Cross-sectional heterogeneity in price-cost margins and the extent of rent sharing in France: Do R&D and innovation matter?

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Abstract

This paper studies cross-sectional heterogeneity in price-cost margins and the extent of rent sharing across 11603 French firms, investigating whether firm R&D intensity and innovation performance account for part of the estimated heterogeneity. The estimates of the average price-cost mark-up and extent of rent sharing amount to 1.762 and 0.648 respectively, while the corresponding estimates of their true dispersion are 0.715 and 0.212. Being a R&D firm or a product innovator affects the price-cost mark-up negatively in the lower tail of the distribution, while it exerts a positive effect on the extent of rent sharing in the upper quantiles.

JEL Classification : C23, D21, J50, L13.

1 Introduction

The aim of this paper is to study cross-sectional heterogeneity in price-cost margins and the extent of rent sharing across French (mainly manufacturing) firms, asking the question whether firm R&D intensity and innovation performance account for part of the estimated heterogeneity. To examine these important issues, we take advantage of a rich panel of French firms over the period 1978-2001. The sample is obtained by merging firm current account and balance sheet data with information on R&D and innovation (INSEE, SESSI, DEP, CIS 2, CIS 3). Methodologically, we follow Crépon-Desplatz-Mairesse (1999, 2002) and Dobbelaere (2004). By embedding an efficient bargaining type model in a microeconomic version of Hall's (1988) framework, we derive a reduced-form equation. Estimating this equation allows the identification of the firm price-cost margin and the extent of rent sharing.

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In the first part of the paper, we analyse whether the observed dispersion in the two parameters is true or whether it is merely a reflection of sampling variability. We estimate the true dispersion or true heterogeneity in the firm price-cost margin and the extent of rent sharing using the Swamy (1970) methodology (i.e., correcting the observed heterogeneity for sampling heterogeneity). Being based on individual firm regression estimates, the Swamy estimates are robust to the possibility of correlated effects (see Mairesse-Griliches, 1990). The estimates of the average price-cost margin and the average extent of rent sharing are respectively 1.762 and 0.648, while the corresponding estimates of their true dispersion are 0.715 and 0.212, which seems plausible given our prior expectation about a reasonable heterogeneity in both parameters. To investigate whether this heterogeneity is not an artefact of "outliers" and large sampling errors, we perform a cleaning experiment. This experiment confirms our previous conclusions. We also estimate the structural parameters at the sectoral level. The sectoral average price-cost mark-up and the average extent of rent sharing amount to 1.726 and 0.353 respectively.

In the second part of the paper, we investigate whether firm-level R&D intensity and innovation performance can explain the observed heterogeneity in price-cost margins and the extent of rent sharing. At the sectoral level, our quantile regression results show a strongly negative impact of being a R&D firm on the estimated price-cost mark-up in the lower tail of the distribution. The same effect is found on the estimated extent of rent sharing. The larger the share of R&D expenditure in sales, the stronger the negative effect on the estimated price-cost mark-up. Being a product innovator during the period 1994-1996 exerts a negative impact on the estimated price-cost mark-up as well as on the estimated extent of rent sharing in the 0.50 quantile. At the firm level, we find a strongly negative effect of being a R&D firm or a product innovator on the estimated price-cost mark-up in the lower tail of the distribution. In the upper quantiles, being a R&D firm or a product innovator affects the estimated extent of rent sharing positively.

Recently, an empirical literature has emerged that examines simultaneously imperfections in both the product and the labour market (Bughin, 1996; Crépon et al., 2002; Dobbelaere, 2004; Neven et al., 2002). Our analysis goes beyond the existing literature as it focuses on heterogeneity in price-cost margins and the extent of rent sharing at the *firm* level[1] and tries to identify factors explaining the observed firm-level heterogeneity.

We proceed as follows. Section 2 briefly presents our theoretical framework. In Section 3, we start by estimating the structural parameters of interest at the sectoral level. Consequently, we provide different estimators and indicators of heterogeneity in the firm price-cost margins and the extent of rent sharing. Section 4 concentrates on the role of firm-level R&D intensity and innovation performance in explaining the observed heterogeneity in both parameters at the sectoral as well as at the firm level. Section 5 concludes.

[1]The existing literature is limited to studying heterogeneity among sectors.

2 Theoretical Framework

Theoretically, we rely on a model of Crépon et al. (1999, 2002).[2] We start from a production function $Q_{it} = \theta_{it} F(N_{it},\, M_{it},\, K_{it})$, where i is a firm index, t a time index, N is labour, M is material input, K is capital and $\theta_{it} = Ae^{a_i + a_t + u_{it}}$ is an index of technical change or "true" total factor productivity. The logarithmic differentiation of the production function gives:

$$\Delta q_{it} = \varepsilon^{Q}_{N_{it}} \Delta n_{it} + \varepsilon^{Q}_{M_{it}} \Delta m_{it} + \varepsilon^{Q}_{K_{it}} \Delta k_{it} + \Delta \theta_{it} \tag{1}$$

We first assume that firms operate under imperfect competition in the product market and act as price takers in the input markets. Assuming that labour and material input are variable factors, short run profit maximization implies the following two first-order conditions:

$$\varepsilon^{Q}_{N_{it}} = \mu_{it} \alpha_{Nit} \tag{2}$$

$$\varepsilon^{Q}_{M_{it}} = \mu_{it} \alpha_{Mit} \tag{3}$$

where $\alpha_{Jit} = \frac{P_{Jit} J_{it}}{P_{it} Q_{it}}$ $(J = N,\, M)$ is the share of inputs in total revenue. $\mu_{it} = \frac{P_{it}}{C_{Q,it}}$ refers to the mark-up of price over marginal cost. Assuming constant returns to scale $\left(\varepsilon^{Q}_{N_{it}} + \varepsilon^{Q}_{M_{it}} + \varepsilon^{Q}_{K_{it}} = 1\right)$, the capital elasticity can be expressed as:

$$\varepsilon^{Q}_{K_{it}} = 1 - \mu_{it} \alpha_{Nit} - \mu_{it} \alpha_{Mit} \tag{4}$$

Inserting (2), (3) and (4) in (1) and rearranging terms gives following expression of the Solow Residual SR_{it}:

$$\begin{aligned} & \Delta q_{it} - \alpha_{Nit} \Delta n_{it} - \alpha_{Mit} \Delta m_{it} - (1 - \alpha_{Nit} - \alpha_{Mit}) \Delta k_{it} \\ = \; & (\mu_{it} - 1) \left[\alpha_{Nit} (\Delta n_{it} - \Delta k_{it}) + \alpha_{Mit} (\Delta m_{it} - \Delta k_{it}) \right] + \Delta \theta_{it} \\ = \; & \beta_{it} \left(\Delta q_{it} - \Delta k_{it} \right) + \left(1 - \beta_{it} \right) \Delta \theta_{it} \end{aligned} \tag{5}$$

where $\beta_{it} = \frac{P_{it} - C_{Q,it}}{P_{it}} = \frac{\mu_{it} - 1}{\mu_{it}}$ is the price-cost margin.

Let us now abstain from the assumption that labour is priced competitively. We assume that the union and the firm are involved in an Efficient Bargaining procedure, with both wages (w) and labour (N) being the subject of agreement. The union objective is to maximize $U(w_{it},\, N_{it}) = N_{it} w_{it} + (\overline{N}_{it} - N_{it}) \overline{w}_{it}$, where $\overline{N}$ is union membership $(0 < N_{it} \leq \overline{N}_{it})$ and $\overline{w}_{it} \leq w_{it}$ is the alternative wage. The firm objective is to maximize its short-run profit function:

[2] For technical details, see Crépon et al. (1999, 2002).

$\pi(w_{it},\, N_{it}) = R_{it} - w_{it}N_{it} - j_{it}M_{it}$. The outcome of the bargaining is the asymmetric generalized Nash solution to:

$$\max_{w_{it},\, N_{it},\, M_{it}} \left\{N_{it}w_{it} + \left(\overline{N}_{it} - N_{it}\right)\overline{w}_{it} - \overline{N}_{it}\overline{w}_{it}\right\}^{\phi_{it}} \left\{R_{it} - w_{it}N_{it} - j_{it}M_{it}\right\}^{1-\phi_{it}} \tag{6}$$

where $\phi_{it} \in [0,\, 1]$ represents the bargaining power of the union.
The first-order condition with respect to material input is $R_{Mit} = j_{it}$, which directly leads to the corresponding equation (3). Maximization with respect to the wage rate and labour respectively gives the following first-order conditions:

$$w_{it} = \overline{w}_{it} + \frac{\phi_{it}}{1-\phi_{it}}\left[\frac{R_{it} - w_{it}N_{it} - j_{it}M_{it}}{N_{it}}\right] \tag{7}$$

$$w_{it} = R_{Nit} + \phi_{it}\left[\frac{R_{it} - R_{Nit}N_{it} - j_{it}M_{it}}{N_{it}}\right] \tag{8}$$

Solving simultaneously (7) and (8), leads to an expression for the contract curve: $R_{Nit} = \overline{w}_{it}$, or a modified equation (2):

$$\varepsilon^{Q}_{N_{it}} = \mu_{it}\left(\frac{\overline{w}_{it}N_{it}}{P_{it}Q_{it}}\right) \tag{9}$$

