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Appropriability, Opportunity, Firm Size and Innovation Activities
Empirical Results Using East and West German Firm Level Data

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Abstract R&D expenditures of firms varies vastly between and within industries. In recent years a lot of theoretical and empirical studies attempted to explain the distribution of R&D expenditures. Four main factors repeatedly appeared in this literature: Firm size, market power, appropriablility and technological opportunity. The present paper tests the empirical content of the hypotheses raised in this literature. It employs the data of the first wave of the Mannheim Innovation Panel conducted in 1993.

Our study divers from the literature in several aspects: (1) The data covers firms from all size classes. The questionaire was designed to minimize the undercounting problem of R&D in small firms. (2) Besides a traditional definition of R&D we also used the concept of total innovation expenditures to capture the importance of non-R&D innovation activities which are especially important for small firms. (3) We give reliable estimates on the occurence of R&D and innovation activities in small and medium sized enterprises in Germany. (4) Our data base includes R&D performers as well as non-R&D performers. (5) We distinguish between the decision to perform R&D or not and the decision on the amount invested in R&D. We show that there are several differences with respect to both stages. (6) As our survey collects information on several R&D enhancing characteristics of firm and market we are able to employ a more extended set of variables explaining R&D performance than most previous studies.

The main results can be summarized as follows: (1) Once small firms have decided to invest in innovation activities, the amount they invest as a percentage of sales is larger than the innovation intensity of big firms. On the other hand, the probability that a firm is engaged in R&D increases strongly with firm size. The large and small firms differential in intensity can even be more pronounced if we use total innovation expenditures instead of the narrowly defined R&D expenditures only. (2) Evidence of a positive relationship between seller concentration and innovation input is rather weak. (3) Stronger appropriability conditions and higher technological opportunities enhance firms spending on investment in innovation activities and/or in R&D. (4) Certain other firm characteristics (exporting firm, financial constraints) play a role in determining innovation expenditures and R&D expenditures.

1. Introduction

Almost twenty years ago Kamien and Schwarz (1975) concluded in their famous survey on innovation and market structure that the bulk of the empirical literature exhibits a u-shaped relationship between innovation activity on one side and market structure as well as firm size on the other. Ten years later Cohen, Levin and Mowery (1987) argued that these correlations vanish if one controls for interindustry differences in technological opportunity and appropriability. As it is obvious from the papers by Acs and Audretsch (1987) and Pavitt, Robson and Townsend (1987) small firms contribute - at least in some sectors of the manufacturing sector - more than bigger firms to the commercialisation of new products than is indicated by their share in national R&D expenditures record in traditional R&D statistics. Based on the Dutch innovation survey in 1984 Kleinknecht (1989) found the largest R&D intensities in small firms. Moreover, standard R&D statistics are affected by a severe undercounting of R&D in small firms (see e.g. Kleinknecht, Poot and Reijnen 1991).

This chapter starts from this literature, but it differs from the existing studies in several points. First, we do not only employ R&D expenditures as a measure of innovative activities. In addition, we use new data on total innovation expenditures including R&D and expenditures on design activities, tooling-up etc. Since this measure does not only rely on formal R&D it should be less affected by the R&D-under-counting problem. Second, our data set contains small, medium-sized and large enterprises ranging from 5 to nearly 80000 employees. It should therefore overcome the bias toward large firms present in a lot of empirical studies. Third, our innovation survey also covers non-innovative firms. This enables us to empirically model not only the decision on how much to invest in new products and/or processes but also shed some light on the decision whether firms invest in innovation activities or not. Fourth, as our data set comprises information on technological opportunity, appropriability and certain firm characteristics it is possible to investigate the role of these factors at the firm level. This seems especially important in the light of the large degree of heterogeneity of innovation activities even within narrowly defined industry classifications. Moreover we shed some light on the role of liquidity constraints on R&D expenditures.

