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On the Relationship Between International Outsourcing and Price-Cost Margins in European Industries

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Abstract

This paper sets up a model, where multinationals compete in quantities and domestic firms form a competitive fringe. Within this framework, we analyse the relationship between market concentration, international outsourcing and the industry price-cost margin. The empirical results of a panel of 66 industries and the EU12 countries in the 1990s strongly confirm our theoretical hypotheses. Market concentration and international outsourcing are positively related to industry price-cost margins. In a thought experiment we show that industry price-cost margins would have decreased by 0.4 percentage points more in the 90s, if international outsourcing had not changed since 1990. In addition, international outsourcing accounts for a convergence in margins across industries in the last decade.

Key words: International outsourcing; Price-cost margin; Panel econometrics
JEL classification: F14; F15; F23; L11; C33

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1 Introduction[1]

"We live in an age of outsourcing." (Grossman and Helpman, 2002b, p. 1) In recent years, this phenomenon has become a key issue in the political and scientific debate on possible adverse consequences of globalization, thereby mainly focussing on wage and employment effects.[2] However, despite the salient role of international outsourcing for modern industrial production (Grossman and Helpman 2002b, 2003), an empirical assessment of the relationship between international outsourcing and industrial economic measures, like the *price-cost margin,* is so far missing in the literature. To close this gap is the purpose of this paper.

Empirical research in industrial economics on the relationship between globalization and price-cost margins has particularly focussed on the imports-as-market-discipline (IMD) hypothesis. There is a well-established consensus that imports are a source of competitive discipline, which seems robust to the choice of import competition measure (Geroski and Jacquemin, 1981; de Ghellinck et al., 1988; Levinsohn, 1993; Katics and Petersen, 1994; Co, 2001). The IMD hypothesis has been tested on both the firm level (Levinsohn, 1993) and the industry level (Co, 2001), without distinguishing between final and intermediate goods imports. Since firm level data for price cost margins and the required explanatory variables are not accessible for a large sample of countries and a sufficiently long period, we stick to industry level information.[3] Conveniently, import data comprise both final goods and intermediate goods (components). While the former may be interpreted as a source of competitive pressure, we argue that access to foreign labor markets and increased trade in intermediate goods may counteract this effect. In fact, the IMD hypothesis interprets all imports as final goods imports, which is at odds with the stylized facts on the composition of trade (Feenstra, 1998). Interpreting all imports as

[1] We are indebted in Nigel Driffield, Michael Pfaffermayr and Laura Rondi for helpful comments and suggestions.

[2] Arndt (1997), Deardorff (2001), Egger and Egger (2001, 2003), Feenstra and Hanson (1996), Jones (2000), Venables (1999).

[3] As Tybout (2003, p. 5) points out, "import competition can only be observed at the industry level".

final goods ones could result in an underestimation of the importance of the IMD effect of final goods. Moreover, assuming that intermediate goods imports (international outsourcing) exert the same impact as final goods imports as in previous IMD studies may be misleading. Accordingly, one would wish to decompose overall industry imports into the two components, final and intermediate goods, to obtain unbiased estimates for both types of imports.

Previous research has pointed to an important nexus between industry price-cost margins, changing market concentration and multinationality.[4] This paper provides first insights into the relationship between international outsourcing and industry price-cost margins in a large cross-section of industries and EU countries in three years of the 90s. Thereby, we understand international outsourcing in a broad sense including intra-firm (Dunning, 1988, calls this the *internalization* strategy) and extra-firm (*arm's length*) cross-border sourcing of intermediate goods. In a theoretical model with multinationals competing in quantities and other firms representing a competitive fringe, we analyse the relationship between market concentration (of multinationals) or international outsourcing on the one hand, and the price-cost margin of the industry on the other hand. In such a model, multinationality per se does not exhibit any impact on price-cost margins if markets are symmetric. In the empirical part of the paper, we test our theoretical hypotheses using a panel of 66 manufacturing industries in the pre-1995 12 EU member countries. Starting from the 5-digit trade statistics level, we are able to reclassify trade data of the EU12 economies to NACE-3-digit data when distinguishing between final and intermediate goods trade. Our empirical findings are in accordance with our theoretical hypotheses.

A thought experiment underpins the importance of international outsourcing for price-cost margins in the EU. In the average low-PCM industry, price-cost margins would have decreased 0.5 percentage points faster between 1991 and 1998, if outsourcing had

[4]See Martin (1993) for an overview and Davies and Lyons (1996), Lyons et al. (2001), Sleuwaegen and Veugelers (2001) for applications in the context of EU integration. Chung (2001) and Co (2001) investigate the relationship between foreign direct investment and markups/margins for US industries.

not changed since 1990. The reduction in the outsourcing activity of the high-margins industries has led to an additional decrease in their margins by 0.1 percentage points over the same period. In that way, cross-border sourcing behaviour has induced a convergence in margins across industries within the EU12 area in the last decade.

2 Theoretical Background

2.1 The Basic Model

We consider a model where n multinational firms compete on m markets with a given number of N_j home producers, $j = 1, ..., m$. The latter form a competitive fringe and can only serve their respective home market. The production technology of competitive home producers is represented by a convex cost function of the form $C^x(x_j) = \frac{1}{2}x_j^2$, with x_j being the output of an individual firm active in market j and $C^x(\cdot)$ being identical for all competitive firms both within and across markets. Noteworthy, competitive firms do not have access to international outsourcing.[5] Total production costs of multinational firms $C\left(\sum_j q_{kj}, a_O^k; s\right)$ depend on total firm output $\sum_j q_{kj}$ and the degree of international outsourcing $a_O^k = O_k / \left(\sum_j q_{kj}\right)$, where O_k denotes the amount of intermediate goods used in the production of multinational k.[6] Parameter s captures all trade costs induced by cross-border tansactions in the case of outsourcing. These costs include tariffs, non-tariff barriers and transport costs. We assume positive and increasing marginal costs of producing output q_k, i.e. $\partial C(\cdot) / \partial \left(\sum_j q_{kj}\right) > 0$ and $\partial^2 C(\cdot) / \partial \left(\sum_j q_{kj}\right)^2 > 0$, respectively. Since international outsourcing means access to cheaper resources abroad, we assume $\partial C(\cdot) / \partial a_O^k < 0$ and $\partial^2 C(\cdot) / \partial a_O^k \partial \left(\sum_j q_{kj}\right) < 0$, where the latter assumption

[5] It is crucial for our analysis to distinguish between two types of firms regarding their outsourcing opportunities. For analytical tractability, we choose the simplest possible set-up, where competitive firms do not have access to international outsourcing. However, one may alternatively consider a model with competitive and multinational firms being engaged in outsourcing but facing different access costs to foreign intermediate goods.

[6] Therefore, a_O^k describes the factor input coefficient of imported intermediate goods.

implies that larger firms gain more from international outsourcing than smaller ones. In addition, $\partial^2 C(\cdot)/\partial\left(a_O^k\right)^2 > 0$ seems appropriate, if the cost-saving advantage of international outsourcing is different across production processes and firms try to outsource those processes with the highest cost-saving advantage first.[7] Moreover, for the purpose of analytical tractability we assume that production costs $C(\cdot)$ are linearly homogeneous in the two arguments $\sum_j q_{kj}$ and a_O^k.[8] Finally, there may also arise coordination costs (not captured by $C(\cdot)$) of linking different production processes which, following Jones and Kierzkowski (2001), are especially pronounced in the case of international outsourcing.[9] We hypothesize that coordination costs, denoted as τa_O^k, depend on the degree of international outsourcing rather than on the absolute value of imported intermediate goods.

