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by

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Abstract

This paper considers the effect of different firm leadership on the innovative performance of firms from seven EU countries. We investigate whether owner-led or manager-led firms achieve a larger share of their turnover with product innovations. Economic theory does not propose clear answers to this question. In the empirical analysis, it turns out that the manager-led firms are more active innovators: the share of sales based on new products is larger if firms' managers do not hold any of the firms' capital. Surprisingly, there are no differences between the seven countries included in the regression analysis.

JEL-Classification: O32, O31, D21, C24

Keywords: R&D, Product Innovations, Manager, Tobit, Fractional Response Model

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1 Introduction

It is well known that the traditional textbook model of the owner-led firm is inadequate for large modern corporations. Nowadays, these are led by managers, who are paid a fixed salary and additionally receive a share of the firm's realized profits or turnover. However, the fixed portion of the remuneration is usually much larger than the profit-related portion (Jensen and Murphy 1990)[2]. The managers' incentives may be different from those of traditional firm owners and therefore it is questionable whether managerial firms behave like owner-led firms.

The economic literature intensively discusses the consequences of managerial leadership of the modern corporation. One topic is the effect of leadership on growth and the investment behaviour related with this. It is frequently stated that managers - instead of following profit-maximizing behavior - tend to invest too much into capital. The obvious reason for this is to intensify growth of the firm, thus possibly raising personal income as well as personal prestige and power.

The purpose of this paper is to point to another possible difference between managerial and owner-led firms: The pursuit of innovative activity. We discuss the arguments against or in favor of innovative activities of managerial firms and subsequently we present the results of an empirical study concerning this topic. We use data from firms in five sectors concerning seven European countries. All firms are small or medium sized with a maximum of 1000 employees. Overall, 474 observations can be used.

2 Theoretical Considerations

The discussion on managers leads directly to the well-known principal-agent models (see e.g. Milgrom and Roberts, 1992). The main question in these models is how to make the managers act in the interest of the firms' capital owners. Naturally, owners want to maximize their profits. Managers seek to optimize their monetary and non-monetary income which is related to profits but also to firm size or similar characteristics. Empirical studies show that managerial income is only weakly related to a firm's profitability but rather strongly to firm size (see e.g. Leech and Leahy, 1991, or Kraft and Niederprüm, 1999). There is no clear explanation for this phenomena. Rosen (1992) argues that the leader of a larger organization has a greater responsibility and if he or she is successful, the marginal product will be higher than at the top of a smaller company. Thus the mere observation of higher salaries paid by larger firms says

[2] Several studies besides Jensen and Murphy (1990) have examined the dependence of management compensation on performance [cf. Gibbons and Murphy (1990), Main (1991), Kaplan (1994a,b)] as well as "punishment" in the case of management failure [Weisbach (1988); Warner, Watts and Wruck (1988); Gilson (1989); Fizel and Louie (1990)].

nothing about the incentive structure. Zábojník (1998) explains sales maximization as a possibility to solve the problem of underinvestment into specific human capital. Risk aversion of the managers is clearly an explanation (see among others Holmström and Milgrom 1987) and this leads to second-best solutions. The owners must take into account the risk aversion of the managers, when they determine the salary. A very large variable component of the compensation must be accompanied by a very large compensation of the associated risk, which means the expected (mean) income must be very high in order to produce the certainty equivalent, which matches the utility level of a lower but fixed remuneration. As a consequence the variable part and the risk compensation have to be balanced, which however makes first-best solutions impossible.

If innovative activity by the managerial firm is considered, there are opposing forces at work. Every investment into R&D activities is necessarily a risky undertaking. The outcome of such an investment is unknown. This may perhaps have consequences for a manager, who is responsible for such decisions where failure might lead to job loss. Presumably this will only occur if the projects have a great importance for the firm, but it is a possibility. This argument would imply lower innovative activities than a traditional capitalist firm would perform. As stated above, risk aversion is an important explanation of the weak correlation between profitability and managers‘ salaries. R&D processes are by their very nature risky and therefore one can argue that managers are reluctant to invest in such projects and prefer to follow established investment and merger activities.

