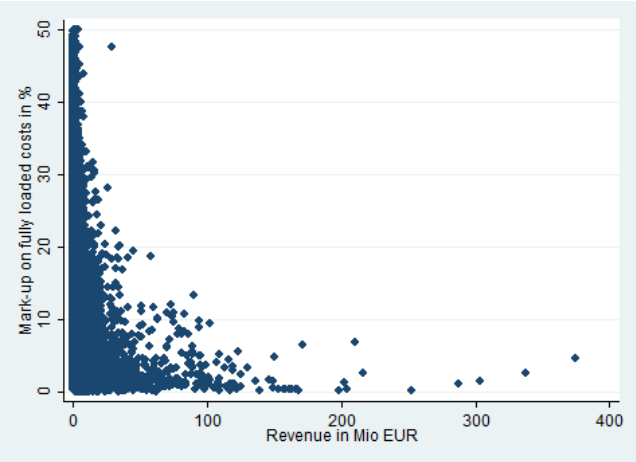
[11] If available in the Amadeus Neo Database cost of goods sold are used as partial-costs or alternatively the material costs.

[12] The weighting was done using the size of the turnover.

and therefore a first indication for the existence of economies of scale.

Figure 1 illustrates the cost plus markups based on fully loaded costs in relation to the obtained revenue turnover. It shows that the cost plus markups based on fully loaded costs tend to decrease with increasing revenues. This is as an indicator for declining economies of scale.[13] On the contrary, Figure 2 for the cost plus markups based on variable costs does not seem to show a clear systematic relation between revenues and cost plus markups.

*Figure 1: Relative cost-plus based on **fully-loaded costs***



Source: Calculations based on the data of Amadeus Neo Database

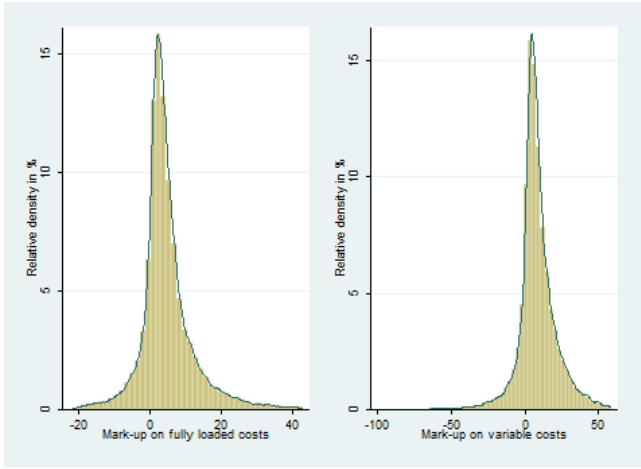
*Figure 2: Relative cost-plus based on **variable costs***

Source: Calculations based on the data of Amadeus Neo Database

The density plots for both the cost plus markups on fully loaded as well as variable costs are given in Figure 5. Although both differ in their location parameter—for example, mean or median—both show a remarkable symmetric distribution with a well-behaved single peak at the center of the distribution. This is important since it allows for a robust interpretation of the presented interquartile ranges and the following regression analysis.

[13] It is noted that the scatterplot in Figure 1 cannot clarify any country or sector differences.

Figure 3: Density plots for fully-loaded and variable cost



Source: Calculations based on the data of Amadeus Neo Database

Econometric analysis

In order to properly estimate economies of scale, it is common in the econometric literature to parametrically estimate a production function based on standard microeconomic theory framework. In microeconomic theory, the standard neoclassical production function combines labor L and capital K by means of a constant elasticity of substitution ρ. The relative weighting of both of the input factors shall be δ whereby A is an exogenously given technology parameter. The parameter ν is the scale parameter of the production function and in particular important for economies of scale.

In case $\nu = 1$, the neoclassical production function (or ''constant elasticity of substitution'' function) reduces to the so called Cobb-Douglas production function with constant returns to scale, i.e. doubling of the input factors labor and capital also doubles the output y. Thus, this is the case of constant economies of scale. However, if $\nu < 1$ increasing labor and capital by the factor of two only increase output by a factor of less than two such that we realize negative economies of scale. In contrast, $\nu > 1$, overproportionally increases output which reflects positive economies of scale.

In the following, the output variable y is either a gross margin in case of variable costs or a net margin in case of fully loaded costs. Given the assumption of a neoclassical production function the functional form assumed is given by:

$$y = A\,(\delta K^{-\rho} + (1-\delta)\,L^{-\rho})^{-\nu/\rho}$$

The exogenous parameters can be estimated using the data available in the Amadeus Neo Database. Applying a Taylor series expansion to the neoclassical production function yields the following equation which can be estimated using the ordinary least squares method:

$$\ln(y_{t,i}) = \beta_0 + \beta_K \ln(K_{t,i}) + \beta_L \ln(L_{t,i}) + \beta_{K,L} f(K_{t,i}, L_{t,i}) + \varepsilon_{t,i}$$

In the econometric literature, this approach is of great importance since as it allows a microeconomic theory based derivative of the explanatory variables.[14]

[14] C.f. Anderson and van Wincoop, ,,Gravity with Gravitas: A Solution to the Border Puzzle'', 2003, American Economic

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Considering fixed effects[15] and country as well as sector dummies, the following overview of the estimation parameters is given in Table 3.[16]

Review, 93(1), pp. 170-192 for a further discussion on this microeconomic theory based estimation approach.