Defining μ_{it} as $\varepsilon^{R}_{Q_{it}} = \left[\frac{R_{Q,it}Q_{it}}{R_{it}}\right]^{-1}$, the marginal revenue of labour can be expressed as $R_{N,it} = \frac{P_{it}Q_{N,it}}{\mu_{it}}$. Using this expression of $R_{N,it}$, (8) can be rewritten as $\alpha_{Nit} = \phi_{it}\left(1-\alpha_{Mit}\right) + \left(1-\phi_{it}\right)\frac{\varepsilon^{Q}_{N_{it}}}{\mu_{it}}$.
Rewriting $\varepsilon^{Q}_{N_{it}} = \mu_{it}\alpha_{Nit} + \mu_{it}\frac{\phi_{it}}{1-\phi_{it}}\left(\alpha_{Nit} + \alpha_{Mit}\right) - 1)$, an extra term shows up in the expression of the Solow Residual:[3]

$$\begin{aligned} & \Delta q_{it} - \alpha_{Nit}\Delta n_{it} - \alpha_{Mit}\Delta m_{it} - (1-\alpha_{Nit}-\alpha_{Mit})\Delta k_{it} \\ = \; & \beta_{it}\left(\Delta q_{it} - \Delta k_{it}\right) + \frac{\phi_{it}}{1-\phi_{it}}\left(\alpha_{Nit} + \alpha_{Mit} - 1\right)\left(\Delta n_{it} - \Delta k_{it}\right) \\ & + \left(1-\beta_{it}\right)\Delta\theta_{it} \end{aligned} \tag{10}$$

By embedding the Efficient Bargaining model into a microeconomic version of Hall's (1988) framework, the Solow Residual can be decomposed into three components: (1) a factor representing the price-cost margin, (2) a factor reflecting the relative bargaining power and (3) a technological term. The advantages of the extended approach are twofold: it avoids the problematic computation of the user cost of capital to assess the magnitude of the price-cost mark-up and it avoids the measurement of the alternative wage to estimate the extent of rent sharing.

[3] Note that to accomodate two imperfectly competitive markets, we need at least two variable input factors to identify the model. Going beyond Hall (1988) is hence not possible when starting from a value added specification.

3 Cross-sectional heterogeneity in price-cost margins and the extent of rent sharing

In this section, we first present the data. Second, we ignore firm-level heterogeneity and estimate the structural parameters of interest (μ and ϕ) at the sectoral level. Finally, we investigate potential heterogeneity in price-cost margins and the extent of rent sharing across French (mainly manufacturing) firms. Our main question is whether the observed dispersion is just a reflection of sampling variability or whether it is an indication of real heterogeneity.

3.1 Data description

We use an unbalanced panel of French firms over the period 1978-2001. This sample has been constructed by merging accounting information of firms from EAE ("Enquête Annuelle d' Entreprise", "Service des Etudes et Statistiques Industrielles" (SESSI)) with data of Research & Development collected by DEP ("Ministère de l' Education et de la Recherche"). We only keep firms for which we have at least 12 years of observations, ending up with an unbalanced panel of 11603 firms with the number of observations for each firm varying between 12 and 24.[4] The R&D surveys (DEP) provide three R&D variables: a dichotomous R&D indicator, total R&D expenditure and R&D expenditure on personnel. R&D firms are identified through the R&D indicator. We consider two subsamples: the pure non-R&D firms (11005 firms) and the pure R&D firms for which we have data on R&D expenditure for at least 12 years (598 firms). We use real current production deflated by the two-digit producer price index of the French industrial classification as a proxy for output (Q). Labour (N) refers to the average number of employees in each firm for each year and material input (M) refers to intermediate consumption deflated by the two-digit intermediate consumption price index. The capital stock (K) is proxied by fixed capital. The shares of labour (α_N) and material input (α_M) are constructed by dividing respectively the firm total labour cost and undeflated intermediate consumption by the firm undeflated production and by taking the average of these ratios over adjacent years. Table 1 reports the means, standard deviations and first and third quartiles of our main variables.

<Insert Table 1 about here>

3.2 Estimation method and results

We impose that $\beta_{it} = \beta = \frac{\mu-1}{\mu}$ and $\phi_{it} = \phi$ in the empirical specifications at the sectoral level,and $\beta_t = \beta = \frac{\mu-1}{\mu}$ and $\phi_t = \phi$ in those at the firm

[4] Putting the number of firms between brackets and the number of observations between square brackets, the structure of the data is given by: (1435) [12], (1305) [13], (1225) [14], (1431) [15], (4744) [16], (168) [17], (169) [18], (160) [19], (124) [20], (99) [21], (112) [22], (109) [23], (522) [24].

level. Consistent with the assumption of constancy of μ and ϕ, we also assume constant firm-level input shares.[5]

3.2.1 Sector-level results

We estimate the following specification for each sector j :[6]

$$\begin{aligned} SR_{it} &= \Delta q_{it} - \left(\frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Nit}\right)\Delta n_{it} - \left(\frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Mit}\right)\Delta m_{it} \\ &\quad - \left(1 - \frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Nit} - \frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Mit}\right)\Delta k_{it} \\ &= \beta\left(\Delta q_{it} - \Delta k_{it}\right) + \\ &\quad \frac{\phi}{1-\phi}\left(\frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Nit} + \frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Mit} - 1\right)\left(\Delta n_{it} - \Delta k_{it}\right) + \zeta_{it} \end{aligned} \tag{11}$$

where $\beta = \frac{\mu-1}{\mu}$ and n_t denotes the number of years within firm i.
Since transitory productivity shocks might affect changes in factor inputs (Δn, Δm and Δk), and since the production price is endogenous to our model, Ordinary Least Squares (OLS) estimates of the reduced-form coefficients and the corresponding structural estimates are likely to be biased and inconsistent. To avoid such biases and to take into account endogeneity problems, we estimate (11) for each sector by the Generalized Method of Moments (GMM) technique. More specifically, we use as instruments the 2- and 3-period lagged values of the growth of the input factors Δn, Δm and Δk. The exogeneity of the instruments with respect to the error term is tested by the Sargan test statistic which is distributed as chi-squared. To capture possible unobservable aggregate shocks and productivity shocks common to all firms within sector j in a given year, we include time dummies. Estimation is carried out using the Dynamic Panel Data program, which works with the Ox programming language (Doornik et al., 2002).
We decompose the total sample into 48 sectors (46 manufacturing sectors, 1 energy and 1 construction sector) according to the French industrial classification ("Nomenclature économique de synthèse - Niveau 3" [NES 114]). Table 2 shows the sector repartition of the sample and the estimated structural parameters ($\hat{\mu}_j$ and $\hat{\phi}_j$) for each sector j which are computed from the two-step estimated values of the reduced-form coefficients. The standard errors (σ) are computed

[5]Variation in input shares is idiosyncratic and possibly related to variation in hours of work, machinery, capacity utilization (variation in the business cycle). When estimating our parameters of interest, we want to abstract from this possible source of contamination.

[6]We also estimated the specification with firm- and time-varying input shares within each sector j: $\widehat{SR}_{it} = \Delta q_{it} - \alpha_{Nit}\Delta n_{it} - \alpha_{Mit}\Delta m_{it} - (1-\alpha_{Nit} - \alpha_{Mit})\Delta k_{it} = \beta\left(\Delta q_{it} - \Delta k_{it}\right) + \frac{\phi}{1-\phi}\left(\alpha_{Nit} + \alpha_{Mit} - 1\right)\left(\Delta n_{it} - \Delta k_{it}\right) + \varsigma_{it}$.

using the Delta Method (Woolridge, 2002).[7] For all reported results, we can never reject the null hypothesis that the instruments are valid on the basis of the Sargan test. For all sectors, the ratio of price over marginal cost is significantly larger than one at the 1% level and -except for 8 sectors- the extent of rent sharing is significantly positive. The average price-cost mark-up and the average extent of rent sharing amount to 1.726 and 0.353 respectively.[8] The correlation between the two estimated structural parameters is 0.513. When we pool all sectors and assume constant firm-level input shares, the overall average price-cost mark-up and extent of rent sharing are estimated at 1.526 and 0.480 respectively.[9]

<Insert Table 2 about here>

3.2.2 Firm-level results

We now address the question whether there is real heterogeneity in price-cost mark-ups and the extent of rent sharing at the firm level. For each firm i, we estimate the following specification:[10]

$$\begin{aligned} SR_t &= \Delta q_t - \left(\frac{1}{n_t} \sum_{t=1}^{n_t} \alpha_{Nt} \right) \Delta n_t - \left(\frac{1}{n_t} \sum_{t=1}^{n_t} \alpha_{Mt} \right) \Delta m_t \\ &\quad - \left(1 - \frac{1}{n_t} \sum_{t=1}^{n_t} \alpha_{Nt} - \frac{1}{n_t} \sum_{t=1}^{n_t} \alpha_{Mt} \right) \Delta k_t \qquad (12) \\ &= \beta \left(\Delta q_t - \Delta k_t \right) + \frac{\phi}{1-\phi} \left(\frac{1}{n_t} \sum_{t=1}^{n_t} \alpha_{Nt} + \frac{1}{n_t} \sum_{t=1}^{n_t} \alpha_{Mt} - 1 \right) \left(\Delta n_t - \Delta k_t \right) + \varepsilon_t \end{aligned}$$

We estimate (12) for each of the 11603 firms by the Two-Stage Least Squares (TSLS) method and use the 2-period lagged values of Δn, Δm and Δk as instruments.[11] As mentioned above, the number of observations for each firm varies between 12 and 24.

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[7] $\sigma_{\widehat{\mu}} = \frac{\sigma_{\widehat{\frac{\mu}{1-\mu}}}}{(1-\widehat{\frac{\mu}{1-\mu}})^2}$; $\sigma_{\widehat{\phi}} = \frac{\sigma_{\widehat{\frac{\sigma}{1-\phi}}}}{\left(1+\widehat{\frac{\phi}{1-\phi}}\right)^2}$.