In contrast to the “risk argument“, an opposing “size effect“ might be present. It is a stylized fact that managers' income and also prestige as well as personal power are directly related to firm size. Therefore it is frequently hypothesized that manager-led firms tend to grow faster than owner-led ones. The growth of firms is realized among other determinants by mergers and capital investment. Many studies find that mergers are not profitable and therefore personal aims of managers must be responsible (among other reasons) for the observed merger activities. Other studies find that manager-led firms invest too much into capital and that the returns from investment are considerably smaller than the sum invested (Mueller, 1999). This is evidence in favor of the so-called „free cash-flow hypothesis“ (Jensen and Meckling, 1976). Our point in this connection is the effect of leadership on innovative activity. The introduction of new products and new processes is obviously a consequence of earlier R&D projects. Managers may pursue more R&D than the owner-led firm as it will have an impact on the development of new products and this in turn will lead to a larger sales volume.

The theoretical discussion leads to contradictory effects. The managerial firm may show more, equal or less innovative activity than the owner-led firm. The result depends on the relative importance of the risk or size argument. Our topic is the empirical test of the behaviour of managers and owners. We try to investigate whether manager-led firms show more or less innovative output than owner-led firms. Given the evidence with respect to investment

and mergers it seems to be an interesting topic for empirical research to compare the managerial firm with the owner-led firm. According to our knowledge until now no empirical study has considered the effect of firm leadership and ownership on innovation performance of firms. Given the importance of technical progress for individual firms as well as for the whole economy, this question of leadership does not seem to be a trivial one.

3 Empirical Findings

This study uses survey data collected during a research project funded by the European Commission. The survey was carried out by means of Computer Aided Telephone Interviews (CATI). It is a cross-sectional survey which refers to the year 1999. The database contains information on the firm level for five sectors: Food and Beverages (NACE[3]: 15), Chemicals excluding pharmaceuticals (NACE 24 excluding 24.4), Manufacturing of Communication Equipment (NACE 32), Telecom Services (NACE 64.2) and Computer Services (NACE 72). The Countries included are Denmark, France, Germany, Greece, Italy, the Netherlands and the United Kingdom. Furthermore, the survey was restricted to firms with 10 to 1000 employees. This enables a comparison between countries, which typically have very different firm size distributions, like e.g. Germany with many large firms and Greece with mainly smaller ones. The typical respondent in the interviews is either the head of the R&D department or if the firm did not have their own R&D lab, we contacted the person in charge of R&D activities or innovation, respectively. Especially in the smaller firms, the interviewee often was the general manager.

Our data contains only very limited information on R&D expenditures. We measure the success of innovations as the share of sales resulting from significantly improved or new products developed during the recent three years (*NewProd*). This measure of innovative activity is clearly an output of innovation projects and not an input as, for example, R&D. We do not claim that our measure is superior to R&D or patents, but we think it is an interesting alternative to consider not only the pursuit of R&D projects but also the importance of the product innovations determined by the market. Unsuccessful R&D activities which do not lead to new products or newly developed products which have no success on the market are not measured as innovations because in a market economy it is ultimately the customers who determine the success of innovative activities. Our theoretical discussion considers R&D as the strategic variable, which depends on the leadership in firms. However, for obvious reasons there is a strong relation between R&D and the introduction of new products. Several other studies were criticized because they only use input indicators like R&D expenditure to measure innovation activities. Hansen (1992) argues: "Some firms may not be able to report resources devoted to innovation separately from resources devoted to other functions within the firm. If a

[3] Nomenclature of Economic Activities in the European Union (NACE).

portion of the company president's time is devoted to innovation, for example, it is unlikely that this portion of his or her salary will be counted in the R&D spending category". Especially, for small and medium sized enterprises this problem is likely to be true. Due to that fact, small firms would systematically underreport their R&D expenditure. Regarding these criticisms, we think that the share of turnover with new or improved products is is a useful alternative measure of innovative activity, especially for our sample of small and medium sized firms.