The inverse demand functions for the m markets are given by

$$p_j = A_j - b\left(Q_j + X_j\right), \; j = 1, ..., m. \tag{1}$$

Thereby, $Q_j \equiv \sum_k q_{kj}$ is the aggregate output of all multinational firms in market j. $X_j \equiv N_j x_j$ denotes the overall output of competitive home producers. Use $x_j = p_j$, according to $C^x(x_j) = \frac{1}{2}x_j^2$. Then, the profit maximization problem of multinational firms is given by[10]

$$\max_{q_{k1},\ldots q_{km},\, a_O^k} \pi_k = \sum_{j=1}^{m} \frac{A_j - bQ_j}{1 + bN_j} q_{kj} - C\left(\sum_{j=1}^{m} q_{kj}, a_O^k; s\right) - \tau a_O^k, \tag{2}$$

[7] In contrast to the seminal paper of Grossman and Helpman (2002a) we do not formalize the decision problem of firms with respect to in house production and outside purchases. Rather and as usual in the trade literature dealing with international outsourcing, our focus lies on the cost-saving effect induced by the internationalization of production.

[8] Of course, the above mentioned properties of $C(\cdot)$ only hold for interior solutions, implying that at least some of the intermediate goods are produced by the multinaltional firm at home.

[9] Compare also Jones (2000) for a discussion on the importance of service links and other coordination/communication costs. Glass and Saggi (2001) also introduce this type of costs.

[10] Due to the assumption of competitive home producers, multinational firms face demand curves of the form

$$p_j\left(1 + bN_j\right) = A_j - bQ_j, \quad j = 1, ..., m.$$

according to (1). In the case of identical multinationals and symmetric markets, the first-order conditions for an interior solution ($q > 0$, $a_O > 0$) are given by

$$\frac{A - b(n+1)q}{1+bN} - \frac{\partial C(mq, a_O; s)}{\partial (mq)} = 0 \text{ and} \tag{3}$$

$$\frac{\partial C(mq, a_O; s)}{\partial (a_O)} + \tau = 0, \tag{4}$$

where $q_{ij} = q$, $a_O^k = a_O$, $A_j = A$ and $N_j = N$ have been used. The equilibrium concentration rate, measured as output of an individual multinational producer relative to market output, and the price-cost margin of the industry are then given by

$$CR = \frac{q(1+bN)}{nq + NA} \text{ and} \tag{5}$$

$$PCM_{ind} = n \cdot CR \cdot PCM_{mult}, \tag{6}$$

where $X = Np$ and $p = \frac{A-bnq}{1+bN}$ have been used, according to (1) and the symmetry assumptions. Moreover, $PCM_{mult} \equiv \frac{1}{n|\varepsilon|}$, where $\varepsilon \equiv -\frac{A-bnq}{bnq}$ denotes the elasticity of demand with respect to prices.

2.2 Comparative Static Analysis

In the following, we analyze how trade costs s, coordination costs τ, market access (*multinationality*) m, the number of multinationals n and the number of competitive firms N affect output q, outsourcing coefficient a_O, concentration rate CR and price-cost margin PCM_{ind}.

Proposition 1 *If marginal production costs are increasing and the cost-saving advantage induced by international outsourcing is decreasing in trade costs s, i.e. if $\partial^2 C(\cdot)/\partial\left(\sum_j q_{ij}\right)\partial s > 0$ and $\partial^2 C(\cdot)/\partial a_O^i \partial s > 0$, respectively, an increase in trade costs s as well as in coordination costs τ lowers both outsourcing coefficient a_O and output q. Moreover, s as well as τ has a negative impact on concentration rate CR and price-cost margin PCM_{ind}.*

Proof. See the appendix. ■

An increase in s (τ) implies that international outsourcing becomes less attractive, so that multinationals tend to decrease their outsourcing activities. Since outsourcing makes the production of output q more attractive, a decline in a_O, implied by an increase in s (τ), has a negative impact on the output of multinationals q. Be aware that trade costs s have also a direct positive impact on $C(\cdot)$, according to $\partial^2 C(\cdot)\,\partial(mq)\,\partial s > 0$. Thus, output q unambiguously decreases with s (τ). But, if the output of multinationals declines, the output of competitive firms x increases due to a reduction in the competitive pressure. According to the latter, a decline in output q not only reduces PCM_{mult}, but also the concentration rate CR. Since competitive firms sell their products at marginal costs, the impact of trade costs s (coordination costs τ) on PCM_{ind} turns out to be unambiguously negative.

The impact of multinationality m on the variables of interest is summarized by the following proposition.

Proposition 2 *An increase in multinationality (market access) m increases outsourcing coefficient a_O but has no impact on output q. Moreover and as a consequence, m has also no impact on concentration rate CR and price-cost margin PCM_{ind}.*

Proof. See the appendix. ■

The intuition for Proposition 2 is the following. First, access to an additional market at a given outsourcing coefficient a_O and a given output level at each individual market q implies that unit production costs increase. Thus, a reduction of q becomes attractive. This is a *negative direct* effect. Second, access to an additional market at a given q makes outsourcing more attractive so that the outsourcing coefficient a_O increases. However, an increase in the outsourcing coefficient a_O reduces production costs $C(\cdot)$, which gives an incentive to increase the output in each market q. This is a *positive indirect* effect. It turns out that both effects exactly cancel out in equilibrium so that q is not affected by a change in multinationality m. Note thereby, that q is independent of m since the outsourcing coefficient a_O is increasing in m. Moreover, since q is not affected, it is clear that a change in (market access) m neither has an impact on CR nor on PCM_{ind}.

Of course, our finding that m does neither affect CR nor PCM_{ind} critically depends on two restrictive assumptions, namely that markets are symmetric and that access to an additional market does not imply more competition due to an increase in the number of multinationals n.

The impact of the number of multinationals n on a_O, q, CR and PCM_{ind} is summarized by the following proposition.

Proposition 3 *An increase in the number of multinational firms n reduces both outsourcing coefficient a_O and output per market q. Moreover, concentration rate CR is decreasing in the number of multinationals n, whereas the impact on the price-cost margin of the industry PCM_{ind} is ambiguous.*

Proof. See the appendix. ■

The intuition for this finding is that an increase in the number of multinational firms n reinforces competition, so that both q and a_O decline. The latter effect arises since a decline in output q makes outsourcing less attractive, according to $\frac{\partial^2 C(\cdot)}{\partial a_O \partial q}$. The impact of the firm number n on the concentration rate CR is negative, since individual output q declines whereas market output $nq + Nx$ increases. Concerning its impact on PCM_{mult}, n reveals two opposing effects. First, an increase in n has a *direct negative* effect on PCM_{mult}, according to $PCM_{mult} = 1/(n|\varepsilon|)$. Second, nq increases in n implying that the elasticity of demand with respect to prices $|\varepsilon|$, goes down. This is an *indirect positive* effect of the number of multinationals on PCM_{mult}. Since in equilibrium firms are selling at the elastic range of the demand function, i.e. $n|\varepsilon| > 1$, PCM_{mult} turns out to be unambiguously declining in the number of multinational firms n. Finally, be aware that total output of multinationals nq increases at the expense of the production of competitive suppliers Nx. Thus, $n \cdot CR$ unambiguously increases with n, according to (5).[11] Together with $dPCM_{mult}/dn < 0$, there are two opposing effects of n on PCM_{ind}, according to (6). Since it is not clear which of the two effects is stronger, $dPCM_{ind}/dn$ turns out to be ambiguous.

[11] Be aware that $d(n \cdot CR)/dn = [CR + n \cdot dCR/dn]$, with $CR > -n \cdot dCR/dn$.