[8] When we estimate the structural parameters $\hat{\mu}_j$ and $\hat{\phi}_j$, dropping the constraint that firm-level input shares are constant, the average price-cost mark-up and the average extent of rent sharing are found to be respectively 1.572 and 0.140 and the correlation between the two estimated parameters amounts to 0.530.

[9] Results not reported but available upon request. Note that we use the 3- and 4-period lagged values of Δn, Δm and Δk to estimate the structural parameters at the overall level since the estimates do not satisfy the Sargan test when using the 2- and 3-period lagged values.

[10] We also report the results of the specification with time-varying input shares within each firm i: $\widetilde{SR}_t = \Delta q_t - \alpha_{Nt}\Delta n_t - \alpha_{Mt}\Delta m_t - (1-\alpha_{Nt}-\alpha_{Mt})\Delta k_t = \beta(\Delta q_t - \Delta k_t) + \frac{\phi}{1-\phi}(\alpha_{Nt} + \alpha_{Mt} - 1)(\Delta n_t - \Delta k_t) + \varrho_t$.

[11] Besides allowing for the possible heterogeneity across firms, we could also focus on the stability of the structural parameters over time. However, relaxing the constancy of μ_i and ϕ_i in the time dimension would strain our already overextended computational framework.

Table 3 presents the TSLS-results of estimating (12) [Specification (1)] and a variant of (12) with time-varying firm input shares [Specification (2)] in a comprehendible fashion. The first row lists the simple averages of the individually estimated reduced-form coefficients (columns 1 and 3) and the derived structural parameters $\hat{\mu}_i$ (column 2) and $\hat{\phi}_i$ (column 4). The second row reports the weighted average where the weight is defined as the inverse of the square root of the sampling variance. The median values are given in the third row. Focusing on the specification with constant firm-level input shares, the median value of the price-cost mark-up $\hat{\mu}_i$ and the extent of rent sharing $\hat{\phi}_i$ are estimated at 1.610 and 0.770 respectively. The fourth row displays the robust observed variance (dispersion). A robust estimated dispersion sd_o of 1.427 for $\hat{\mu}_i$ and 0.270 for $\hat{\phi}_i$ is however not credible given our prior expectation about a reasonable heterogeneity in both parameters. To illustrate the enormous dispersion in the estimated structural parameters, Figures A.1 and A.2 in Appendix plot the distribution of the estimated structural parameters $\hat{\mu}_i$ and $\hat{\phi}_i$ against their estimated precision (the inverse of their standard errors). The figures clearly show that the heterogeneity at the firm level is largely magnified by the large sampling errors arising from the rather short time series available. The fifth row in Table 3 reports the robust sampling variance (dispersion). To determine the "true" dispersion or heterogeneity in the individual $\hat{\mu}_i$'s and $\hat{\phi}_i$'s, we follow the Swamy (1970) methodology. This method allows us to estimate the variance components of heterogeneity, i.e. the pure sampling variance and the true amount of dispersion. Being based on individual firm regression estimates, the Swamy estimates are robust to the possibility of correlated effects (see Mairesse-Griliches, 1990). Row 6 lists the Swamy estimates which are computed as the difference between the robust observed variance of the individually estimated $\hat{\mu}_i$ and $\hat{\phi}_i$ and the median of the corresponding robust sampling variance. Concentrating on Specification (1), the estimates of true dispersion of 0.715 for $\hat{\mu}_i$ and 0.212 for $\hat{\phi}_i$ are good indicators of a credible amount of heterogeneity. Row 7 reports the F-statistic for the hypothesis of equality of the parameter estimates across firms. Given the large number of degrees of freedom, all the F-statistics are significant at conventional significance levels (the critical value barely exceeds 1 for our sample size). Hence, the hypothesis of homogeneity is clearly rejected.

<Insert Table 3 about here>

To investigate whether the observed heterogeneity is not just an artefact of outliers and large sampling errors, we performed a cleaning experiment. We eliminated all firms for which the sampling variance of $\hat{\mu}_i$ ($\hat{\phi}_i$) exceeded 1 (0.1), ending up with 2905 firms. Our results point to a median value of $\hat{\mu}_i$ ($\hat{\phi}_i$) of 1.539 (0.785) and a true dispersion of 0.354 for $\hat{\mu}_i$ and 0.134 for $\hat{\phi}_i$. Our previous conclusion is confirmed: we clearly find persistent individual firm differences in the estimated $\hat{\mu}_i$'s and $\hat{\phi}_i$'s.

When we split up the full sample into the R&D subsample (598 firms) and the non-R&D subsample (11005 firms), we do not find any significantly different results between the two subsamples except that there are no individual firm differences in the $\hat{\mu}_i$'s in the R&D subsample.[12]

4 Do R&D and innovation explain part of the observed heterogeneity in $\hat{\mu}$ and $\hat{\phi}$?

Given the observed heterogeneity in price-cost marginds and the extent of rent sharing, we investigate in this section whether firm-level technology variables, measured by firm-level R&D intensity and innovation performance, explain part of the observed heterogeneity. First, we discuss the data. Second, we analyse whether the technology variables influence $\hat{\mu}$ and $\hat{\phi}$ at the sectoral level. Finally, we move to the firm level.

4.1 Data description

Similar to the first part of the analysis, we merge the R&D information (DEP) with accounting information of firms from EAE (SESSI). We identify R&D firms through the dichotomous R&D indicator and construct four R&D intensity indicators: total R&D expenditure divided by sales, R&D expenditure on personnel divided by sales, total R&D expenditure divided by the number of employees and R&D expenditure on personnel divided by the number of employees.
The innovation variables are taken from the second and third Community Innovation Surveys (CIS 2 and CIS 3). We use a dichotomous indicator of product innovation, which makes the distinction between product innovations new to the firm and product innovations new to the market, and two quantitative or intensity indicators of both types of product innovations (see Mairesse-Mohnen, 2005). The latter variables are measured by respectively the share of sales accounted for by substantially improved or new products to the firm and the share of sales accounted for by products new to the market; both subject to having introduced such a product in respectively the firm or the market during the last 3 years. Our selection of firms being innovators as opposed to non-innovators is based on the filter question whether the firm has introduced in 1994-1996 (CIS 2) or in 1998-2000 (CIS 3) a substantially improved or entirely new product to the firm (but not necessarily new to the market) or a product new to the market which indicates a more fundamental innovation. A firm answering no to this filter question is considered as a non-innovator.[13] We merge the innovation data with the sample constructed in the first part of the analysis. Table 4 presents the sample averages of the R&D and the innovation variables and two additional control variables used in the analysis (capital intensity measured as fixed capital divided by sales and employment). In the last part of the table, we

[12]The median values of $\hat{\mu}_i$ and $\hat{\phi}_i$ are 1.527 and 0.762 for the R&D subsample and 1.615 and 0.771 for the non-R&D subsample. The corresponding true dispersion is 0 ($\hat{\mu}_i$) and 0.187 ($\hat{\phi}_i$) for the R&D subsample, and 0.722 ($\hat{\mu}_i$) and 0.212 ($\hat{\phi}_i$) for the non-R&D subsample.

[13]Note that we did not take into account the timing of CIS 2 versus CIS 3, i.e. we run the regressions with the CIS 2 and the CIS 3 variables separately.

make the stringent assumption that a firm is only considered as an innovative firm if it has introduced a new product in the firm or in the market during the period 1994-1996 as well as during the period 1998-2000. Put differently, the filter question has to be answered affirmatively in both the CIS 2 and the CIS 3 survey.

<Insert Table 4 about here>

4.2 Estimation method and results

4.2.1 Estimation method

As a benchmark, we start by estimating R&D and innovation effects on price-cost mark-ups and the extent of rent sharing by conventional Ordinary Least Squares (OLS), hence focusing on average effects. However, this mean regression may hide how the covariates affect the response variables $\hat{\mu}$ and $\hat{\phi}$ differently at different points of the conditional distribution of these structural parameters. Our main results are therefore based on the Quantile Regression (QR) method (Koenker and Bassett, 1978). The quantile regression estimator is particularly useful to our analysis since it gives less weight to outlier data points of the dependent variables $\hat{\mu}$ and $\hat{\phi}$ than OLS. Additionally, the semi-parametric nature of the approach, relaxing the constancy of the parameter estimates across the entire distribution of the dependent variables, guarantees robustness to potential heteroscedasticity.
For quantile τ of $\mathbf{y}$, the regression model is specified as:

$$\mathbf{y} = \mathbf{X}^{'}\boldsymbol{\beta}_{\tau} + \boldsymbol{\upsilon}_{\tau} \qquad \forall \tau \in \ (0,1) \tag{13}$$

where $\mathbf{y}$ is a $n \times 1$ vector of dependent variables, $\mathbf{X}^{'}$ is a $n \times k$ matrix of explanatory variables, $\boldsymbol{\beta}$ a $k \times 1$ vector of coefficients and $\boldsymbol{\upsilon}$ is the error term with distribution not necessarily known. The τ^{th} quantile regression estimator is the solution to the minimization of the weighted sum of the absolute residuals:

$$\widehat{\boldsymbol{\beta}}_{\tau} = \arg\min_{\boldsymbol{\beta}} \left\{ \sum_{\{\mathbf{y} \succeq \mathbf{X}^{'}\beta\}} \tau \left| \mathbf{y} - \mathbf{X}^{'}\boldsymbol{\beta} \right| + \sum_{\{\mathbf{y} < \mathbf{X}^{'}\beta\}} (1-\tau) \left| \mathbf{y} - \mathbf{X}^{'}\boldsymbol{\beta} \right| \right\} \tag{14}$$

From (14), it is clear that the marginal effects of the covariates $\left(\widehat{\boldsymbol{\beta}}_{\tau}\right)$ may differ over quantiles. In our analysis, we focus on the 0.25, the 0.50 and the 0.75 quantile.