The explanatory variables include industry dummies which control for different technological opportunities in the five sectors and country dummies that shift inter-country differences like culture, organizational structures or market conditions. Furthermore, we control for size effects. We use the number of employees divided by 1000 (*EMP*). Additionally, a dummy variable indicates whether the firm is led by an owner or a member of the owner's family (*OWN* = 1). *OWN* is zero otherwise. This identifies the managerial firms and the impact of managers' leadership on innovative performance. Moreover, we add a dummy variable if a firm continuously performs R&D activities (*R&D* = 1). Otherwise, *R&D* is zero. Firms that undertake R&D permanently are expected to be more innovative than firms which only occasionally carry out R&D or do not invest in their own R&D activities at all. Finally, we take the pressure of competition into account: *ln(COMP)* is the log of the number of firms which are considered as direct competitors in the main field of business by the interviewees. A high competitive pressure may lead to intense investment into R&D and thus to many innovations on the market. Of course the effect could also go into the other direction (Neo-Schumpeter hypothesis). Overall, we use 474 observations in the following regression analyses. Descriptive statistics of the variables used are given in Table 1.

Table 1: Descriptive Statistics (474 observations)

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
NewProd	39.02	28.93	0	100
EMP (in thousands)	.17	.22	.002	1
R&D (continuous activities)	.70	.46	0	1
OWN	.50	.50	0	1
ln(COMP)	2.65	1.33	0	8.52
Industry Dummies				
Food and Beverages	.23	.42	0	1
Chemicals	.22	.42	0	1
Communication Equipment	.20	.40	0	1
Telecom/Computer Services	.35	.48	0	1
Country Dummies				
France	.13	.33	0	1
Denmark	.14	.35	0	1
Greece	.21	.41	0	1
Netherlands	.18	.39	0	1
Germany	.12	.33	0	1
United Kingdom	.08	.27	0	1
Italy	.14	.35	0	1

Of course, there is a relationship between leadership, R&D and firm size. The smaller firms tend to be led by the owners and several do not perform R&D on a continuous basis. The correlation between the number of employees and the ownership amounts to –0.3. The firm size and continuous R&D activities exhibit a correlation of 0.15. Finally, the correlation between the owner and the R&D variable is 0.14. This is no multicollinearity in the sense that it is causing technical problems in the estimations.

Some firms did not introduce new or improved products to the market, i.e. some observations are left censored. We take this restriction into account by estimating Tobit models (cf. e.g. Greene, 1997, or Gourieroux, 2000). Let the latent variable y_i^* of our econometric model be $N\left(\mu,\sigma^2\right)$ and

$$y_i^* = x_i'\beta + \varepsilon_i\,, \tag{1}$$

where β is the parameter vector to be estimated, x_i the vector of explanatory variables and ε_i the error term. Let the observed share of turnover with new or improved products be

$$y_i = \begin{cases} 0 \text{ if } y_i^* \le 0, \\ y_i^* \text{ if } y_i^* > 0. \end{cases} \tag{2}$$

The corresponding likelihood function for the homoscedastic Tobit model is

$$\ln L = \sum_{y_i>0} -\frac{1}{2}\left[\ln(2\pi) + \ln\sigma^2 + \frac{(y_i - x_i'\beta)^2}{\sigma^2}\right] + \sum_{y_i=0} \ln\left[1 - \Phi\left(\frac{x_i'\beta}{\sigma}\right)\right] \tag{3}$$

where σ is the standard deviation to be estimated and Φ indicates the cumulative density function of the standard normal distribution.

First, we estimate a homoscedastic Tobit model. However, if heteroscedasticity occurs, the homoscedastic model will lead to inconsistent estimates for both the standard errors and the coefficients. Therefore, based on the homoscedastic model, we compute Lagrange multiplier (LM) tests on heteroscedasticity (see Greene, 1997, p. 969). Because of the results of the LM statistics, we consider a Tobit model with multiplicative heteroscedasticity (see Greene, 1997, p. 967). We replace σ with

$$\sigma_i = \sigma \cdot \exp\left(w_i'\alpha\right) \tag{4}$$

in the likelihood function (see equation 3). w_i' denotes the vector of variables causing heteroscedasticity and α is a vector of additional parameters to be estimated.

Initially, we included *EMP*, industry dummies and country dummies in the heteroscedasticity term. However, it turned out that the country dummies have no impact on the estimated variance and thus, we dropped them from the final specification. The results of both the homoscedastic model and the heteroscedastic one are given in Table 2. As the test statistics reject the hypothesis of homoscedasticity, we only discuss the heteroscedastic model.