Finally, the impact of the number of competitive firms N on the variables of interest is summarized by the following proposition.

Proposition 4 *An increase in the number of competitive firms N lowers both outsourcing coefficient a_O and output q. Moreover, N has a negative impact on concentration rate CR and the price-cost margin of the industry PCM_{ind}.*

An increase in N implies a higher competitive pressure so that multinationals reduce output q. As argued in the intuition for Proposition 3, this makes outsourcing activities less attractive. Thus, also a_O is negatively related to N. Due to its negative impact on q, an increase in N also implies a decline in CR, since competitive firms increase their output at the expense of multinational ones. Finally, since the economy becomes more competitive, N reduces PCM_{mult} so that PCM_{ind} is also decreasing in N.

2.3 Summary of the Theoretical Hypotheses

From our theoretical analysis above we would expect that an increase in international outsourcing in terms of output of multinationals a_O induced by a decline in trade costs s, coordination costs τ or the number of national competitiors N goes along with an increase in the concentration rate CR and the price-cost margin per industry PCM_{ind}. A decline in the competitive pressure induced by a decrease in the number of multinationals n would also increase both outsourcing coefficient a_O and concentration rate CR. However, the impact of n on the price-cost margin per industry PCM_{ind} turns out to be ambiguous. Finally, access to an additional market, i.e. an increase in m, is solely absorbed by an increase in outsourcing coefficient a_O. Neither CR nor PCM_{ind} are affected, since output per market q turns out to be constant. However, as pointed out above, the finding that m does neither affect CR nor PCM_{ind}, may critically depend on our symmetry assumptions.

3 Data and Empirical Results

To construct an empirical model, we build upon insights from our theoretical analysis that price-cost margins per industry are only directly affected by firm number n, while all the other exogenous variables (s, τ, m and N) impact on PCM_{ind} only through changes of the concentration rate and the price-cost margin of multinationals (PCM_{mult}), which are directly related to changes of firm output q and (at least for a given m) outsourcing coefficient a_O. Hence, in our empirical analysis we use $CR5$ (the concentration rate of the top five firms with respect to their output in each industry) and a_O as *approximate but observable measures* of changes in the firm numbers (n or N, respectively), overall trade costs s in a wide sense and coordination costs τ.[12] In addition, we control for multinationality, which may have an impact on price-cost margins in an asymmetric world (not in the case of symmetric markets above). Finally, we know from our theoretical investigation that the impact of multinationality m and the outsourcing coefficient a_O on the one hand, and the concentration rate $CR5$ and a_O on the other hand, are not necessarily independent. Therefore, we should control for interactions of these two pairs.

In addition to the variables that are based on our theoretical considerations, we control for further variables which may be related to price-cost margins, according to earlier empirical findings. Motivated by Co (2001) and Levinsohn (1993), we use the investment-to-output ratio (KO) to control for differences in margins due to capital intensity.[13] The final goods import-to-output ratio (IMP) is also used as an explanatory variable to see whether the IMD hypothesis is still supported if we distinguish between final and intermediate goods imports. As suggested by Co (2001), we also control for the possible

[12] We cannot control for the direct impact of firm number n, since no data is available for this variable. Similarly, data on trade and coordination costs are partly unobserved and usually affected by substantial measurement errors (see Hummels and Lugovskyy, 2003).

[13] Fors (1997) and Griliches (1998) illustrate that investment to output ratios are good approximations of changes in capital stocks. For some firm-level data bases, capital stocks are available from balance sheets (see Konings and Vandenbussche, 2002). Unfortunately, information on capital stocks is not available at the industry level.

interaction between the concentration rate $CR5$ and the final goods import-to-output ratio IMP.

We estimate two-way fixed effects regressions, which account for fixed time and country-industry effects in order to control for unobserved cycle and cross-section specific influences, thereby reducing the possible omitted variable bias. The estimated specification reads

$$\begin{aligned} PCM_{ind,ijt} = \beta_0 + \beta_1 KO_{ijt} + \beta_2 m_{i(t-1)} + \beta_3 m_{i(t-2)} + \beta_4 CR5_{i(t-1)} + \beta_5 IMP_{ij(t-1)} \\ + \beta_6 CR5_{i(t-1)} \cdot IMP_{ij(t-1)} + \beta_7 a_{Oij(t-1)} + \beta_8 m_{i(t-1)} a_{Oij(t-1)} + \beta_9 CR5_{i(t-1)} a_{Oij(t-1)} \\ + \mu_{ij} + \lambda_t + \varepsilon_{ijt}, \quad (7) \end{aligned}$$

where $i = 1, ..., 66$, $j = 1, ..., 11$ and $t = 1991, 1994, 1998$ are industry, country[14] and year indices, respectively. Martin (1979) and Geroski (1982) address the problem of potential endogeneity in margins regressions. Martin (1979) suggests to account for a partial adjustment scheme. Given that we have only three data points in the time dimension of each industry in a typical EU economy at hand, this is impossible in our case. Rather, we follow Pirotte (1999) and interpret the fixed effects parameter estimates as valid approximations of the short run elasticities. Due to the lack of appropriate instruments, we use lagged values of the potentially endogenous variables.[15] Of course, this strategy is only helpful for longitudinal panels of data. In cross-sections, the inclusion of lagged values cannot help to overcome the endogeneity problem, and Martin's (1979) and Geroski's (1982) arguments apply. To be more precise, we use lagged $CR5$ and a_O since they are jointly determined with PCM in our theoretical model. Similarly, we use only the lagged final goods import-to-output ratio IMP and multinationality m. See Chung

[14]The EU member countries as of before 1995, where Belgium and Luxembourg are treated as a single economy due to the availability of trade data: Belgium-Luxembourg, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, UK.

[15]We may assume all lagged variables as predetermined, i.e., independent of subsequent structural disturbances (a standard assumption in dynamic panel econometrics). Greene (1997, p. 714) argues that "variables that are predetermined in a model can be treated, at least asymptotically, as if they were exogenous in the sense that consistent estimates can be obtained when they appear as regressors."

(2001) for a similar approach in a different setting. As motivated in Co (2001), we also include $m_{i(t-2)}$ since the impact of multinationality on PCM_{ind} may be less immediate. μ_{ij} are fixed country-industry effects, which control for all unobserved country, industry and country-by-industry effects. Noteworthy, in this design pure country or industry effects are nested in μ_{ij}, but μ_{ij} additionally controls for country specific deviations from the average industry effects, which may be due to legal, institutional, infrustructure and other aspects.[16] λ_t denotes fixed time effects to account for a common cyclical behavior of margins (Domowitz et al., 1986), and ε_{ijt} is a classical error term.

For the empirical assessment, we use data on gross production, value added, gross fixed capital formation and wages at the NACE 3-digit level from New Cronos (EUROSTAT) for EU12 countries. As usual, we define the PCM_{ind} by the Lerner index:

$$PCM_{ind,ijt} = \frac{value\ added_{ijt} - wages_{ijt}}{gross\ production_{ijt}}. \tag{8}$$

UN Broad Economic Categories distinguish between final goods and intermediate goods trade at the Standard International Trade Classification (SITC) Revision 3 5-digit level. Intermediate goods are components that are used in the production of other goods. Final goods are all other products. We define intermediate goods imports of the EU12 countries from non-EU countries as our wide measure of outsourcing. The data are reclassified to NACE 3-digit following the available correspondence table. Due to data availability, we cannot distinguish between international outsurcing of multinationals and of other firms. However, as long as multinationals have easier access to foreign intermediate goods markets, our measure of outsourcing seems appropriate for the empirical assessment. Data on the EU12 market share of the largest five enterprises ($CR5$) and multinationality (m), which is measured by the entropy index of production of the largest multinationals across EU12 member countries, are from Davies and Lyons (1996) and Sleuwaegen and Veugelers

[16] In any estimated specification, we tested the model with pure country and industry effects against our nested model. The former is always rejected in terms of an F-test. Hence, a three-way fixed effects approach with time, country and industry effects is likely to attribute some effect to observed variables, which in fact is due to unobserved, time-invariant (legal, infrastructure, institutional, etc.) country-by-industry specific determinants of margins.