4.2.2 Sector-level results

At this stage, the dependent variable is either the vector of estimated $\hat{\mu}_j$'s or the vector of estimated $\hat{\phi}_j$'s $(j = 1, ..., 48)$ obtained from the first part of our analysis. For each of these dependent variables, we have two different matrices of regressors. The first set consists of the R&D identifier, the R&D identifier multiplied by each of the four different R&D intensiy measures, capital intensity, the real average sectoral wage and employment. The second set contains for both types of innovative firms, a (product) innovation dummy, the innovation dummy multiplied by the innovation intensity measure (the share of innovative sales), capital intensity, the real average sectoral wage and employment. Except for the R&D identifier, the innovation dummy and the share of innovative sales, all explanatory variables are specified in logs.[14]

The OLS and the quantile regression coefficients of the set of regressors explaining the vector of estimated $\hat{\mu}_j$'s ($\hat{\phi}_j$'s) are reported in Table 5 (Table 6). As far as the effect of R&D is concerned, we only report the regression results using total R&D expenditure divided by sales or employment as R&D intensity measure. The results using R&D expenditure on personnel divided by sales or employment are very similar to these results. Concerning the effect of innovation performance, we report the regression results using innovation variables of respectively the CIS 2 and CIS 3 survey and results merging the information of both surveys. All tables show the regression coefficients for type A-firms (firms innovating with products new to the firm). The regression coefficients of the innovation variables for type B-firms (firms innovating with products new to the market) are displayed in italics.

Focusing on the effect of R&D on the estimated sectoral price-cost mark-up (upper part of Table 5), we find a strongly negative impact of being a R&D firm in the 0.25 and the 0.50 quantile. The larger the share of R&D expenditure in sales, the stronger this negative effect. Concentrating on the impact of innovation performance (lower part of Table 5), the results show that being a type A-innovator during the period 1994-1996 exerts a significantly negative effect on the estimated price-cost mark-up in the 0.50 quantile. If we impose the restriction that firms are only considered as innovators if they innovate in both the 1994-1996 and the 1998-2000 period, we find a significantly positive effect of being an innovator in the 0.25 quantile which turns into a negative effect in the 0.75 quantile. The larger the share of innovative sales in these innovative firms, the weaker the positive effect in the 0.25 quantile. Concentrating on the role of R&D and innovation performance in explaining the vector of estimated $\hat{\phi}_j$'s (Table 6), we find also a strongly negative impact of being a R&D firm, which increases with the share of R&D expenditure in sales, on the estimated extent of rent sharing in the lower tail of the distribution (0.25 quantile). Being a type A-innovator during the period 1994-1996 or the period 1998-2000, affects the estimated extent of rent sharing negatively in the 0.50 and the 0.75 quantile.

<Insert Table 5 and Table 6 about here>

[14] All sector-level regressors are obtained by taking the mean of the firm-level regressors within each sector.

4.2.3 Firm-level results

The dependent variable is either the vector of estimated $\hat{\mu}_i$'s or the vector of estimated $\hat{\phi}_i$'s $(i = 1, ..., 11603)$[15] obtained from the first part of our analysis. For each of these dependent variables, we use the same sets of regressors as for the sectoral analysis. In addition, we also control for sector effects.
Table 7 (Table 8) reports the regression results of the effect of firm R&D and innovation on the vector of estimated $\hat{\mu}_i$'s ($\hat{\phi}_i$'s). Consistent with the sector-level results, we find a strongly negative impact of being a R&D firm on the estimated price-cost mark-up in the lower tail of the distribution (0.25 quantile). The same impact is found of being a type A- or type B-innovator in the 1994-1996 period, the 1998-2000 period or both periods. The larger the share of innovative sales in the 1998-2000 period, the stronger the negative effect. The effects of R&D and innovation performance on the estimated firm-level extent of rent sharing (Table 8) differ considerably from the sector-level results. The first part of Table 8 shows a significantly positive effect of being a R&D firm on the estimated extent of rent sharing in the upper quantiles. The larger the share of R&D expenditure in sales, the stronger the effect. Consistent with these results, we find that being a type A-innovator during the period 1994-1996 or the period 1998-2000 exerts a significantly positive impact on the estimated extent of rent sharing in the upper tail of the distribution.

<Insert Table 7 and Table 8 about here>

5 Conclusion

This paper focuses on cross-sectional heterogeneity in price-cost margins and the extent of rent sharing across French (mainly manufacturing) firms and identifies the role of firm R&D intensity and innovation performance in explaining part of the heterogeneity. Using a sample of 11603 firms, we estimate first the true dispersion or true heterogeneity in both parameters using the Swamy (1970) methodology. The estimates of the firm-level average price-cost mark-up and extent of rent sharing amount to 1.762 and 0.648 respectively, while the corresponding estimates of their true dispersion are 0.715 and 0.212. Starting from the finding of persistent individual firm differences in the estimated structural parameters, we investigate in the second part of the paper whether firm-level R&D intensity and innovation performance account for part of the estimated heterogeneity. Our quantile regression results show a strongly negative effect of being a R&D firm or a product innovator on the estimated firm-level price-cost mark-up in the lower tail of the distribution. In the upper quantiles, we find a significantly positive impact of being a R&D firm or a product innovator on the estimated firm-level extent of rent sharing.

[15] Since we merge the innovation data with the sample constructed in the first part of the analysis, we end up with only 1862 firms when using the CIS 2 survey, 1974 firms when using the CIS 3 survey and 3131 firms when using both surveys.

Appendix

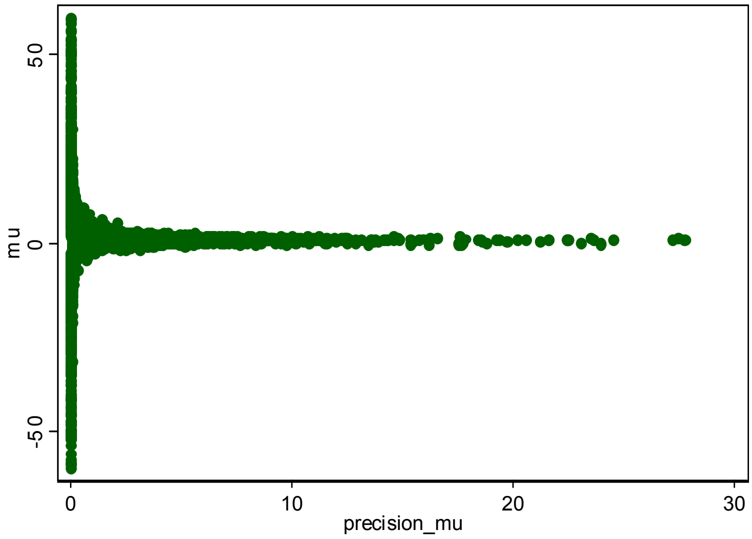

Figure A.1. Mu ($\hat{\mu}_i$) - precision mu

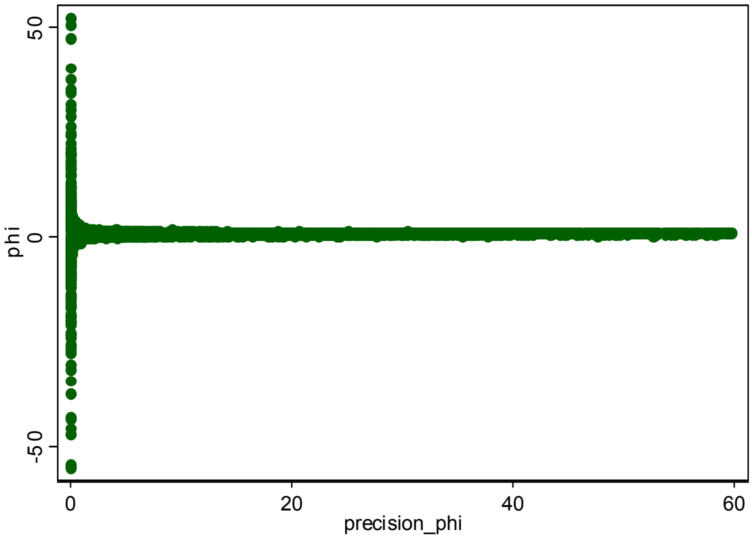

Figure A.2. Phi ($\hat{\phi}_i$) - precision phi

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Table 1
Summary statistics

Variables	1978-2001				
	Mean	Sd.	Q_1	Q_3	N
Real firm output growth rate Δq	0.023	0.286	-0.066	0.110	168113
Labour growth rate Δn	0.006	0.237	-0.046	0.060	168113
Capital growth rate Δk	-0.003	0.318	-0.077	0.063	168113
Materials growth rate Δm	0.045	0.394	-0.069	0.151	167934
Labour share in nominal output α_N	0.314	0.143	0.210	0.398	168113
Materials share in nominal output α_M	0.497	0.174	0.389	0.616	168113
Solow residual SR^a	-0.0003	0.144	-0.059	0.059	167934
$\Delta q - \Delta k$	0.026	0.258	-0.086	0.136	168113
$(\alpha_N + \alpha_M - 1)(\Delta n - \Delta k)$	-0.001	0.059	-0.001	0.010	168113

^{a} $SR = \Delta q - \alpha_N \Delta n - \alpha_M \Delta m - (1 - \alpha_N - \alpha_M)\Delta k$.