The outline of the paper is as follows: The next section describes the data set at hand, followed by a short description of the innovation activities of firms in the german manufacturing sectors. Section 4 provides an overview of theoretical hypothesis on factors determining investment in R&D. The next section introduces definitions of the innovation input measures and discusses some descriptive statistics on the relation of participation in R&D and the amount spend on the one side and firm size on the other side. In section 6 we present the results of several regression equations for R&D and innovation expenditures. We discuss our results in the light of existing theories and relate our findings to recent studies. Section 7 draws some conclusions and opens routes for further research.

2. The Mannheim Innovation Panel

Before we turn to the empirical results we will shortly describe the origin of the data used. The Mannheim Innovation Panel (MIP) was started in Germany in Summer 1993. The data were collected by the 'Zentrum für Europäische Wirtschaftsforschung' (ZEW) and the 'Institut für angewandte Sozialforschung' (infas). This project was financed and supported by the German Ministry of Education, Science, Research and Technology (BMBF). The first wave was part of the Community Innovation Survey of the European Commission. The questionnaire follows the guidelines proposed by the OECD (1992) and is a somewhat extended version of the harmonised questionnaire for innovation surveys developed by EUROSTAT (for more detail of this project see Smith 1992).

The survey is partly based on the Mannheim Enterprise Panel (Mannheimer Unternehmenspanel = MUP). The addresses stems from the 'Verband der Vereine Creditreform' (VVC), the largest credit rating agency in Germany (see Licht and Stahl 1995 for further details). Several variables from this source have been merged to the survey data of the MIP (e.g. foundation date, legal form, creditrating indicators).

Severel months after the inital survey, a sample of almost 1000 non-respondents was interviewed by phone to test the hypothesis of self-selection of innovating and/or R&D performing firms into the initial survey. As the participation rate in the non-response survey was nearly 90 percent a possible response bias is rather unlikely. Therefore, combining the data from the initial survey, the non-response survey and the VVC it is possible to calculate firm-specific response probabilities which are adjusted for the presence of firm size specific R&D bias in the original survey. Bias adjusted weighting factors for the participants were calculated as the inverse of the firm-specific response probability multiplied by the inverse of strata-specific inclusion probability (see Beise et.al. 1995 for details).

3. Innovation Activities in German Manufacturing

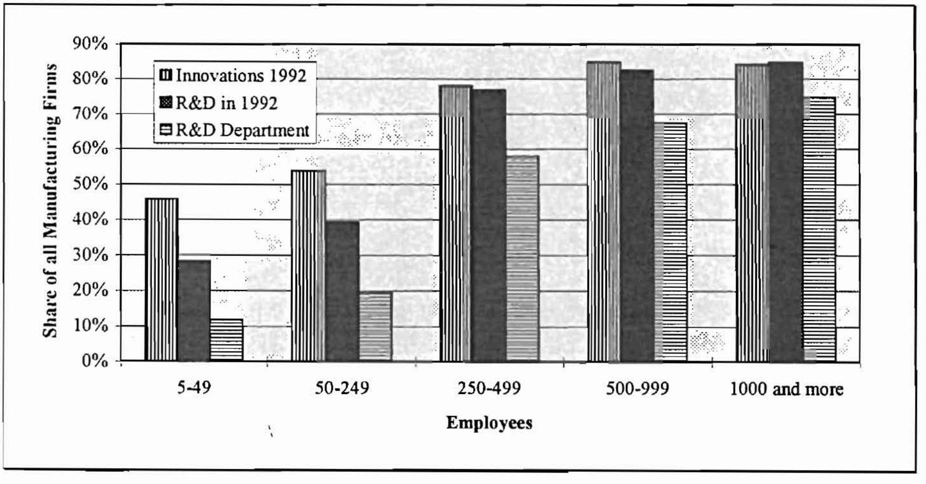
Industry case studies and a number of innovation surveys carried out in the 1980's reveal that only a fraction of the technological effort of firms is accounted as R&D. Not all expenditures dedicated to the creation of new and improved products and processes are covered by the OECD 'Frascati'-definition of R&D (see OECD 1993). R&D is only one of the steps in the innovation process.