(2001), available for 1987, 1993 and 1997. The entropy index measures the distribution of production activities of (domestic and foreign) multinationals among EU12 countries. For each firm in a specific industry, the index is defined as $\sum_j -s_j \ln(s_j)$, with s_j denoting country j's production share in overall EU12 production.[17] Hence, the index is maximized as the distribution is uniform. Suppose that production plants are all of the same size, and multinationals operate only a single plant in a country. Then, the index rises with the number of markets the multinational operates in. Therefore, the index represents a measure of multinationality. We use the industry average of the multinational firm-specific index values. The data are interpolated in order to obtain an estimate of $CR5$ and m for 1990, which is the first year reliable trade data are available for. Since $CR5$ and multinationality are published in an aggregated form of NACE 3-digit (called SPES), the industry and trade data are further reclassified to SPES, too (see Sleuwaegen and Veugelers, 2001). We exclude all country-industry observations from the analysis, which are not observed at least twice in the three years under consideration and come up with 2020 observations in the regression analysis. The PCM_{ind} in 1991, 1994 and 1998 is explained by contemporaneous explanatory variables (observed in 1991, 1994 and 1998) and lagged (observed in 1990, 1993 and 1997) as well as twice-lagged variables (observed in 1989, 1992 and 1996).

Table 1 summarizes the descriptive statistics for the full sample and two subsamples. The first subsample[18] consists of those industry-by-country pairings (ij) with an average PCM higher than the overall mean (high PCM), and the second subsample are the other pairings (low PCM). According to the table, the two subsamples significantly differ not only in terms of the PCM but also of almost all explanatory variables. Specifically, the final goods imports to output ratio and outsourcing are higher for the low-PCM subsample, while all other variables are significantly lower. These differences lead us to the suggestion

[17] In our data, the entropy index exhibits a minimum value of 0.14 for the casting, forging, and first treatment of metal industry and a maximum one of 0.83 for the dairy products industry. Average level and standard deviation are given for the full sample and two subsamples in Table 1, below.

[18] To define the subsamples, we average all data over time.

that the impact of these variables on the industry PCM might also differ between the two subsamples. Accordingly, we run the regressions also for the two subsamples, separately.

> Table 1 <

Table 2 presents the results from nine regressions: Models 1-3 for the full sample and two sub-samples. Model 1 corresponds to (7), and Models 2 and 3 are restricted versions of (7). In Model 2, we assume that all interaction terms have zero impact (i.e., $\beta_6 = \beta_8 = \beta_9 = 0$), and in Model 3 we additionally assume that final goods imports and outsourcing have the same impact (i.e., $\beta_5 = \beta_7$). However, for both the full sample and the high-PCM subsample Models 2 and 3 are rejected against Model 1 on the basis of an F-test. Only for the low-PCM subsample the more parsimonious models are not rejected. According to the F-test of Model 3 against Model 2, the latter is supported in all cases. Below, we base the further analysis and discussion on the Model 3 parameters for both the full sample and the two subsamples. However, pooling of the parameters for the low-PCM and the high-PCM subsamples in the full sample is rejected according to an F-test. Therefore, the respective heterogeneous parameter estimates are relevant. Note that the reported adjusted R^2 figures are very high. The reason is that the μ_{ij} (i.e., the industry-by-country dummy variables) account for a lot of variation in the data. Of course the corresponding within R^2 figures are considerably lower.[19] However, they also point to a good explanatory power of our model.

> Table 2 <

Because of the presence of interaction terms, the results in Table 2 do not allow for direct conclusions on the marginal effects. The required information can be obtained by first differencing (7) with respect to the variables of interest. Noteworthy, the marginal impact varies across observations and it is usually evaluated at the sample means of the

[19] These figures indicate, how much of the variation in the data after subtracting the industry-by-country means is explained by the explanatory variables.

respective interacted variables.[20] The positive average marginal impact of multinational activity for the full sample or the high-PCM subsample is not significant after controlling for market concentration and intra-firm components trade activity (internalization). This is in accordance with our theoretical hypotheses. However, there is a significant positive marginal effect for the low-PCM subsample.[21] In line with previous empirical work and with our theoretical model, we identify a positive direct impact of lagged industry concentration on margins. Similar to Co's (2001) result for the US, this impact is the lower, the larger the industry (in our case: *final goods*) imports (see interaction term (6) in Table 2). On average, the marginal effect of concentration is insignificant. However, it is negative and significant at 10% in the high-PCM subsample and insignificant in the low-PCM subsample, which cannot be explained by our theoretical model. There is evidence in favor of the IMD hypothesis, since a marginal increase in final goods imports significantly reduces the industry PCM (see Co, 2001, Levinsohn, 1993, and Tybout, 2003, for an overview), irrespective of which sample of the data is considered. We find that it is important to distinguish between final goods imports and intermediate goods imports (international outsourcing), since their marginal impact on the industry PCM differs in sign (compare also the results between the parsimonious Models 2 and 3 in Table 2 on this). According to Table 3, in both the full sample and the two subsample regressions the marginal effect of outsourcing is positive, significant at 1%, and robust with respect to outliers (compare the median regression results at the bottom of Table 3), pointing to the relevance of our theoretical model. According to our estimates, a one percentage point increase in

[20] For instance, the marginal impact of outsourcing on the PCM in our case is $\partial PCM_{ind,ijt}/\partial a_{Oij(t-1)} = \beta_7 + \beta_8 m_{ij(t-1)} + \beta_9 CR5_{i(t-1)}$. Following Greene (1997), we use the average of m_i and $CR5_i$ in the full sample or the two subsamples, as reported in Table 1, to evaluate the effect. Since the focus of our paper lies on the impact of international outsourcing, the marginal effect of this variable is shown in Table 3. Marginal effects of the other explanatory variables are discussed in detail below but are not separately displayed in Table 3.

[21] In contrast to Co (2001), our data do not allow to distinguish between changes in multinational activities due to greenfield investment and mergers and acquisitions. Co identifies a positive marginal effect of FDI in industries with low levels of concenration.

outsourcing leads to an increase in the PCM of about 0.5 percentage points on average. Aggregating over the two different concepts of imports (final and intermediate goods) leads to upward biased estimates of the import-to-output parameters (compare Model 2 with Model 3 for all sample definitions).[22]

> Table 3 <

With the regression results of Model 1 at hand, we can turn to a thought experiment, where we try to isolate the impact of the change in outsourcing (i.e. intermediate goods import) activity on PCMs between 1990 and 1997. Therefore, we obtain two different sets of model predictions on the basis of the parameter estimates of the three regressions in Table 2. One, where we allow all variables (including the outsourcing-to-output ratio, a_{Oijt}) to develop as observed, and a second, where we hold the outsourcing-to-output ratio constant at its 1990 value in all industries and countries. The difference between the observed and the simulated change in PCMs can then be interpreted as the contribution of the outsourcing-to-output ratio change alone. Table 4 summarizes the simulation results.