Table 2
Sector analysis: Sector repartition and estimated sector-level structural parameters $\hat{\mu}_j$ and $\hat{\phi}_j$

	Code	Name	# Obs. (# Firms)	$\hat{\beta}_j = \widehat{\frac{\mu_j}{1-\mu_j}}$	Mark-up $\hat{\mu}_j$	$\widehat{\frac{\phi_j}{1-\phi_j}}$	Rent sharing $\hat{\phi}_j$
Sec 1	B01	Meat preparations	6848 (458)	0.303*** (0.059)	1.427*** (0.121)	0.145 (0.163)	-0.167 (0.224)
Sec 2	B02	Milk products	1781 (114)	0.296*** (0.079)	1.413*** (0.129)	0.113 (0.295)	0.093 (0.233)
Sec 3	B03	Beverages	1739 (108)	0.359*** (0.064)	1.587*** (0.137)	0.604** (0.298)	0.397*** (0.090)
Sec 4	B04	Food production for animals	1867 (122)	0.282*** (0.045)	1.393*** (0.075)	-0.005 (0.284)	-0.012 (0.217)
Sec 5	B05	Other food products	8148 (538)	0.416*** (0.046)	1.662*** (0.134)	0.650*** (0.176)	0.347*** (0.089)
Sec 6	C11	Clothing and skin goods	7717 (499)	0.413*** (0.043)	1.700*** (0.120)	0.902*** (0.267)	0.457*** (0.064)
Sec 7	C12	Leather goods and footwear	3485 (215)	0.402*** (0.063)	1.714*** (0.203)	0.725*** (0.262)	0.444*** (0.084)
Sec 8	C20	Publishing, (re)printing	11840 (778)	0.374*** (0.055)	1.531*** (0.130)	0.621** (0.309)	0.366*** (0.123)
Sec 9	C31	Pharmaceutical products	1441 (87)	0.427*** (0.077)	1.888*** (0.187)	0.504 (0.408)	0.388*** (0.104)
Sec 10	C32	Soap, perfume and maintenance products	1376 (84)	0.381*** (0.056)	1.526*** (0.101)	0.721*** (0.172)	0.331*** (0.084)
Sec 11	C41	Furniture	4983 (324)	0.392*** (0.036)	1.634*** (0.109)	0.898*** (0.239)	0.456*** (0.081)
Sec 12	C42	Jewellery and musical instruments	984 (61)	0.448*** (0.095)	1.850*** (0.185)	1.592*** (0.591)	0.576*** (0.069)
Sec 13	C43	Sport articles, games and other products	2282 (151)	0.427*** (0.053)	1.614*** (0.130)	0.764*** (0.228)	0.384*** (0.096)
Sec 14	C46	Optical and photographic instruments, clockwork	1126 (73)	0.414*** (0.077)	1.693*** (0.164)	1.297*** (0.488)	0.457*** (0.088)
Sec 15	D01	Motor vehicles	2124 (137)	0.337*** (0.052)	1.580*** (0.116)	0.219 (0.248)	0.162 (0.151)
Sec 16	D02	Transport equipment	1537 (91)	0.441*** (0.066)	1.858*** (0.185)	0.439 (0.313)	0.312*** (0.113)
Sec 17	E11-E14	Ship building, aircraft and railway construction	1761 (109)	0.381*** (0.074)	1.667*** (0.155)	1.309*** (0.519)	0.584*** (0.083)
Sec 18	E21	Metal products for construction	3275 (219)	0.274*** (0.044)	1.488*** (0.105)	1.229* (0.770)	0.570*** (0.102)
Sec 19	E22	Ferruginous and steam boilers	5965 (399)	0.492*** (0.042)	2.062*** (0.187)	2.936*** (0.559)	0.732*** (0.040)
Sec 20	E23	Mechanical equipment	2527 (157)	0.446*** (0.068)	1.855*** (0.205)	0.737** (0.325)	0.412*** (0.096)
Sec 21	E24	Machinery for general usage	4524 (296)	0.318*** (0.055)	1.581*** (0.130)	0.408 (0.349)	0.326** (0.138)
Sec 22	E25-E26	Agriculture machinery	1928 (127)	0.292*** (0.068)	1.392*** (0.098)	0.582 (0.491)	0.287 (0.206)
Sec 23	E27	Other machinery for specific usage	4302 (285)	0.446*** (0.063)	1.679*** (0.139)	1.285** (0.619)	0.458*** (0.151)
Sec 24	E31-E32	Office and electronic machinery	1220 (79)	0.343*** (0.097)	1.589*** (0.198)	0.631* (0.384)	0.361*** (0.127)
Sec 25	E33	Emission and transmission equipment	905 (61)	0.242** (0.112)	1.333*** (0.114)	0.071 (0.787)	-0.944 (1.757)
Sec 26	E34	Orthopaedic equipment	1156 (76)	0.440*** (0.101)	1.621*** (0.277)	0.930* (0.499)	0.331** (0.170)
Sec 27	E35	Precision instruments	1807 (122)	0.351*** (0.059)	1.540*** (0.144)	1.387* (0.796)	0.434** (0.196)
Sec 28	F11-F12	Mineral products	3043 (202)	0.425*** (0.054)	1.881*** (0.171)	0.832*** (0.287)	0.492*** (0.054)
Sec 29	F13	Glass products	1458 (92)	0.398*** (0.070)	1.925*** (0.178)	0.873*** (0.340)	0.487*** (0.069)

Table 2 (ctd)

Sector analysis: Sector repartition and estimated sector-level structural parameters $\hat{\mu}_j$ and $\hat{\phi}_j$

	Code	Name	# Obs. (# Firms)	$\hat{\beta}_j = \widehat{\frac{\mu_j}{1-\mu_j}}$	Mark-up $\hat{\mu}_j$	$\widehat{\frac{\phi_j}{1-\phi_j}}$	Rent sharing $\hat{\phi}_j$
Sec 30	F14	Earthenware products and construction material	5986 (387)	0.454*** (0.057)	1.821*** (0.188)	0.524*** (0.215)	0.356*** (0.088)
Sec 31	F21	Textile art	4467 (280)	0.399*** (0.044)	1.705*** (0.121)	0.590*** (0.209)	0.379*** (0.085)
Sec 32	F22	Textile products	3489 (224)	0.384*** (0.053)	1.694*** (0.132)	0.400* (0.240)	0.295*** (0.119)
Sec 33	F23	Clothing	1471 (93)	0.411*** (0.059)	1.831*** (0.144)	1.205*** (0.423)	0.553*** (0.057)
Sec 34	F31	Wooden products	7559 (495)	0.416*** (0.036)	1.743*** (0.104)	0.741*** (0.175)	0.433*** (0.053)
Sec 35	F32-F33	Paper and printing products	4925 (306)	0.356*** (0.046)	1.546*** (0.101)	0.343* (0.186)	0.266*** (0.100)
Sec 36	F41-F42	Mineral and organic chemical products	1166 (73)	0.457*** (0.087)	1.934*** (0.264)	0.645* (0.400)	0.451*** (0.102)
Sec 37	F43	Parachemical products	1736 (110)	0.386*** (0.056)	1.782*** (0.162)	-0.040 (0.185)	-0.019 (0.174)
Sec 38	F45	Rubber products	1083 (70)	0.458*** (0.096)	1.958*** (0.242)	0.380 (0.344)	0.279** (0.127)
Sec 39	F46	Transformation of plastic products	8323 (552)	0.353*** (0.044)	1.537*** (0.107)	0.685*** (0.262)	0.400*** (0.091)
Sec 40	F51-F52	Steel products, non-ferrous metals	1735 (108)	0.456*** (0.048)	1.854*** (0.174)	0.532** (0.274)	0.360*** (0.085)
Sec 41	F53	Ironware	1853 (115)	0.469*** (0.036)	1.876*** (0.124)	1.214*** (0.192)	0.553*** (0.038)
Sec 42	F54	Industrial service to metal products	14937 (991)	0.512*** (0.049)	2.109*** (0.185)	1.690*** (0.325)	0.630*** (0.040)
Sec 43	F55	Metal products	7603 (487)	0.525*** (0.058)	2.080*** (0.238)	1.020*** (0.245)	0.505*** (0.057)
Sec 44	F56	Recuperation	1178 (80)	0.563*** (0.083)	2.151*** (0.365)	0.371** (0.185)	0.235** (0.104)
Sec 45	F61	Electrical goods	3295 (206)	0.332*** (0.047)	1.497*** (0.104)	0.257 (0.268)	0.217 (0.166)
Sec 46	F62	Electrical components	1361 (91)	0.419*** (0.074)	1.712*** (0.154)	1.098*** (0.358)	0.520*** (0.066)
Sec 47	F62	Energy	1304 (87)	0.561*** (0.057)	2.266*** (0.304)	1.130*** (0.356)	0.528*** (0.068)
Sec 48	G11-G15, G21-G22	Construction	1165 (80)	0.480*** (0.079)	2.081*** (0.311)	0.894*** (0.356)	0.485*** (0.025)

Manufacturing industry (Sec 1-Sec 46), Energy (Sec 47) and Construction (Sec 48).

Time dummies are included but not reported.

Standard errors in parentheses. *** Significant at 1%; ** Significant at 5%; * Significant at 10%.

Instruments: Δn, Δm and Δk, all dated $(t-2)$ and $(t-3)$.