Table 2: Tobit Regression Results (474 observations)

	Dependent Variable: *NewProd*			
	Homoscedastic Tobit		Heteroscedastic Tobit [a]	
Exogeneous Variables	**Coefficient**	**t-value**	**Coefficient**	**t-value**
EMP	-17.61 ***	-2.80	-17.04 ***	-3.25
R&D	10.40 ***	3.58	7.76 ***	2.77
OWN	-6.57 **	-2.34	-5.98 **	-2.25
ln(COMP)	.52	.52	-.08	-.08
Industry Dummies [b]				
- Chemicals	4.58	1.18	5.50 *	1.69
- Communication Equipment	22.16 ***	5.68	23.57 ***	6.64
- Telecom/Computer Services	26.77 ***	7.84	27.19 ***	8.83
Country Dummies [c]				
- Denmark	-1.59	-.33	-.22	-.05
- Greece	.93	.21	.85	.19
- Netherlands	-8.04 *	-1.74	-6.49	-1.51
- Germany	2.01	.39	5.22	1.06
- United Kingdom	.80	.14	3.38	.56
- Italy	-3.99	-.83	-3.28	-.78
Constant term	22.95 ***	4.28	24.33 ***	4.90
Log Likelihood	-2,140.43		-2,124.31	
LR test on joint significance of country dummies ~ $\chi(6)$ [d]	7.16		9.31	

Notes: *** report a significance level of 1%, ** of 5% and * of 10%.

a) The heteroscedastic Tobit model contains industry dummies and *EMP* in the heteroscedasticity term. The estimates are not reported, but available upon request.
b) Reference class: Food and Beverages
c) Reference class: France.
d) The critical value for rejection of the null hypothesis that all country dummies are jointly zero is 12.59 (10.64) at the 5% (10%) significance level.

The estimates show that firms which are led by managers are clearly more innovative than others. This is a remarkable result as it states that leadership of a firm does indeed have an effect on innovation. The impact of leadership by managers is established for investment and merger activities but until now not for innovations.

The other results are interesting as well: There are no differences among countries regarding the innovative performance of firms. The *LR* statistic on joint significance of the country dummies indicates that the hypothesis „all country dummies are jointly zero“ cannot be rejected.

The dummy variable which indicates continuous R&D activities of the firm is positively significant. Moreover, the share of turnover with new products is decreasing with size. We also tested non-linear relationships, but it turned out that that a linear specification of size suffices.

This result is in line with Hansen (1992) who studied the relationship between the share of sales with new products introduced in the recent five years and firm size or age. Hansen also finds a negative sign for firm size. Younger and smaller firms were more innovative in his study. However, the relation between innovation input and output requires closer investigation, but this question is beyond the scope of the present paper.

The industry dummies report that the manufacturers of communication equipment as well as the telecom and computer services are more innovative than the "traditional" industries of chemical or food and beverages production. This result is most likely a reflection of the product life-cycle in these industries.

Some readers may worry about the application of the Tobit model because it is a special case of a selection model (often called generalized Tobit model), in which one usually models two firm decisions. First, a firm has to decide whether to innovate or not. Besides this propensity to innovate, firms have to determine how much to innovate by a second decision. The Tobit model incorporates both decisions by assuming that the explanatory variables driving both decisions enter the two equations with the same magnitude. Applying a Tobit model, we assume that there is an underlying structural model for the unobserved variable y^*. However, we only observe $y > 0$ if the propensity to innovate is also larger than zero. If this propensity is below zero, we only observe $y = 0$. As this construction of the model may seem a little artificial to some people, we also estimate a fractional response model, which treats the dependent variable just naturally as a share which is bound between zero and one.[4]

Following the methodology described in Papke and Wooldridge (1996), we now assume that

$$E\left(y_i \mid x_i^{'}\right) = G\left(x_i^{'}\beta\right) \tag{5}$$

where G is a function satisfying $0 < G\left(x_i^{'}\beta\right) < 1$. This ensures that all predicted values of y lie between zero and one. As G we choose the cumulative density function of the standard normal distribution: $\Phi\left(x_i^{'}\beta\right)$. The estimation procedure is a particular quasi-likelihood method (QMLE) based on Gourieroux et al. (1984) and McCullagh and Nelder (1989). The Bernoulli log-likelihood function is given as

$$l_i\left(\beta\right) = y_i \ln\left[\Phi\left(x_i^{'}\beta\right)\right] + \left(1 - y_i\right)\ln\left[1 - \Phi\left(x_i^{'}\beta\right)\right]. \tag{6}$$