> Table 4 <

First, we admit a reduction in the margins of both the high-PCM and the low-PCM industry. On average, this reduction amounts to about 0.6 percentage points in our sample. Between 1990 and 1997, international outsourcing rose by 0.78 percentage points in the average industry and country. However, the change in outsourcing was quite different in the two subsamples. While outsourcing shrank by about 0.02 percentage points in the high-PCM subsample, it rose by 1.56 percentage points in the low-PCM subsample. In the second row of Table 4, we compute the difference between the model prediction with outsourcing as observed ("observed") and that one assuming outsourcing to be constant at the level of 1990 ("simulated"). According to our results, the average industry PCM

[22] Our theoretical model would also suggest a positive coefficient β_8 of the interaction term $m_{i(t-1)}a_{Oij(t-1)}$. This is in line with our findings for the high-PCM subsample. The respective parameter estimate for the low-PCM subsample is insignificant.

shrank by about 0.4 percentage point less because of the change in the outsourcing activity in the 90's. Much of this is traceable to the increase in international outsourcing in the low-PCM industries. The decline in the high-PCM industries' outsourcing activity accounts for a reduction in PCMs by 0.1 percentage points, while no change in outsourcing in the low-PCM industries would have led to a further reduction in PCM by 0.5 percentage points. Altogether, this suggests an outsourcing-induced 'convergence' of PCMs to the EU12 average in EU manufacturing between 1991 and 1998.

Table 4 presents three additional rows of results, which summarize the findings of an analysis of variance of the "observed - simulated" change in PCMs. The corresponding numbers are to be interpreted as the contribution of the mentioned dimensions of variance (within industries and countries, between industries, between countries) to the overall variance of the outsourcing-induced change in PCMs. Since we focus on the short run (fixed effects) impact, it is not surprising that the within industries and countries variation dominates. Additionally, we observe that outsourcing induces a considerable shift in PCMs across industries, whereas the impact on the cross country distribution of PCMs is only small and insignificant.

4 Conclusions

This paper analyses the effects of outsourcing on price-cost margins in the EU12. From a model, where multinationals compete in quanities (Cournot) and other firms represent a competitive fringe, we expect a positive relationship between the industry price cost margin and market concentration (of multinationals) on the one hand, and (for a given level of multinationality) between the industry price-cost margin and international outsourcing on the other hand. Based on insights of our theoretical analysis, we construct an empirical model to test our hypotheses in a panel of 66 (aggregates of NACE 3-digit) industries and the EU12 countries in the 1990s, respectively. Due to the lack of data, we use an industry's *intermediate goods* import to output ratio as a wide measure of international outsourcing and we use *final goods* imports as an additional control variable, motivated by the imports-as-market-discipline hypothesis. The empirical findings strongly support our theoretical hypotheses and underpin the importance of distinguishing between intermediate goods (international outsourcing) and final goods imports to obtain unbiased estimates for both types of imports.

We undertake an experiment of thought to demonstrate the importance of outsourcing. In the 90s, especially the low-margins industries engaged in international outsourcing whereas we observe a decline in the outsourcing activity of the high-margins industries. Price-cost margins in the average low-margins industry would have declined by 0.5 percentage points faster between 1991 and 1998 if the observed increase in international outsourcing since 1990 had not taken place. Moreover, the reduction in international outsourcing accounts for an additional decline in the EU12 high-margins industries by about 0.1 percentage points. In that way, the observed change in outsourcing has induced a convergence of EU12 industry price-cost margins and has led to a considerable shift in the distribution of margins across industries rather than across countries. However, for a deeper understanding of this convergence effect of international outsourcing further theoretical and empirical research is needed.

Appendix

Define

$$\Gamma_1(q, a_O, s, m, n, N) \equiv \frac{A-(n+1)\,bq}{1+bN} - \frac{\partial C(mq, a_O, s)}{\partial (mq)} = 0, \tag{9a}$$

$$\Gamma_2(q, a_O, s, m, n, N) \equiv \frac{\partial C(mq, a_O, s)}{\partial a_O} + \tau = 0. \tag{9b}$$

according to (3) and (4). Then, the linearization of system (9) is[23]

$$\frac{\partial \Gamma_1(\cdot)}{\partial q}dq + \frac{\partial \Gamma_1(\cdot)}{\partial a_O}da_O + \frac{\partial \Gamma_1(\cdot)}{\partial s}ds + \frac{\partial \Gamma_1(\cdot)}{\partial m}dm + \frac{\partial \Gamma_1(\cdot)}{\partial n}dn + \frac{\partial \Gamma_1(\cdot)}{\partial N}dN = 0, \tag{10a}$$

$$\frac{\partial \Gamma_2(\cdot)}{\partial q}dq + \frac{\partial \Gamma_2(\cdot)}{\partial a_O}da_O + \frac{\partial \Gamma_2(\cdot)}{\partial s}ds + \frac{\partial \Gamma_2(\cdot)}{\partial \tau}d\tau + \frac{\partial \Gamma_2(\cdot)}{\partial m}dm = 0. \tag{10b}$$

[23] According to system (9), we use $\frac{\partial \Gamma_1(\cdot)}{\partial \tau} = \frac{\partial \Gamma_2(\cdot)}{\partial n} = \frac{\partial \Gamma_2(\cdot)}{\partial N} = 0$.

Proof of Proposition 1

Use $dm = dn = dN = 0$ and, in addition, $d\tau = 0$ and apply Cramer's rule to (10). Then, we obtain

$$\frac{dq}{ds} = -\frac{\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial s} & \frac{\partial\Gamma_1(\cdot)}{\partial a_O} \\ \frac{\partial\Gamma_2(\cdot)}{\partial s} & \frac{\partial\Gamma_2(\cdot)}{\partial a_O} \end{pmatrix}}{\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial q} & \frac{\partial\Gamma_1(\cdot)}{\partial a_O} \\ \frac{\partial\Gamma_2(\cdot)}{\partial q} & \frac{\partial\Gamma_2(\cdot)}{\partial a_O} \end{pmatrix}}. \tag{11}$$

Use

$$\frac{\partial\Gamma_1(\cdot)}{\partial q} = -\left(\frac{(n+1)\,b}{1+bN} + \frac{\partial^2 C(\cdot)}{\partial(mq)^2}m\right), \quad \frac{\partial\Gamma_2(\cdot)}{\partial q} = m\frac{\partial^2 C(\cdot)}{\partial a_O \partial(mq)}, \tag{12}$$

$$\frac{\partial\Gamma_1(\cdot)}{\partial a_O} = -\frac{\partial^2 C(\cdot)}{\partial(mq)\,\partial a_O} \quad \text{and} \quad \frac{\partial\Gamma_2(\cdot)}{\partial a_O} = \frac{\partial^2 C(\cdot)}{\partial(a_O)^2}, \tag{13}$$

to find

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial q} & \frac{\partial\Gamma_1(\cdot)}{\partial a_O} \\ \frac{\partial\Gamma_2(\cdot)}{\partial q} & \frac{\partial\Gamma_2(\cdot)}{\partial a_O} \end{pmatrix} = -\left(\frac{(n+1)\,b}{1+bN} + \frac{\partial^2 C(\cdot)}{\partial(mq)^2}m\right) \times \frac{\partial^2 C(\cdot)}{\partial(a_O)^2} + m\left(\frac{\partial^2 C(\cdot)}{\partial a_O \partial(mq)}\right)^2. \tag{14}$$