Table 3
Heterogeneity of firm mark-up and extent of rent sharing:
Different indicators and estimates

11603 firms	$\hat{\beta}_i = \widehat{\frac{\mu_i}{1-\mu_i}}$	Mark-up $\hat{\mu}_i$	$\widehat{\frac{\phi_i}{1-\phi_i}}$	Rent sharing $\hat{\phi}_i$
Simple average				
Specification (1)[a]	0.530	1.762	0.565	0.648
Specification (2)[b]	0.440	-120.5	1.707	0.542
Weighted average				
Specification (1)[a]	0.540	1.346	1.878	0.893
Specification (2)[b]	0.427	1.175	1.225	0.813
Median				
Specification (1)[a]	0.534	1.610	1.965	0.770
Specification (2)[b]	0.427	1.381	1.309	0.764
Robust observed variance $\mathbf{sd}_o^2$ **(disp.** $\mathbf{sd}_o$**)**				
Specification (1)[a]	0.189	2.036	12.075	0.073
	(0.435)	(1.427)	(3.475)	(0.270)
Specification (2)[b]	0.220	1.194	10.745	0.103
	(0.470)	(1.093)	(3.278)	(0.321)
Robust sampling variance $\mathbf{sd}_s^2$ **(disp.** $\mathbf{sd}_s$**)**				
Specification (1)[a]	0.107	1.524	6.918	0.028
	(0.327)	(1.234)	(2.630)	(0.167)
Specification (2)[b]	0.120	0.881	8.461	0.065
	(0.346)	(0.938)	(2.908)	(0.254)
True variance $\boldsymbol{\sigma}_t^2$ **(disp.** $\boldsymbol{\sigma}_t$**)**[c]				
Specification (1)[a]	0.082	0.512	5.157	0.045
	(0.286)	(0.715)	(2.270)	(0.212)
Specification (2)[b]	0.100	0.313	2.284	0.038
	(0.316)	(0.559)	(1.511)	(0.194)
F-test[d]				
Specification (1)[a]	1.766	1.335	1.745	2.607
Specification (2)[b]	1.833	1.355	1.269	1.584

[a] Specification (1): constant firm input shares:

$$SR_t = \Delta q_t - \left(\frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Nt}\right)\Delta n_t - \left(\frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Mt}\right)\Delta m_t - \left(1 - \frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Nt} - \frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Mt}\right)\Delta k_t$$
$$= \beta\left(\Delta q_t - \Delta k_t\right) + \frac{\phi}{1-\phi}\left(\frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Nt} + \frac{1}{n_t}\sum_{t=1}^{n_t}\alpha_{Mt} - 1\right)\left(\Delta n_t - \Delta k_t\right) + \varepsilon_t$$

[b] Specification (2): time-varying firm input shares:

$$\widetilde{SR}_t = \Delta q_t - \alpha_{Nt}\Delta n_t - \alpha_{Mt}\Delta m_t - (1-\alpha_{Nt}-\alpha_{Mt})\Delta k_t = \beta(\Delta q_t - \Delta k_t) + \frac{\phi}{1-\phi}(\alpha_{Nt}+\alpha_{Mt}-1)(\Delta n_t - \Delta k_t) + \varrho_t$$

Instruments Specification (1) - Specification (2): 2-period lagged values of Δn, Δm and Δk.

[c] True variance (dispersion) is computed by adjusting the observed variance for sampling variability: $\sigma_t^2 = sd_o^2 - sd_s^2$.

[d] F-test $= \frac{sd_o^2}{sd_s^2}$.

Table 4
Summary statistics: R&D and innovation data

R&D variables	Total sample	R&D subsample	Non-R&D subsample
Number of firms	11603	598	11005
R&D exp./sales	n.r.	0.034 (0.010)	n.r.
R&D exp.$_{personnel}$/sales	n.r.	0.017 (0.006)	n.r.
R&D exp./employment	n.r.	3.084 (0.634)	n.r.
R&D exp.$_{personnel}$/employment	n.r.	1.496 (0.392)	n.r.
Capital intensity	0.467 (0.339)	0.720 (0.551)	0.453 (0.330)
Employment	173 (41)	797 (452)	85 (39)
Innovation variables (CIS 2)	Total sample	Innovative subsample	Non-innovative subsample
Number of firms (type A)[a]	1856	720	1136
Share of innovative sales (type A)	n.r.	0.121 (0.050)	n.r.
Capital intensity	0.324 (0.287)	0.343 (0.314)	0.311 (0.272)
Employment	506 (79)	1014 (206)	184 (57)
Number of firms (type B)[b]	1856	438	1418
Share of innovative sales (type B)	n.r.	0.137 (0.100)	n.r.
Capital intensity	0.324 (0.287)	0.346 (0.319)	0.317 (0.279)
Employment	506 (79)	1272 (241)	269 (65)
Innovation variables (CIS 3)	Total sample	Innovative subsample	Non-innovative subsample
Number of firms (type A)[a]	1950	822	1128
Share of innovative sales (type A)	n.r.	0.130 (0.100)	n.r.
Capital intensity	0.311 (0.267)	0.337 (0.296)	0.293 (0.247)
Employment	425 (96)	718 (190)	212 (65)
Number of firms (type B)[b]	1933	448	1485
Share of innovative sales (type B)	n.r.	0.110 (0.060)	n.r.
Capital intensity	0.310 (0.267)	0.341 (0.300)	0.304 (0.257)
Employment	425 (96)	1006 (266)	249 (78)
Innovation variables (CIS 2 & CIS 3)	Total sample	Innovative subsample	Non-innovative subsample
Number of firms (type A)[a]	3112	228	2884
Share of innovative sales (type A)	n.r.	0.136 (0.105)	n.r.
Capital intensity	0.307 (0.265)	0.385 (0.366)	0.301 (0.258)
Employment	343 (70)	1728 (660)	233 (63)
Number of firms (type B)[b]	3088	108	2980
Share of innovative sales (type B)	n.r.	0.131 (0.092)	n.r.
Capital intensity	0.306 (0.263)	0.388 (0.366)	0.303 (0.260)
Employment	328 (69)	2333 (754)	255 (65)

n.r.: not relevant. Median values in parentheses.
[a]: type A-firms: firms innovating with products new to the firm.
[b]: type B-firms: firms innovating with products new to the market.

Table 5
The role of R&D intensity and innovation performance in explaining $\hat{\mu}_j$:
OLS and quantile regression coefficients

R&D variables	$\hat{\boldsymbol{\beta}}_{OLS}$	$\hat{\boldsymbol{\beta}}(\mathbf{0.25})$	$\hat{\boldsymbol{\beta}}(\mathbf{0.50})$	$\hat{\boldsymbol{\beta}}(\mathbf{0.75})$
Constant	2.821*** (0.547)	2.151*** (0.254)	1.883*** (0.415)	3.080** (1.337)
R&Ddum	-1.504 (0.512)	-1.052** (0.512)	-2.225** (1.060)	-1.137 (2.969)
R&Ddum * R&D exp./sales	-0.599 (0.512)	-0.758*** (0.227)	-0.860** (0.390)	-0.217 (0.916)
Capital intensity	0.236*** (0.096)	0.278*** (0.041)	0.249*** (0.075)	0.231 (0.195)
Real average sectoral wage	0.156 (0.300)	-0.461*** (0.148)	-0.179 (0.233)	0.421 (0.629)
Employment	-0.135 (0.122)	-0.200*** (0.063)	-0.019 (0.092)	-0.066 (0.262)
R^2	0.222	0.225	0.189	0.119
# Obs.	48	48	48	48
Constant	2.898*** (0.554)	2.343*** (0.623)	1.982*** (0.572)	3.048** (1.396)
R&Ddum	0.345 (1.053)	1.535 (1.644)	0.782 (1.036)	-0.500 (1.758)
R&Ddum * R&D exp./employ.	-0.142 (0.457)	-0.345 (0.690)	-0.293 (0.462)	0.032 (1.251)
Capital intensity	0.260*** (0.095)	0.268*** (0.097)	0.300*** (0.102)	0.234 (0.192)
Real average sectoral wage	0.253 (0.294)	-0.250 (0.366)	-0.036 (0.323)	0.428 (0.654)
Employment	-0.112 (0.127)	-0.181 (0.160)	0.020 (0.126)	-0.055 (0.293)
R^2	0.199	0.203	0.165	0.128
# Obs.	48	48	48	48
Innovation variables	$\hat{\boldsymbol{\beta}}_{OLS}$	$\hat{\boldsymbol{\beta}}(\mathbf{0.25})$	$\hat{\boldsymbol{\beta}}(\mathbf{0.50})$	$\hat{\boldsymbol{\beta}}(\mathbf{0.75})$
Constant	2.696*** (0.504)	1.967** (0.912)	1.975*** (0.351)	3.632*** (0.665)
Innovationdum (CIS 2)	-0.242 (0.187)	-0.192 (0.411)	-0.249** (0.109)	-0.312 (0.202)
	0.037 (0.270)	*0.511 (0.472)*	*-0.271 (0.287)*	*-0.147 (0.484)*
Innovationdum *	-1.175 (0.840)	-0.021 (1.556)	-0.661 (0.491)	-1.382 (1.114)
Share of innovative sales (CIS 2)	*-2.390** (1.212)*	*-3.030 (1.880)*	*-1.978 (1.265)*	*-1.306 (2.414)*
Capital intensity	0.207** (0.089)	0.202 (0.154)	0.209*** (0.063)	0.202* (0.122)
Real average sectoral wage	0.394* (0.233)	0.015 (0.498)	0.238 (0.158)	0.797*** (0.276)
Employment	0.003 (0.094)	0.015 (0.171)	0.125** (0.054)	-0.061 (0.110)
R^2	0.378	0.198	0.273	0.311
# Obs.	44	44	44	44
Constant	2.464*** (0.566)	1.803 (1.301)	2.325*** (0.845)	3.069*** (1.006)
Innovationdum (CIS 3)	-0.299 (0.248)	0.008 (0.656)	-0.379 (0.389)	-0.393 (0.451)
	-0.354 (0.285)	*0.193 (0.551)*	*-0.398 (0.330)*	*-1.011** (0.502)*
Innovationdum *	-1.475 (1.310)	-1.680 (3.403)	-0.847 (1.913)	-2.159 (2.461)
Share of innovative sales (CIS 3)	*-2.098 (1.730)*	*-3.202 (3.597)*	*-1.387 (1.958)*	*-1.317 (2.814)*
Capital intensity	0.194** (0.098)	0.247 (0.214)	0.163 (0.152)	0.234 (0.183)
Real average sectoral wage	0.366 (0.249)	0.122 (0.651)	0.387 (0.378)	0.637 (0.516)
Employment	0.057 (0.103)	0.101 (0.208)	0.086 (0.155)	0.055 (0.181)
R^2	0.314	0.110	0.219	0.266
# Obs.	48	48	48	48
Constant	2.831*** (0.591)	2.548*** (0.754)	1.924** (0.846)	3.512*** (0.984)
Innovationdum (CIS 2 & 3)	0.530 (0.765)	1.528* (0.815)	0.160 (1.068)	-0.758 (1.058)
	0.110 (1.178)	*2.866** (1.429)*	*-0.260 (1.558)*	*-2.716** (1.223)*
Innovationdum *	-5.414 (4.328)	-6.602* (3.464)	-2.731 (5.609)	-3.664 (4.357)
Share of innovative sales (CIS 2 & 3)	*-7.279 (5.416)*	*-12.996*** (4.334)*	*-7.358 (5.184)*	*-5.276 (4.706)*
Capital intensity	0.236** (0.102)	0.281*** (0.100)	0.315** (0.144)	0.222 (0.143)
Real average sectoral wage	0.301 (0.109)	-0.097 (0.367)	0.001 (0.401)	0.740* (0.415)
Employment	-0.082 (0.109)	-0.171 (0.136)	0.066 (0.156)	-0.058 (0.219)
R^2	0.246	0.192	0.189	0.198
# Obs.	48	48	48	48