There are also R&D-activities which are not R&D from the viewpoint of firms. Even the definition of the Frascati Manual is not obvious. Therefore, there is an possible underestimation of informal R&D especially in small firms (see e.g. Kleinknecht, Poot and Reijnen 1991). For example, firms without formal R&D departments in the mechanical engineering assign a great part of their R&D activities to product design.

In order to circumvent the undercounting problem, innovation activities should be broadly defined in surveys. In the Community Innovtion Survey the definition of innovation focuses on the introduction of new or improved products to the market or on the internal use of new or improved methods of production within a 3-year period. To get an impression of the distribution of (successful) innovation activities compared to R&D-activities the following figures show shares of innovating firms in 1992 as well as shares of R&D-performing firms and shares of firms with formalized R&D in spezialized departments. Figure 1 contains the data for West-German manufacturing firms with 5 employees or more and Figure 2 holds the same facts for East-Germany.

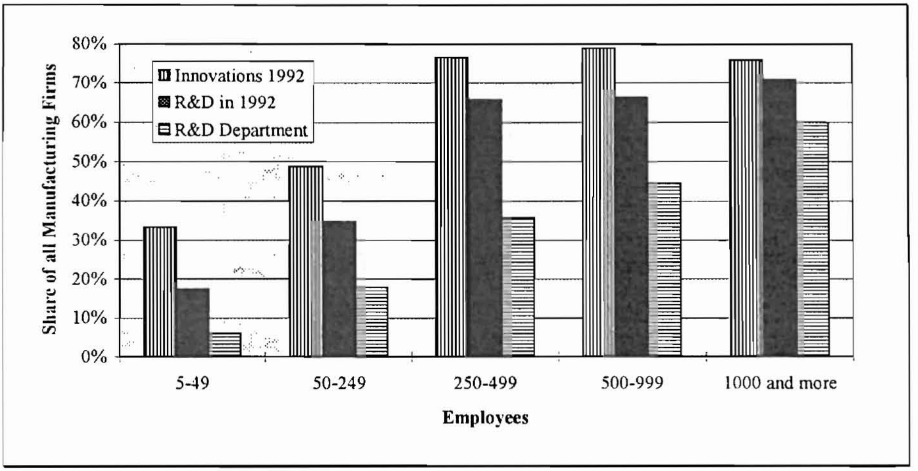
As is obvious from both figures shares of innovating and R&D performing firms increase with firm size until a level of about 500 employees is reached. Especially in small firms innovations are introduced without any (formal) R&D activity. Therefore, the innovative potential of small firms will be severly underestimated if one uses only R&D activities as basis for the assessment. This is an additional feature of the hypothesis of underestimation of the technological innovation potential of small firms as discussed by Kleinknecht, Poot and Reijnen (1991).

Figure 1: Innovating and R&D performing Firms as Share of all Manufacturing Firms in 1992 - West-Germany (Weighted Results)



Source: ZEW - Mannheim Innovation Panel

Figure 2: Innovating and R&D performing Firms as Share of all Manufacturing Firms in 1992 - East-Germany (Weighted Results)