According to the Euler theorem we can use

$$\frac{\partial^2 C(\cdot)}{\partial(mq)^2} = -\frac{a_O}{mq}\frac{\partial^2 C(\cdot)}{\partial(mq)\,\partial a_O} \quad \text{and} \tag{15}$$

$$\frac{\partial^2 C(\cdot)}{\partial(a_O)^2} = -\frac{mq}{a_O}\frac{\partial^2 C(\cdot)}{\partial a_O \partial(mq)}, \tag{16}$$

so that (14) can be simplified to

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial q} & \frac{\partial\Gamma_1(\cdot)}{\partial a_O} \\ \frac{\partial\Gamma_2(\cdot)}{\partial q} & \frac{\partial\Gamma_2(\cdot)}{\partial a_O} \end{pmatrix} = \frac{(n+1)\,b}{1+bN}\frac{mq}{a_O}\frac{\partial^2 C(\cdot)}{\partial(mq)\,\partial a_O} < 0. \tag{17}$$

Moreover, consider

$$\frac{\partial\Gamma_1}{\partial s} = -\frac{\partial^2 C(\cdot)}{\partial(mq)\,\partial s}, \quad \text{and} \quad \frac{\partial\Gamma_2}{\partial s} = \frac{\partial^2 C(\cdot)}{\partial a_O \partial s}, \tag{18}$$

to obtain

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial s} & \frac{\partial\Gamma_1(\cdot)}{\partial a_O} \\ \frac{\partial\Gamma_2(\cdot)}{\partial s} & \frac{\partial\Gamma_2(\cdot)}{\partial a_O} \end{pmatrix} = -\frac{\partial^2 C(\cdot)}{\partial(mq)\partial s}\frac{\partial^2 C(\cdot)}{\partial(a_O)^2} + \frac{\partial^2 C(\cdot)}{\partial(mq)\partial a_O}\frac{\partial^2 C(\cdot)}{\partial a_O\partial s} < 0 \tag{19}$$

for the denominator of (11). Then, substituting (17) and (19) in (11) gives $dq/ds < 0$. Moreover, due to

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial q} & \frac{\partial\Gamma_1(\cdot)}{\partial s} \\ \frac{\partial\Gamma_2(\cdot)}{\partial q} & \frac{\partial\Gamma_2(\cdot)}{\partial s} \end{pmatrix} = -\left(\frac{(n+1)b}{1+bN} + \frac{\partial^2 C(\cdot)}{\partial(mq)^2}m\right)\frac{\partial^2 C(\cdot)}{\partial a_O\partial t} + \frac{\partial^2 C(\cdot)}{\partial a_O\partial(mq)}\frac{\partial^2 C(\cdot)}{\partial(mq)\partial t}m < 0, \tag{20}$$

$da_O/ds < 0$ directly follows from (17), according to Cramer's rule.

Use $dq/ds < 0$ in (5) to obtain $dCR/ds < 0$. Finally, use $PCM_{mult} = 1/(n|\varepsilon|)$ and note that $|\varepsilon| = \frac{A-bnq}{bnq}$ is declining in q to obtain $dPCM_{mult}/ds < 0$ and therefore $dPCM_{ind}/ds < 0$, according to (6).

Similarily, use $dm = dn = dN = 0$ and $ds = 0$, instead of $d\tau = 0$. Moreover, note that

$$\frac{\partial\Gamma_1(\cdot)}{\partial\tau} = 0 \quad \text{and} \quad \frac{\partial\Gamma_2}{\partial\tau} = 1, \tag{21}$$

according to (10). Then,

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial\tau} & \frac{\partial\Gamma_1(\cdot)}{\partial a_O} \\ \frac{\partial\Gamma_2(\cdot)}{\partial\tau} & \frac{\partial\Gamma_2(\cdot)}{\partial a_O} \end{pmatrix} = \frac{\partial^2 C(\cdot)}{\partial(mq)\partial a_O} < 0 \tag{22}$$

implies $dq/d\tau < 0$, according to (17) and Cramer's rule. Moreover, due to

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial q} & \frac{\partial\Gamma_1(\cdot)}{\partial\tau} \\ \frac{\partial\Gamma_2(\cdot)}{\partial q} & \frac{\partial\Gamma_2(\cdot)}{\partial\tau} \end{pmatrix} = -\left(\frac{(n+1)b}{1+bN} + \frac{\partial^2 C(\cdot)}{\partial(mq)^2}m\right) < 0, \tag{23}$$

$da_O/d\tau < 0$ directly follows from (17), according to Cramer's rule.

Use $dq/d\tau < 0$ in (5) to obtain $dCR/d\tau < 0$. Finally, $dPCM_{ind}/d\tau < 0$ is a direct consequence of $dPCM_{mult}/d\tau < 0$, according to (6). This completes the proof of Proposition 1. ■

Proof of Proposition 2

Use $ds = d\tau = dn = dN = 0$ in (10) and

$$\frac{\partial\Gamma_1}{\partial m} = -\frac{\partial^2 C(\cdot)}{\partial(mq)^2}q, \quad \frac{\partial\Gamma_2}{\partial m} = \frac{\partial^2 C(\cdot)}{\partial a_O\partial(mq)}q,$$

according to (9), together with (12) to find

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial m} & \frac{\partial\Gamma_1(\cdot)}{\partial a_O} \\ \frac{\partial\Gamma_2(\cdot)}{\partial m} & \frac{\partial\Gamma_2(\cdot)}{\partial a_O} \end{pmatrix} = -\frac{\partial^2 C(\cdot)}{\partial (mq)^2}\frac{\partial^2 C(\cdot)}{\partial (a_O)^2}q + \frac{\partial^2 C(\cdot)}{\partial (mq)\,\partial a_O}\frac{\partial^2 C(\cdot)}{\partial a_O \partial (mq)}q. \tag{24}$$

According to (15) and (16), we then obtain

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial m} & \frac{\partial\Gamma_1(\cdot)}{\partial a_O} \\ \frac{\partial\Gamma_2(\cdot)}{\partial m} & \frac{\partial\Gamma_2(\cdot)}{\partial a_O} \end{pmatrix} = 0. \tag{25}$$

This implies $dq/dm = 0$, according to Cramer's rule. Moreover, due to

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial q} & \frac{\partial\Gamma_1(\cdot)}{\partial m} \\ \frac{\partial\Gamma_2(\cdot)}{\partial q} & \frac{\partial\Gamma_2(\cdot)}{\partial m} \end{pmatrix} = -\frac{(n+1)\,b}{1+bN}\frac{\partial^2 C(\cdot)}{\partial a_O \partial (mq)}q > 0 \tag{26}$$

we find that $da_O/dm > 0$, according to (17) and Cramer's rule.

Use $dq/dm = 0$ in (5) to find $dCR/dm = 0$. Finally, use $PCM_{mult} = 1/\left(n\left|\varepsilon\right|\right)$ and note that $\frac{d|\varepsilon|}{dm} = \frac{d|\varepsilon|}{dq}\frac{dq}{dm} = 0$ to obtain $dPCM_{mult}/dm = 0$. Then, $dPCM_{ind}/dm = 0$, follows, according to (6). This completes the proof of Proposition 2. ■

Proof of Proposition 3

Use $ds = d\tau = dm = dN = 0$ in (10) and note that

$$\frac{\partial\Gamma_1}{\partial n} = -\frac{bq}{1+bN} \quad \text{and} \quad \frac{\partial\Gamma_2}{\partial n} = 0,$$

according to (9). Then,

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial n} & \frac{\partial\Gamma_1(\cdot)}{\partial a_O} \\ \frac{\partial\Gamma_2(\cdot)}{\partial n} & \frac{\partial\Gamma_2(\cdot)}{\partial a_O} \end{pmatrix} = -\frac{bq}{1+bN}\frac{\partial^2 C(\cdot)}{\partial (a_O)^2} < 0 \tag{27}$$

is an immediate consequence of (12). According to (17) and Cramer's rule, we obtain $dq/dn < 0$. Moreover, due to

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial q} & \frac{\partial\Gamma_1(\cdot)}{\partial n} \\ \frac{\partial\Gamma_2(\cdot)}{\partial q} & \frac{\partial\Gamma_2(\cdot)}{\partial n} \end{pmatrix} = \frac{\partial^2 C(\cdot)}{\partial a_O \partial (mq)}\frac{bq}{1+bN}m < 0 \tag{28}$$

it directly follows that $da_O/dn < 0$.