Standard errors in parentheses. *** Significant at 1%; ** Significant at 5%; * Significant at 10%.
Innovation variables refer to type B-firms.

Table 6
The role of R&D intensity and innovation performance in explaining $\hat{\phi}_j$:
OLS and quantile regression coefficients

R&D variables	$\hat{\boldsymbol{\beta}}_{OLS}$	$\hat{\boldsymbol{\beta}}(\mathbf{0.25})$	$\hat{\boldsymbol{\beta}}(\mathbf{0.50})$	$\hat{\boldsymbol{\beta}}(\mathbf{0.75})$
Constant	1.014 (0.663)	0.713 (0.561)	0.691 (0.668)	0.734 (0.561)
R&Ddum	-2.642 (1.679)	-4.648** (2.119)	0.612 (1.607)	0.245 (1.055)
R&Ddum * R&D exp./sales	-1.041* (0.621)	-1.677** (0.864)	0.212 (0.636)	0.230 (0.433)
Capital intensity	0.173 (0.117)	0.184* (0.111)	0.083 (0.104)	0.080 (0.091)
Real average sectoral wage	-0.277 (0.363)	-0.376 (0.378)	0.013 (0.381)	0.171 (0.293)
Employment	-0.191 (0.148)	-0.170 (0.179)	-0.038 (0.148)	0.033 (0.107)
R^2	0.155	0.080	0.040	0.049
# Obs.	48	48	48	48
Constant	1.176* (0.677)	0.588 (1.346)	0.565 (0.415)	0.840** (0.386)
R&Ddum	1.120 (1.286)	-0.285 (2.963)	-1.919** (0.836)	-1.254** (0.585)
R&Ddum * R&D exp./employ.	-0.506 (0.559)	0.269 (1.168)	0.805** (0.334)	0.438* (0.265)
Capital intensity	0.209* (0.117)	0.198 (0.187)	0.049 (0.066)	0.092 (0.059)
Real average sectoral wage	-0.145 (0.359)	-0.159 (0.560)	0.114 (0.241)	0.193 (0.205)
Employment	-0.174 (0.155)	-0.052 (0.323)	0.032 (0.094)	0.022 (0.073)
R^2	0.116	0.061	0.064	0.079
# Obs.	48	48	48	48
Innovation variables	$\hat{\boldsymbol{\beta}}_{OLS}$	$\hat{\boldsymbol{\beta}}(\mathbf{0.25})$	$\hat{\boldsymbol{\beta}}(\mathbf{0.50})$	$\hat{\boldsymbol{\beta}}(\mathbf{0.75})$
Constant	0.839 (0.734)	0.078 (0.726)	0.535 (0.474)	1.171*** (0.256)
Innovationdum (CIS 2)	-0.237 (0.273)	-0.481 (0.409)	-0.500*** (0.170)	-0.561*** (0.075)
	0.363 (0.357)	*0.237 (0.579)*	*-0.258 (0.308)*	*-0.432*** (0.158)*
Innovationdum *	-1.517 (1.225)	0.555 (1.228)	0.096 (0.780)	-0.347 (0.290)
Share of innovative sales (CIS 2)	*-5.093*** (1.597)*	*-4.247 (2.792)*	*-2.318 (1.469)*	*-1.918** (0.810)*
Capital intensity	0.075 (0.129)	0.095 (0.100)	0.033 (0.078)	0.003 (0.038)
Real average sectoral wage	0.089 (0.340)	-0.206 (0.373)	0.101 (0.209)	0.458*** (0.111)
Employment	-0.014 (0.137)	0.070 (0.161)	0.060 (0.084)	0.036 (0.044)
R^2	0.184	0.115	0.154	0.235
# Obs.	44	44	44	44
Constant	0.900 (0.758)	0.639 (0.910)	0.823** (0.424)	0.514 (0.605)
Innovationdum (CIS 3)	-0.219 (0.332)	-0.703 (0.495)	-0.432** (0.198)	-0.472*** (0.177)
	-0.366 (0.375)	*0.193 (0.551)*	*-0.680 (0.329)*	*-0.389 (0.258)*
Innovationdum *	-0.240 (1.755)	1.700 (2.469)	0.164 (1.044)	0.165 (1.013)
Share of innovative sales (CIS 3)	*-0.940 (2.272)*	*-3.202 (3.597)*	*0.955 (1.903)*	*-0.076 (1.950)*
Capital intensity	0.156 (0.131)	0.102 (0.137)	0.003 (0.076)	-0.080 (0.081)
Real average sectoral wage	0.058 (0.329)	-0.074 (0.399)	0.251 (0.181)	0.059 (0.247)
Employment	-0.028 (0.128))	-0.016 (0.141)	0.019 (0.080)	0.029 (0.117)
R^2	0.090	0.091	0.113	0.143
# Obs.	48	48	48	48
Constant	0.970 (0.688)	0.689 (1.219)	0.435 (0.548)	0.855** (0.395)
Innovationdum (CIS 2 & 3)	1.780** (0.891)	0.002 (1.847)	-0.563 (0.725)	-0.676 (0.527)
	2.136* (1.203)	*3.347 (2.490)*	*0.074 (0.969)*	*-1.006 (0.938)*
Innovationdum *	-13.825*** (5.040)	-1.361 (11.216)	0.442 (4.313)	-0.114 (3.014)
Share of innovative sales (CIS 2 & 3)	*-24.636*** (5.530)*	*-32.190*** (8.554)*	*-9.984** (4.386)*	*-4.111 (3.805)*
Capital intensity	0.139 (0.119)	0.164 (0.189)	0.045 (0.087)	0.065 (0.071)
Real average sectoral wage	-0.163 (0.318)	0.073 (0.467)	-0.046 (0.270)	0.119 (0.198)
Employment	-0.143 (0.127)	-0.006 (0.206)	0.006 (0.104)	-0.018 (0.063)
R^2	0.216	0.052	0.067	0.122
# Obs.	48	48	48	48

Standard errors in parentheses. *** Significant at 1%; ** Significant at 5%; * Significant at 10%.
Innovation variables refer to type B-firms.

Table 7

The role of R&D intensity and innovation performance in explaining $\hat{\mu}_i$:
OLS and quantile regression coefficients