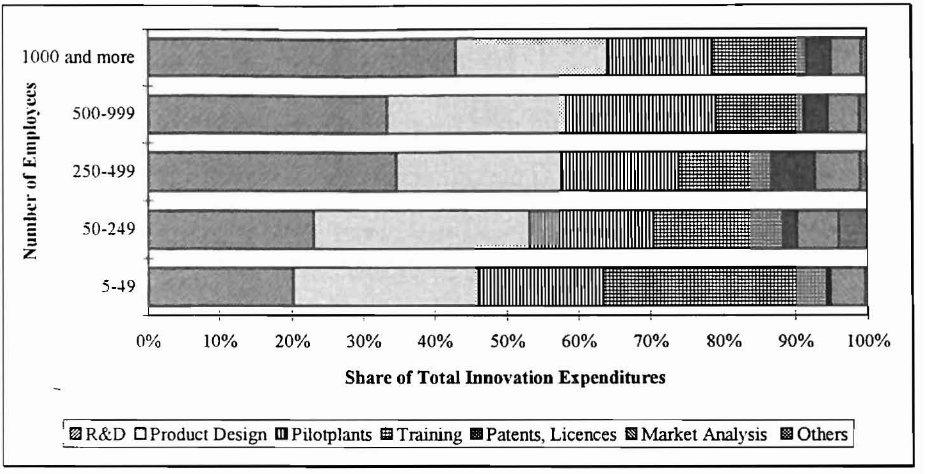


Source: ZEW - Mannheim Innovation Panel

Moreover, in West-Germany nearly all innovating medium sized and large firms perform R&D but not all large firms organize their innovative activities in R&D departments. Despite the urgent need for modernization of products and methods of production during the process of transformation to a market economy the share of innovating firms in East-Germany is somewhat lower than in West-Germany. This is especially true with respect to formalised R&D departments. Whether this is a real East-West differential or solely a consequence of a different industry structure in East-Germany will be analysed later on in this paper.

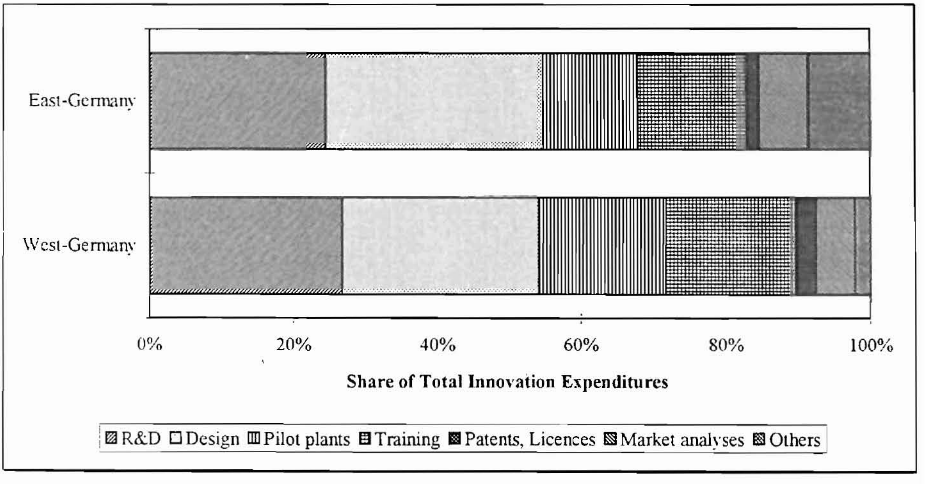
The OSLO-Manual (OECD 1992) enlarges the definition of expenditure related to the technological effort. Apart from R&D the new definition includes product design, trial production, market analysis, training of employees related to innovation projects etc. Figures 3 and 4 show the distribution of total innovation expenditures by these activities by size class and by region. Using (formal) R&D as a proxy for total innovation expenditures will severely underestimate the total amount spent. On the other hand, a lot of firms where unable to give precise numbers on the distribution of total innovation expenditures over these elements. So, one should view the estimates below not as exact numbers but as rough indicators of the importance of the elements.

Figure 3: Components of Innovation Expenditures by Firm Size (Weighted Data)



Source: ZEW - Mannheim Innovation Panel (1995)

Figure 4: Components of Innovation Expenditures in West and East-Germany (Weighted)



Source: ZEW - Mannheim Innovation Panel

The average ratio of R&D to total innovation expenditures over all firms in our sample of 3000 industrial enterprises is sightly above 40%. It is also obvious from Figure 3 that the R&D expenditure share in total innovation expenditures is increasing with firm size. This underlines the danger of assessing the innovation potential of small firms solely by their R&D expenditures. Despite an enormous variation between firms R&D, design as well as training and further education are more or less equally important parts of total innovation expenditures in small firms. In large firms, R&D seems to be the most important part.