Use the Euler theorem, according to (16), to obtain $dq/dn = -q/(n+1)$ from (17) and (27). Then, we find

$$\frac{dCR}{dn} = -\frac{(1+bN)\,q\left(q+\frac{NA}{n+1}\right)}{(nq+NA)^2} < 0, \tag{29}$$

according to (5). Moreover, use $PCM_{mult} = \frac{1}{n|\varepsilon|}$ and $|\varepsilon| = \frac{A-bnq}{bnq}$ to derive

$$\frac{dPCM_{mult}}{dn} = -\frac{|\varepsilon| + n\frac{d|\varepsilon|}{dn}}{(n\,|\varepsilon|)^2} = -\frac{\frac{n}{n+1}\left(\frac{A}{bnq}\right)-1}{\left(n\frac{A-bnq}{bnq}\right)^2}. \tag{30}$$

Then,

$$dPCM_{mult}/dn \lesseqqgtr 0 \quad \text{iff} \quad n\,|\varepsilon| \gtreqqless 1, \tag{31}$$

according to (30). Use $p\left(1-\frac{1}{n|\varepsilon|}\right) = \frac{\partial C(\cdot)}{\partial(mq)}$, according to (3), to find that $n\,|\varepsilon| > 1$ and therefore $dPCM_{mult}/dn < 0$, according to (31). Finally, be aware that

$$\frac{dPCM_{ind}}{dn} = \left[CR + n\frac{dCR}{dn}\right]PCM_{mult} + n\cdot CR\frac{dPCM_{mult}}{dn}, \tag{32}$$

according to (6). Make use of

$$\left[CR + n\frac{dCR}{dn}\right]\frac{1}{CR} = \frac{NA}{(n+1)(nq+NA)}, \tag{33}$$

according to (5) and (29) and note that

$$\frac{dPCM_{mult}}{dn}\frac{n}{PCM_{mult}} = -\frac{n(A-bnq)-bnq}{(n+1)(A-bnq)}, \tag{34}$$

according to (30). Then,

$$\frac{dPCM_{ind}}{dn} \gtreqqless 0, \quad \text{iff} \quad \frac{NA}{nq+NA} \gtreqqless n - \frac{1}{|\varepsilon|}. \tag{35}$$

Now, use[24]

$$q = \frac{A-(1+bN)\,\partial C(\cdot)/\partial(mq)}{b(n+1)}, \tag{36}$$

[24] Eq. (36) is not an explicit solution for the optimal output level q^*, since $\partial C(\cdot)/\partial(mq)$ is a function of q.

according to (3) to reformulate (35) as

$$bNA\left[A-n^2\frac{\partial C(\cdot)}{\partial(mq)}(1+bN)\right]\gtreqless n^2\left[A-\frac{\partial C(\cdot)}{\partial(mq)}(1+bN)\right]\times\frac{\partial C(\cdot)}{\partial(mq)}(1+bN). \quad (37)$$

Rearranging terms in (37) gives

$$\underbrace{\frac{A}{A-\partial C(\cdot)/\partial(mq)}}_{e_1}\underbrace{\frac{A}{(1+bN)\,\partial C(\cdot)/\partial(mq)}}_{e_2}\underbrace{\frac{bN}{1+bN}}_{e_3}\gtreqless n^2, \quad (38)$$

with $e_1>1$, according to (3), $e_2>1$, according to (36) and $e_3<1$. Since $e_1\cdot e_2\cdot e_3\gtreqless n^2$ and, therefore, also the sign of $\frac{dPCM_{ind}}{dn}$ cannot be generally determined we use the following (linearly homogenous) specification for cost function $C(\cdot)$:

$$C\left(\sum\nolimits_j q_{kj},a_O^k;s\right)=\frac{\left(\sum_j q_{kj}\right)^2}{\sum_j q_{kj}+a_O}+s\frac{\left(\sum_j q_{kj}\right)a_O}{\sum_j q_{kj}+a_O},\quad s\in(0,1). \quad (39)$$

In the symmetric equilibrium, the first derivatives of $C(\cdot)$ with respect to q and a_O are given by

$$\frac{\partial C(\cdot)}{\partial mq} = 1-\frac{(1-s)\,a_O^2}{(mq+a_O)^2}, \quad (40)$$

$$\frac{\partial C(\cdot)}{\partial a_O} = -\frac{(1-s)\,(mq)^2}{(mq+a_O)^2}, \quad (41)$$

respectively. Hence, we obtain $\frac{\partial C(\cdot)}{\partial(mq)}=1+\frac{\partial C}{\partial a_O}\left(\frac{a_O}{mq}\right)^2$. In view of (4), it follows that $\frac{\partial C(\cdot)}{\partial(mq)}=1-\tau\left(\sqrt{(1-s)/\tau}-1\right)^2$. By substituting the latter expression in (39) it can be shown that $e_1\cdot e_2\cdot e_3\gtreqless n^2$ and, therefore, also the sign of $\frac{dPCM_{ind}}{dn}$ critically depend on the parameter values and are in general ambiguous.[25] This completes the proof of Proposition 3. ■

Proof of Proposition 4

Use $dt=d\tau=dm=dn=0$ in (10) and note that

$$\frac{\partial\Gamma_1}{\partial N}=-\frac{[A-b(n+1)q]\,b}{(1+bN)^2}\quad\text{and}\quad\frac{\partial\Gamma_2}{\partial N}=0,$$

[25] The ambiguity in the sign of $\frac{dPCM_{ind}}{dn}$ has also been shown in a numerical experiment. The respective parameter values and the progam code for *Mathematica 5* are available from the authors upon request.

according to (9). Then,

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial N} & \frac{\partial\Gamma_1(\cdot)}{\partial a_O} \\ \frac{\partial\Gamma_2(\cdot)}{\partial N} & \frac{\partial\Gamma_2(\cdot)}{\partial a_O} \end{pmatrix} = -\frac{[A-b(n+1)q]\,b}{(1+bN)^2}\frac{\partial^2 C(\cdot)}{\partial(a_O)^2} < 0. \tag{42}$$

According to (17) and Cramer's rule, we obtain $dq/dN < 0$. Moreover, due to

$$\det\begin{pmatrix} \frac{\partial\Gamma_1(\cdot)}{\partial q} & \frac{\partial\Gamma_1(\cdot)}{\partial N} \\ \frac{\partial\Gamma_2(\cdot)}{\partial q} & \frac{\partial\Gamma_2(\cdot)}{\partial N} \end{pmatrix} = \frac{\partial^2 C(\cdot)}{\partial a_O \partial(mq)}\frac{[A-b(n+1)q]\,b}{(1+bN)^2}m < 0 \tag{43}$$

it directly follows that $da_O/dN < 0$.