R&D variables	$\hat{\beta}_{OLS}$	$\hat{\beta}(0.25)$	$\hat{\beta}(0.50)$	$\hat{\beta}(0.75)$
Constant	3.833 (3.276)	1.352*** (0.170)	1.952*** (0.143	2.617*** (0.368)
R&Ddum	2.697 (7.800)	-1.384*** (0.400)	-0.353 (0.335)	0.525 (0.854)
R&Ddum * R&D exp./sales	0.994 (1.709)	0.071 (0.087)	-0.031 (0.072)	0.136 (0.184)
Capital intensity	0.556 (0.457)	0.130*** (0.024)	0.187*** (0.020)	0.362*** (0.051)
Real average sectoral wage	-0.056 (2.443)	-0.065 (0.126)	-0.104 (0.107)	-0.837*** (0.280)
Employment	-0.350 (0.404)	-0.080*** (0.021)	-0.046*** (0.017)	-0.088** (0.045)
R^2	0.042	0.009	0.014	0.021
# Obs.	11603	11603	11603	11603
Constant	3.876*** (0.555)	1.353*** (0.168)	1.946*** (0.141)	2.602*** (0.365)
R&Ddum	-0.635 (5.714)	-1.886*** (0.291)	-0.280 (0.244)	-0.147 (0.619)
R&Ddum * R&D exp./employ.	0.033 (1.658)	0.193*** (0.081)	0.059 (0.069)	0.293* (0.179)
Capital intensity	0.560 (0.457)	0.130*** (0.024)	0.187*** (0.019)	0.362*** (0.051)
Real average sectoral wage	-0.072 (2.446)	-0.064 (0.125)	-0.112 (0.105)	-0.818*** (0.278)
Employment	-0.365 (0.403)	-0.080*** (0.021)	-0.047*** (0.017)	-0.079* (0.044)
R^2	0.042	0.009	0.014	0.021
# Obs.	11603	11603	11603	11603
Innovation variables	$\hat{\beta}_{OLS}$	$\hat{\beta}(0.25)$	$\hat{\beta}(0.50)$	$\hat{\beta}(0.75)$
Constant	3.491 (15.086)	1.308*** (0.445)	2.433*** (0.482)	3.739*** (0.791)
Innovationdum (CIS 2)	-8.815 (11.034)	-1.621*** (0.319)	-0.229 (0.352)	0.410 (0.563)
	-13.353 (13.409)	*-2.715*** (0.444)*	*-0.323 (0.393)*	*0.203 (0.925)*
Innovationdum *	19.318 (13.988)	-0.395 (0.393)	-0.091 (0.428)	-0.630 (0.675)
Share of innovative sales (CIS 2)	*-2.032 (19.314)*	*-0.060 (0.636)*	*0.050 (0.557)*	*0.909 (1.278)*
Capital intensity	-0.024 (2.085)	0.173*** (0.062)	0.195*** (0.066)	0.333*** (0.108)
Real average sectoral wage	-3.240 (11.297)	-0.337 (0.328)	0.069 (0.136)	0.015*** (0.607)
Employment	-1.448 (1.206)	-0.102*** (0.035)	-0.066* (0.038)	-0.065 (0.061)
R^2	0.033	0.009	0.009	0.007
# Obs.	1862	1862	1862	1862
Constant	14.074 (13.261)	1.361*** (0.512)	1.981*** (0.444)	3.441*** (0.850)
Innovationdum (CIS 3)	-4.121 (7.126)	0.015 (0.263)	-0.233 (0.238)	-0.309 (0.461)
	-3.768 (10.170)	*-0.570* (0.312)*	*-0.235 (0.302)*	*-0.495 (0.836)*
Innovationdum *	1.959 (14.316)	-1.084** (0.557)	-0.288 (0.468)	-1.038 (0.795)
Share of innovative sales (CIS 3)	*2.780 (21.109)*	*-2.086*** (0.647)*	*-0.249 (0.592)*	*-0.687 (1.370)*
Capital intensity	0.565 (1.767)	0.160*** (0.064)	0.210*** (0.059)	0.150 (0.120)
Real average sectoral wage	5.142 (9.814)	-0.156 (0.379)	-0.047 (0.328)	0.497 (0.647)
Employment	-0.223 (1.061)	-0.096*** (0.039)	-0.034 (0.035)	0.059 (0.068)
R^2	0.002	0.008	0.005	0.008
# Obs.	1974	1974	1974	1974
Constant	-3.838 (5.617)	1.255*** (0.290)	2.218*** (0.305)	3.148*** (0.776)
Innovationdum (CIS 2 & 3)	0.421 (9.637)	-2.422*** (0.263)	0.427 (0.499)	0.654 (1.338)
	2.713 (24.939)	*-2.844*** (0.808)*	*0.079 (0.726)*	*-1.403 (1.921)*
Innovationdum *	-6.323 (19.041)	-0.338 (0.806)	-1.687* (0.963)	-2.162 (2.518)
Share of innovative sales (CIS 2 & 3)	*-10.535 (52.149)*	*2.811** (1.421)*	*0.454 (1.406)*	*2.233 (2.486)*
Capital intensity	-1.406* (0.792)	0.087** (0.041)	0.173*** (0.043)	0.175 (0.110)
Real average sectoral wage	-2.815 (4.096)	-0.175 (0.211)	-0.017 (0.222)	-0.148 (0.572)
Employment	-0.089 (0.540)	-0.092*** (0.027)	-0.087*** (0.029)	-0.073 (0.073)
R^2	0.002	0.008	0.003	0.005
# Obs.	3131	3131	3131	3131

Standard errors in parentheses. *** Significant at 1%; ** Significant at 5%; * Significant at 10%.

Innovation variables refer to type B-firms. All regressions include sectoral dummies multiplied by respectively R&Ddum and Innovationdum.

Table 8

The role of R&D intensity and innovation performance in explaining $\hat{\phi}_i$:
OLS and quantile regression coefficients

R&D variables	$\hat{\beta}_{OLS}$	$\hat{\beta}(\mathbf{0.25})$	$\hat{\beta}(\mathbf{0.50})$	$\hat{\beta}(\mathbf{0.75})$
Constant	1.657 (1.952)	0.629*** (0.054)	0.761*** (0.023)	0.873*** (0.022)
R&Ddum	2.894 (4.648)	0.136 (0.118)	0.158*** (0.055)	0.093* (0.052)
R&Ddum	0.791 (1.018)	0.019 (0.025)	0.028*** (0.012)	0.028*** (0.010)
Capital intensity	0.210 (0.272)	0.010 (0.007)	-0.030*** (0.003)	-0.035*** (0.003)
Real average sectoral wage	0.020 (1.456)	-0.042 (0.039)	-0.006 (0.017)	0.034** (0.016)
Employment	-0.155 (0.240)	-0.029*** (0.006)	-0.011*** (0.002)	0.005** (0.002)
R^2	0.003	0.002	0.002	0.002
# Obs.	11603	11603	11603	11603
Constant	1.635 (1.953)	0.629*** (0.054)	0.763*** (0.025)	0.875*** (0.022)
R&Ddum	-0.538 (3.405)	0.113 (0.094)	0.047 (0.043)	-0.030 (0.039)
R&Ddum * R&D exp./employ.	0.689 (0.988)	-0.0004 (0.024)	0.011 (0.012)	0.021** (0.010)
Capital intensity	0.218 (0.272)	0.010 (0.007)	-0.029*** (0.003)	-0.035*** (0.003)
Real average sectoral wage	-0.040 (1.457)	-0.042 (0.040)	-0.009 (0.018)	0.035** (0.016)
Employment	-0.166 (0.240)	-0.029*** (0.006)	-0.012*** (0.003)	0.005* (0.002)
R^2	0.003	0.002	0.002	0.021
# Obs.	11603	11603	11603	11603
Innovation variables	$\hat{\beta}_{OLS}$	$\hat{\beta}(\mathbf{0.25})$	$\hat{\beta}(\mathbf{0.50})$	$\hat{\beta}(\mathbf{0.75})$
Constant	2.231 (3.638)	0.645*** (0.151)	0.776*** (0.055)	0.890*** (0.084))
Innovationdum (CIS 2)	-0.132 (2.661)	-0.052 (0.110)	0.066* (0.039)	0.041 (0.064)
	1.069 (3.177)	*-0.016 (0.149)*	*0.027 (0.042)*	*0.050 (0.062)*
Innovationdum *	3.620 (3.373)	0.0007 (0.132)	-0.002 (0.048)	-0.038 (0.082)
Share of innovative sales (CIS 2)	*-3.238 (4.576)*	*0.054 (0.185)*	*-0.034 (0.059)*	*-0.078 (0.089)*
Capital intensity	-0.219 (0.502)	-0.032 (0.020)	-0.043*** (0.007)	-0.042*** (0.012)
Real average sectoral wage	-0.155 (2.724)	0.045 (0.112)	0.031 (0.041)	0.072 (0.062)
Employment	-0.440 (0.290)	-0.010 (0.011)	-0.005 (0.004)	0.008 (0.006)
R^2	0.039	0.008	0.009	0.011
# Obs.	1862	1862	1862	1862
Constant	1.905 (3.579)	0.548*** (0.183)	0.807*** (0.080)	0.978*** (0.080)
Innovationdum (CIS 3)	0.935 (1.923)	-0.062 (0.095)	0.074* (0.043)	0.104*** (0.043)
	1.135 (2.695)	*-0.036 (0.148)*	*0.057 (0.060)*	*0.009 (0.056)*
Innovationdum *	-3.533 (3.864	0.129 (0.186)	0.054 (0.085)	0.031 (0.084)
Share of innovative sales (CIS 3)	*-5.447 (5.594)*	*-0.029 (0.292)*	*0.085 (0.118)*	*0.087 (0.112)*
Capital intensity	-0.443 (0.477)	0.001 (0.024)	-0.012 (0.010)	-0.025*** (0.010)
Real average sectoral wage	0.931 (2.649)	0.052 (0.133)	0.045 (0.059)	0.107* (0.059)
Employment	-0.240 (0.286)	0.009 (0.014)	0.009 (0.006)	0.009 (0.006)
R^2	0.038	0.007	0.006	0.007
# Obs.	1974	1974	1974	1974
Constant	-0.077 (2.084)	0.552*** (0.113)	0.772*** (0.044)	0.910*** (0.053)
Innovationdum (CIS 2 & 3)	-2.688 (3.577)	0.270* (0.165)	0.114* (0.70)	0.032 (0.094)
	-8.390 (5.364)	*0.173 (0.378)*	*0.102 (0.109)*	*-0.013 (0.072)*
Innovationdum *	14.512** (7.067)	-0.110 (0.344)	0.045 (0.141)	-0.068 (0.170)
Share of innovative sales (CIS 2 & 3)	*92.276*** (11.216)*	*-0.895* (0.546)*	*-0.715*** (0.243)*	*-0.244 (0.216)*
Capital intensity	-0.034 (0.294)	0.008 (0.015)	-0.032*** (0.006)	-0.034*** (0.007)
Real average sectoral wage	-0.904 (1.520)	-0.059 (0.080)	0.025 (0.032)	0.097*** (0.039)
Employment	-0.116 (0.200)	-0.018* (0.010)	-0.003 (0.004)	0.016*** (0.005)
R^2	0.075	0.005	0.006	0.010
# Obs.	3131	3131	3131	3131

Standard errors in parentheses. *** Significant at 1%; ** Significant at 5%; * Significant at 10%.

Innovation variables refer to type B-firms. All regressions include sectoral dummies multiplied by respectively R&Ddum and Innovationdum.