Comparing East-Germany and West-Germany Figure 4 leaves us with the impression that there is only a minor difference with respect to the distribution of total innovation expenditures over the above mentioned elements.

The ratio of R&D to total innovation expenditures varies widely within and across industries. In the aircraft and spacecraft industry, R&D covers nearly 60 percent of the total innovation expenditure whereas in construction R&D amounts to roughly 15%. Also, the other components of the innovation expenditures show a large degree of variation. Design is of considerable importance in the textile, leather and shoe industry and of no importance in chemistry. Expenditures related to patents, licences and market analysis do not vary very much but are also of minor importance. Cost of pilot plant, trial production etc. roughly share the same part in all industries.

Apart from the variation across industries, the ratio of R&D to total innovation expenditures differs considerably within industries. Figure 5 shows average values of the R&D-intensity and innovation intensity (expenditures-sales-ratios) in relation to firm size. Our measurement is based on four different types of expenditures for innovation activities:

- total innovation expenditures divided by sales,
- current innovation expenditures divided by sales,
- R&D expenditures divided by sales and
- number of R&D employees divided by the number of all employees.

Total innovation expenditures comprises R&D expenditures as well as expenditures on design, expenditures on training of employees related to the introduction of new products or processes, expenditures related to patents and licences, expenditures for tooling-up, pilot plants, and primary market research. This measure includes current expenditures and capital expenditures of these types.

Current innovation expenditures exclude capital expenditures directly related to innovation projects. This measure is used here because this part of innovation expenditures seems sometimes difficult to estimate for firms as our measurement approach differs from firm's usual internal accounting procedures. We include that measure in figure 5, because some firms were even unable to report a rough estimate on capital expenditures related to innovation.[1] So, current innovation expenditures are less affected by measurement errors than total innovation expenditures.

The definition of *R&D expenditures* used is in line with the Frascati-definition of research and experimental development. This measure includes for some firms part of the expenditures on design and pilot plants as depicted in Figures 3 and 4.

Finally, *R&D employment* seems to be the most easiest observable indicator for inputs in the innovation process from the viewpoint of our firms. It includes employees of the R&D department but also an estimate of the number of employees performing R&D tasks outside of the R&D department(s). One weakness of this measure is that our survey does not ask for full time equivalents. This can lead to an overestimation of the R&D input especially in small firms because in small firms R&D tasks and non-R&D tasks are often assigned to the same employee. Our measurement procedure in the questionnaire, however, does not take account of this fact.

Figure 5 comprises all four definitions of relative inputs of the innovation process by firm size. The figure refers only to firms with at least some expenditures for innovations or R&D in 1992. With the exception of the R&D expenditures the figure shows the highest relative innovation inputs for the smallest size class. The intensities are lowest for medium sized firms. For both measures of innovation expenditures our data show the well-known u-shape relationship between firm size and innovation intensity as found in studies using R&D as proxy of innovation activities. This pattern is less pronounced for both definitions of R&D intensity although the highest values again are found for the smallest and the largest size class. Moreover, only for the R&D expenditures per unit of sales the largest size class shows the largest numbers.

Figure 5 points to the importance of the undercounting problem of innovation activities in small firms which is present in most R&D surveys. A more detailed analysis of the innovation activities of small firms should try to uncover reasons for this firm size distribution. Large fix costs of innovation and R&D activities are only one explanation for high innovation intensities in small firms. This implies that small firms perform R&D not on a continous basis but only from time to time. Given the lower participition rates in R&D of small firms this seems reasonable. But our data set reveals that 3 out of 4 small sized R&D performers do so continously. Therefore, discontinous R&D and innovation activities may not be the only reason for extremely large innovation intensities in small firms.