Use $dq/dN < 0$ in (5) to find $dCR/dN < 0$. Finally, use $PCM_{mult} = 1/(n|\varepsilon|)$ and note that $\frac{d|\varepsilon|}{dN} = \frac{d|\varepsilon|}{dq}\frac{dq}{dN} > 0$ to obtain $dPCM_{mult}/dN < 0$. Then, $dPCM_{ind}/dN < 0$ follows, according to (6). This completes the proof of Proposition 4. ■

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Table 1: Descriptrive Statistics

Variable	Full sample Mean	Std. Dev.	High-PCM sample Mean	Std. Dev.	Low-PCM sample Mean	Std. Dev.	Kruskall-Wallis test[a)] High-Pcm = Low-PCM
Price cost margin	0.16	0.10	0.22	0.12	0.12	0.04	1141.79 ***
Investment-output ratio	0.46	0.16	0.54	0.14	0.41	0.16	410.89 ***
Multinationality	0.60	0.14	0.60	0.14	0.59	0.14	34.27 ***
CR5	0.29	0.23	0.31	0.22	0.27	0.23	4.35 **
Final goods import-output ratio	0.78	4.07	0.59	1.15	0.93	5.28	0.28
Outsourcing	0.20	0.77	0.12	0.21	0.26	0.99	14.59 ***

*** significant at 1%; ** significant at 5%. - a) Distributed as $\chi^2(1)$.

Table 2: Outsourcing, Structure and Price Cost Margins in the EU (1991-1994-1998)
Fixed Effects Regression Results

Dependent Variable is Industry Price Cost Margin	Full Sample			High PCM			Low PCM		
Explanatory Variable[a)]	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Investment-output ratio (1)	0.309 ***	0.353 ***	0.449 ***	0.420 ***	0.473 ***	0.667 ***	0.287 ***	0.289 ***	0.335 ***
	(0.019)	*(0.019)*	*(0.018)*	*(0.034)*	*(0.047)*	*(0.044)*	*(0.009)*	*(0.008)*	*(0.008)*
Multinationality (2)	0.005	-0.001	-0.014	0.096	-0.014	0.020	0.087	0.087 **	0.092 **
	(0.073)	*(0.076)*	*(0.081)*	*(0.106)*	*(0.153)*	*(0.162)*	*(0.039)*	*(0.039)*	*(0.043)*
Twice lagged multinationality (3)	0.000	-0.002	0.004	-0.044	-0.009	-0.007	-0.028	-0.028	-0.033 *
	(0.030)	*(0.031)*	*(0.034)*	*(0.039)*	*(0.057)*	*(0.061)*	*(0.018)*	*(0.018)*	*(0.020)*
CR5 (4)	-0.014	-0.094 ***	-0.015	-0.145 ***	-0.161 **	-0.042	-0.006	-0.013	0.008
	(0.033)	*(0.029)*	*(0.028)*	*(0.053)*	*(0.063)*	*(0.057)*	*(0.015)*	*(0.013)*	*(0.013)*
Final goods import-output ratio (5)	-0.600 ***	-0.158 ***	-	-0.866 ***	-0.290 ***	-	-0.004	-0.013	-
	(0.111)	*(0.061)*	-	*(0.410)*	*(0.042)*	-	*(0.041)*	*(0.021)*	-
Interaction term (6): (4)*(5)	-0.026 ***	-	-	-0.005	-	-	-0.002	-	-
	(0.004)	-	-	*(0.007)*	-	-	*(0.002)*	-	-
Outsourcing (7)	0.490 ***	0.490 ***	-	0.755 ***	0.660 ***	-	0.328 ***	0.328 ***	-
	(0.041)	*(0.042)*	-	*(0.052)*	*(0.075)*	-	*(0.029)*	*(0.029)*	-
Interaction term (8): (2)*(7)	0.014	-	-	0.099 **	-	-	-0.004	-	-
	(0.019)	-	-	*(0.046)*	-	-	*(0.008)*	-	-
Interaction term (9): (4)*(7)	0.089 ***	-	-	0.377 ***	-	-	0.005	-	-
	(0.021)	-	-	*(0.056)*	-	-	*(0.009)*	-	-
Total imports (final plus intermediate goods) (10): (5) + (7)	-	-	-0.007	-	-	-0.090 **	-	-	0.041 *
	-	-	*(0.066)*	-	-	*(0.041)*	-	-	*(0.023)*
Constant	-0.119 *	-0.065	-0.027	-0.095 ***	-0.028	-0.120	-0.149 ***	-0.144 ***	-0.095 ***
	(0.061)	*(0.062)*	*(0.067)*	*(0.088)*	*(0.123)*	*(0.131)*	*(0.034)*	*(0.033)*	*(0.036)*
Number of Observations	2020	2020	2020	844	844	844	1176	1176	1176
Adj. R^2	0.97	0.96	0.95	0.98	0.96	0.95	0.99	0.99	0.99
Within R^2	0.43	0.36	0.32	0.71	0.41	0.42	0.77	0.73	0.71
Time Effects[b)]	5.96 ***	8.55 ***	11.50 ***	15.45 ***	5.32 ***	9.57 ***	14.65 ***	19.78 ***	13.69 ***
Country-Industry Effects[c)]	8.36 ***	5.60 ***	4.80 ***	7.06 ***	3.11 ***	2.68 ***	11.71 ***	12.16 ***	9.65 ***
Hausman Test[d)]	192.18 ***	154.53 ***	12.40 *	185.85 ***	235.59 ***	118.31 ***	3351.18 ***	203.86 ***	387.07 ***
Model 2 versus Model 1[e)]	39.72 ***	-	-	198.96 ***	-	-	0.52	-	-
Model 3 versus Model 1[f)]	32.84 ***	-	-	174.77 ***	-	-	1.50	-	-
Model 3 versus Model 2[g)]	-	11.21 ***	-	-	49.19 ***	-	-	4.42 **	-

a) Standard errors in parentheses. - b) Distributed as F(2,1328) for the full sample, as F(2,548) for the high-PCM sample and as F(2,769) for the low-PCM sample. - c) Distributed as F(680,1328) for the full sample, as F(284,548) for the high-PCM sample and as F(395,769) for the low-PCM sample. - d) Distributed as $\chi^2(11)$ in Model 1, $\chi^2(8)$ in Model 2, and $\chi^2(7)$ in Model 3. - e) Distributed as F(3,1328) for the full sample, as F(3,548) for the high-PCM sample and as F(3,769) for the low-PCM sample. - f) Distributed as F(4,1328) for the full sample, as F(4,548) for the high-PCM sample and as F(4,769) for the low-PCM sample. - g) Distributed as F(1,1331) for the full sample, as F(1,551) for the high-PCM sample and as F(1,772) for the low-PCM sample.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Marginal Effects of Outsourcing on Price Cost Margins in the EU (1991-1994-1998) Based on Preferred Model 3 Parameters

	Marginal effect of outsourcing (evaluated at means):		
	Full Sample	High PCM	Low PCM
Within estimator	0.507 ***	0.927 ***	0.327 ***
	(0.000)	*(0.000)*	*(0.000)*
Simultaneous quantiles regression (median)[a)]	0.556 ***	0.683 ***	0.373 ***
	(0.000)	*(0.000)*	*(0.000)*

P-values in parentheses. - a) With 100 repetitions; regression results not reported. - * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Assessing the Outsourcing Intensity Induced Change in PCM in EU12 Manufacturing (1991-1998)

Total manufacturing	Full sample	High-PCM sample	Low-PCM sample
Observed percentage point change in PCM 1991-98	-0.646	-1.190	-0.283
Observed-simulated percentage point change in PCM 1991-98	0.359 ***	-0.131 ***	0.515 ***
Analysis of variance of outsourcing-induced change in PCM:			
Within industries and countries in %	82.767 ***	81.714 ***	81.639 ***
Between countries in %	1.581	1.818	1.859
Between industries in %	15.652 ***	16.468 ***	16.501 ***

*** significant at 1%.