This corresponds to the familiar log-likelihood of the Probit model, except that we allow y_i being continuous in the interval (0,1). Estimates for β are obtained from the maximization problem $\max_{\beta} \sum_{i=1}^{N} l_i\left(\beta\right)$. According to Papke and Wooldridge, the QMLE is consistent and $\sqrt{N}$-asymptotically normal regardless of the distribution of y_i conditional on x_i.The results

[4] We are grateful to an anonymous referee for the suggestion to use the QML method developed by Papke and Wooldridge (1996) for our empirical study.

of the estimation are displayed in Table 3. The standard errors are computed robust as suggested in Papke and Wooldridge (1996, p. 622-3) to obtain the 'true' asymptotic variance. Note, that in the Tobit estimates *Newprod* has been measured in percentage points, i.e. in the interval (0,100), but for the estimation of the fractional response model we have rescaled it to the interval (0,1).

Table 3: QMLE results of the model for a fractional response variable (474 obs.)

	Dependent Variable: *NewProd*	
Exogeneous Variables	**Coefficient**	**z-value**
EMP	-.47 ***	-2.92
R&D	.26 ***	3.38
OWN	-.17 **	-2.21
ln(COMP)	.02	.57
Industry Dummies [b)]		
- Chemicals	.17 *	1.71
- Communication Equipment	.62 ***	6.35
- Telecom/Computer Services	.73 ***	8.35
Country Dummies [c)]		
- Denmark	-.04	-.28
- Greece	.03	.26
- Netherlands	-.20 *	-1.65
- Germany	.05	.35
- United Kingdom	.03	.20
- Italy	-.12	-.95
Constant term	-.73 ***	-4.81
Quasi Log Likelihood	-298.16	

Notes: *** report a significance level of 1%, ** of 5% and * of 10%.
b) Reference class: Food and Beverages
c) Reference class: France.

We have also carried out a general functional form diagnostic to check for possible unobserved heterogeneity in the model. This test is an extension of the RESET procedure to index models and is described on page 625 in the paper of Papke and Wooldridge. We test whether quadratic and cubic terms of $x_i'\beta$ cause a rejection of our model specification as given in equation (5). We compute the robust LM statistic which is distributed χ^2 with two degrees of freedom. The value of the LM statistic in our case is 1.65 (p-value = 0.44) which means that our specification as presented in Table 3 passes the test and, thus, does not need to be rejected.

The results reveal those of the Tobit models: Owner-led firms have significantly smaller shares of sales with new products than manager-led companies. The share of innovative sales is negatively related to firm size. Firms that engage permanently in R&D activities reach

larger shares of sales with product innovations. Again, we find significant differences among industries but not among countries.

4 Conclusions

We present the results of an empirical study on the innovation activities of European firms. Our dependent variable is the share of sales, which can be attributed to newly developed products. Both Tobit regressions and a quasi maximum likelihood estimator for models of a fractional response variable point to the same conclusion: It turns out, that managerial led firms have a larger share than the other firms.

This is important empirical evidence concerning the effects of leadership on the behavior of firms. While the impact of managers has been discussed in other connections, it has been neglected with respect to innovation.

A welfare theoretic evaluation of this result is controversial. Economists usually favour the view that the capital owners are most knowledgeable regarding what has to be done to maximize profits and therefore they will invest the profit-maximizing amount of R&D. This in turn implies that the managerial firms invest too much if profit maximization is the aim.

However, innovations have strong spill-over effects to other firms and these positive externalities may change the evaluation of innovative activity from a social point of view. With these externalities in mind, owner-led firms may invest too little into innovation while managers are closer to the social optimum. However, they do this in order to maximize their own interests and do not think about a socially desirable level of innovation and, hence, it would be pure coincidence if the social optimum of innovation is reached.

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