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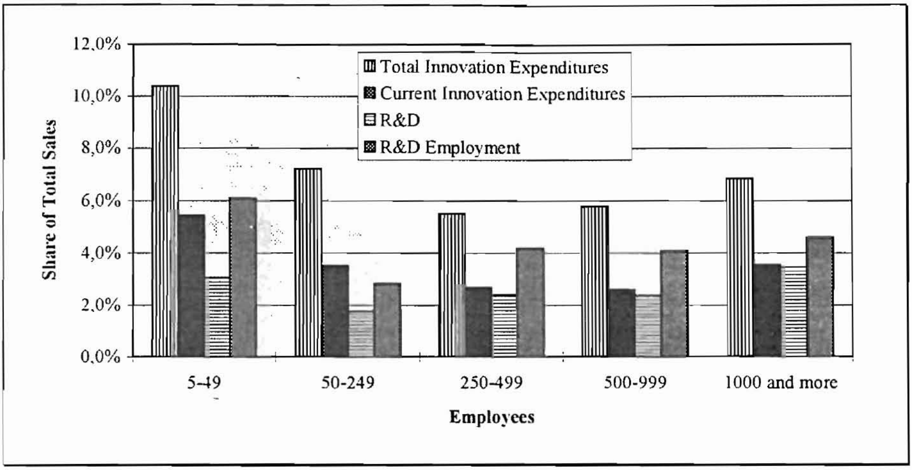
[1] To overcome the missing value problem on capital expenditures related to inovation we imputed missing values using regression techniques. After carefully detecting for outliers we found a fairly stable industry specific relationship between total capital expenditures and capital expenditures directly related to innovations.

Figure 5: R&D Intensity and Innovation Intensity by Firm Size



Source: ZEW - Mannheim Innovation Panel

Moreover, given the large inter-industry and intra-industry variability in the relation of R&D to total innovation expenditures, it is an open question whether innovation expenditures follow the same incentives as R&D expenditure. Therefore, we shall try to find out whether the traditional set of variables used in empirical studies on the determinants of innovative activities apply if we use total innovation expenditures instead of R&D expenditures as proxy for innovation activities of private firms. In what follows, we give a brief review of theoretical hypotheses on investment in R&D and then consider the existing empirical evidence.

4. Theoretical Hypotheses on Factors Determining Investment in R&D

In the literature firms are considered to invest in R&D and innovation activities because these investments are viewed as being profitable in the future. Therefore, all factors influencing future profitability should be related to the amount firms invest. The bulk of literature shows a huge variety of hypotheses and factors which are potential candidates for inclusion in an empirical model.

As already noted by Schumpeter, firm size and market structure should be related to innovation activities. This well-known Schumpeter hypotheses have been tested in various forms using a variety of data sets. At best it can be said that the results are rather mixed. Recent empirical work is reviewed by Cohen and Levin (1989).

Schmookler (1966) emphasized the role of demand. Firms in a growing market should profit from the exploitation of the supply of technological knowledge generated in the science sector. Therefore, medium and long-term demand expectations should be related positively to the amount firms invest in innovation. Also increases in demand should lead to increases of innovative investments.

In more recent years, two additional hypotheses have entered the stage. Spence (1984) showed that the larger the ability to appropriate returns from R&D the larger the investments in innovation. However, if appropriability conditions are weak, positive spillovers reduce the costs of producing innovation for others and therefore enhance their technological opportunity. As a consequence, spillovers will increase the productivity of innovation expenditure at the aggregate level and we face a trade-off between the incentive and the efficiency aspect of appropriability. A great ability to appropriate returns to innovation leads to larger innovative activities but reduces the technological opportunities because spillovers are reduced.

Incentives for R&D vary with technological opportunities. Nelson (1988), for example, shows that the larger the technological opportunitiy, the larger the incentives for firms to invest in R&D. This proposition is also confirmed by a number of historical studies of technology. On the other hand, the empirical implementation of technological opportunity suffers from lack of a precise measurement of technological opportunities at the firm level. In addition to these arguments several hypotheses relating innovation intensity to financial restrictions, the degree of diversification (e.g. Scherer 1984), risk inherent in research projects, and risk preference of the firms' owners can be found in literature (e.g. Rosen 1991).