[15] C.f. Greene, ,,Econometric Analysis'', 1999, Macmillan, for more detail in relation to ,,fixed effects'' method.

[16] The estimation parameter for capital and labor in the fixed effects estimation take the shape of comparable size estimations. This speaks against a significant influence of company specific not observable factors.

Table 3: Overview of the estimation parameters and significance levels

Parameter		*variable costs*	*fully loaded costs*
Labor	β_L	0.675 (**)	0.120 (**)
Capital stock	β_K	0.183 (**)	0.695 (**)
Capital share	δ	0.183 (***)	0.695 (***)
Labor share	$1\text{-}\delta$	0.817 (***)	0.305 (***)
Elasticity of substitution	ρ	-0.063 (**)	-0.001
Scale parameter	ν	0.858 (***)	0.815 (***)

Source: Calculations based on the data of Amadeus Neo Database
*Explanations: Significance level: ** $p<0.05$, *** $p<0.01$*

As shown in Table 3, the estimated coefficients are statistically highly significant—that is, we find a statically systematic relationship between the input factors as well as the explanatory variable. This means that the econometric model has explanatory power for the gross margin in the case of variable costs as well as for the net margin in the case of fully loaded costs.

For fully loaded as well as for variable costs, the estimated scale effect is significantly smaller than 1 at the 1 percent significance level. This finding implies negative economies of scale for the manufacturing companies in the data set. However, a comparison of the scale parameters shows that in the case of fully loaded costs the scale parameter is smaller than in the case of variable costs. This means that the negative economies of scale are more pronounced for fully loaded costs than for variable costs.

Although the analysis of the economic reason for negative scale effects is beyond the scope of this article, in the case of variable costs, one could argue that increasing output is associated to a disproportional increase in production e.g. due to constraint capacities. In the case of fully loaded costs, it can be argued that there is an additional effect associated to an increase in operating expenses. In sum, the negative scale effects observed on fully loaded costs is more pronounced than in the case of variable costs.

Now the decisive question is whether this statically significant relation can lead to economically significant differences in the markups based on fully loaded versus variable costs. This question can be answered by using the estimated parameter. Doubling the input factors labor *L* and capital *K* ''only'' leads to a small reduction of the cost plus markups on partially loaded costs, whereas the decrease of the cost plus based on fully loaded costs is more pronounced.

From the econometric specification of the estimate function, as shown in Table 3, not only economies of scale but also country- and sector-specific differences can be controlled for and have been econometrically estimated. The authors cannot find any overwhelming significant country differences,[17] whereas the differences between sectors can be quite significant. A detailed discussion of the sector differences is, however, not the focus of this analysis.[18]

To validate the previously shown data t-tests were conducted that compared the highest percentiles to the lowest percentiles as well as the first to the fourth quartile of the markups based on fully loaded and variable costs. The results show that a significantly lower markup based on full costs is applied for the highest percentile (fourth quartile) whereas for the markup based on partial costs no statically significant difference can be found. Therefore, it cannot be said that the cost-plus based on variable costs is negatively dependent on the turnover.

Conclusion

The analysis presented discusses the statistical as well as economic significance of economies of scale for production entities. The possibility to consider economies of scale arises directly from the comparability factors, in particular the economic circumstances that include company size differences.

The econometric analysis shows that statistically significant scale effects can be found for fully loaded as well as variable costs as a cost plus markup basis. The economic significance, however, differs. The results of this analysis indicate that the impact of size effects is more pronounced for fully loaded than for variable costs. The authors' interpretation of the results is that while they show an impact of size on direct production costs, the negative impact is more pronounced if one takes operating expenses into account.

[17] In order to control for country and sector effects, the model outlined in Equation 1 was estimated by pooled ordinary least squares.

[18] The additional results are available at https://wiwi.hs-duesseldorf.de/personen/christian.schwarz/Seiten/transferpreise.aspx.

Thus, taking the turnover as a relevant comparability factor into account for benchmark study purposes, the markup on variable costs appears to be more robust than the markup on full costs as it is less affected by the turnover. If the markup on full costs is applied, it might be necessary to take into account that differences in the turnover between the tested party and the comparables can have a considerable impact on the markup. Therefore, the calculation of adjustments may be appropriate to ensure the arm's-length nature of the derived transfer prices. In order to derive arm's-length markups in the light of negative economies of scale, the estimation parameter presented in Table 3 can be used to conduct such adjustments.

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