5. Measurement Issues and Descriptive Statistics for the Data Set

In the following we present some descriptive statistics of the data set and give the definition of variables, restricting our attention to the manufacturing sector. We do not consider firms from mining or energy because both sector are highly regulated in Germany which implies that their innovation activities are probably ruled by different incentives compared to the manufacturing sector. As data on seller concentration do not exist for construction and service industries we delete these sectors from our analysis. We also excluded such firms where we suppose that some of their answers in the questionnaire were wrong or which clearly represent outliers. We jugded this on the basis of an extreme sales per employee ratio or investment per employee ratio. Furthermore, we excluded firms with item non-response.[2] Finally, we restrict our analysis to such firms which introduced product or process innovations in at least one year in the period 1990 to 1992 or intend to do so in 1993 to 1995. 65 percent of the respondents launched a new or improved product within the last 3 years. Processes innovations were undertaken by more than half of our sample. All data relate - unless otherwise noted - to the year 1992.

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[2] When calculating the scores for the factor analysis (see Appendix) we used regression techniques to impute missing values for some of the underlying variables.

Table 1 gives a short summary of the variables used. Table 2a and 2b contain descriptive statistics for the data set at hand. The descriptive statistics are given separately for firm size classes (Columns 3 to 7) and for West and East-Germany (Columns 1 and 2).[3] As can be seen from the tables, East-German firms are much smaller on average than West-German firms. Nearly 50 percent of all firms in the two smallest size classes are from East-Germany (EAST) whereas this share is reduced to 13 percent and 8 percent in the two largest size classes.

Table 1: List of variables and description

Variable	Short description of the variable
RDA	R&D activities in 1992 (yes/no)
RDIS	R&D intensity (R&D expenditures divided by sales)
RDIE	R&D emploment intensity (R&D employment dividid by total employment)
ININT_T	Innovation intensity I (total innovation expenditures divided by sales)
ININT_C	Innovation intensity II (current innovation expenditures divided by sales)
EMP	Firm size (Number of employees)
SCIENCE	Importance of scientific institutions and scientific journals as source of information for the innovation activities (factor score; see Appendix 2)
OTH_FIRMS	Importance of private firms (suppliers, customers, competitors) as source of information for innovation activities (factor score; see Appendix 2)
TECH_OPP	Barriers to innovation. low technological opportunity (1=important)
APPRO	Barriers to innovation. innovation too easy to copy (1=important)
CR_{10}	10- firm concentration ratio
DIVERS	Product diversification (10000/squared sum of sales shares for the four most important product groups given by the firms)
CREDIT	Financial constraints (Firm does not have a first class credit-rating = 1)
SKILL	Barriers to innovation: scarcity of skilled personal (1=important)
GLOBAL	Objectives of Innovation: Importance of global markets (see Appendix 3)
COST_SAV	Objectives of Innovation: Importance of Cost savings (see Appendix 3)
EXP	Exporting firm (dummy variable)
EAST	Firm from East-Germany
DAUGHTER	Firm is a daughter company

[3] West Germany refers to the 'Alte Bundesländer' including West Berlin. East Germany contains all firms from the former GDR.

Technological opportunity is captured by three variables. Following Levin and Reiss (1988) we employ the scores of factor analysis on the sources of information for the firms' innovation activities (see Appendix 2). We assume that the higher firms rate scientific institutions or scientific media (journals etc.) on a five-point scale as sources of information, the higher are their technological opportunities (SCIENCE). On average, firms from high-tech industries receive the highest score. As can be seen from Table 1 this score is increasing with firm size and is larger for West than for East-German firms. On the other hand, small firms evaluate knowledge obtained from private sources (suppliers, customers, competitors) higher (OTH_FIRM). In addition, a more direct measure of technological opportunity is used, relying on the firm's rating of obstacles to innovation. Firms were asked to evaluate 21 possible obstacles to innovation on a five point scale. One of these items was 'low technological opportunity' (TECH_OPP). This dummy takes a value of 1 if the rating is 'important' or 'very important'.

Appropriability conditions are reflected by the dummy variable APPRO. This dummy is based on the rating of the question whether the firm expects a low rentability due to the fact that innovations are 'too easy to copy'. The variable is strongly decreasing with firm size, pointing to the fact that small firms - on average - are more engaged in incremental innovations.

The variable on the *degree of competition in the firm's market* is proxied by the 10-firm concentration ratio (CR_{10}). The CR_{10} index is chosen for reasons of data availability. The data are taken either from publications of the Statistical Office or from the German Monopoly Commission. As a rule, we use the CR_{10} at the four digit level of the German industry classification (SYPRO). As for some industries (e.g. aircraft or spacecraft) the 10-firm-concentration ratio is not available at the four digit level, we used the two-digit-SYPRO-level which corresponds to a three-digit-SIC level. In some cases the industry affiliation of the firms contained in our original data base is only correct up to a three-digit-level. This forces us to use the three digit-level in such cases. In order to avoid simultaneity biases we use the concentration ratios for the year 1989 for West-Germany. We also attached this measure to the East-German firms as after unification West-German firms rapidly entered the East-German market. Given the size structure of East-German firms and the relative size of the additional markets, we believe that this can be accepted as a reasonable working hypothesis. As can be seen from Table 2, market concentration increases with firm size.

The *degree of diversification* is measured by the distribution of sales over the four largest lines of business or product groups. The index is calculated according to the Herfindahl formula as the sum of the squared shares of sales of these lines of businesses in total sales. We take the reciprocal of this measure as indicator of diversification multiplied by 10000. This number takes the value 1 if all sales fall within one product group. Therefore, the value 4 is assigned if all sales are distributed over four product groups in equal shares. The measure is not perfect as large firms probably use a broader definition of product groups than smaller firms. As can be expected the diversification index increases with firm size and is typically larger in West-German enterprises.

Table 2: Descriptive Statistics by Region and Size Class (Unweighted mean values or shares for the sample used in regression analyses)

	Region		Firm Size (number of employees)				
	West-Germany (1)	East-Germany (2)	5-49 (3)	50-249 (4)	250-499 (5)	500-999 (6)	1000 and more (7)
RDA	0.78	0.62	0.52	0.70	0.86	0.88	0.93
RDIS	0.03	0.03	0.03	0.03	0.02	0.03	0.04
RDIE	0.04	0.05	0.05	0.04	0.04	0.04	0.05
ININT_T	0.07	0.15	0.11	0.11	0.07	0.06	0.07
ININT_C	0.03	0.06	0.05	0.04	0.03	0.03	0.04
EMP	1179.84	212.70	24.04	123.43	352.91	695.44	4923.88
SCIENCE	0.09	-0.12	-0.23	-0.12	0.17	0.33	0.47
OTH_FIRMS	-0.07	0.21	0.08	0.02	-0.06	-0.03	-0.03
TECH_OPP	0.22	0.23	0.27	0.22	0.20	0.20	0.19
APPRO	0.39	0.32	0.44	0.39	0.33	0.36	0.25
CR_{10}	44.65	46.88	41.03	42.98	43.79	47.35	49.50
DIVERS	2.16	1.99	1.93	2.06	2.17	2.26	2.38
CREDIT	0.70	0.99	0.95	0.89	0.75	0.56	0.43
SKILL	0.32	0.28	0.40	0.31	0.27	0.29	0.18
GLOBAL	0.18	-0.36	-0.33	-0.09	0.19	0.34	0.54
COST_SAV	-0.01	0.07	-0.01	-0.01	-0.01	-0.02	0.16
EXP	0.88	0.53	0.56	0.77	0.89	0.96	0.96
EAST		1.00	0.41	0.38	0.17	0.13	0.08
DAUGTHER	0.26	0.18	0.02	0.24	0.31	0.41	0.42

Source: ZEW - Mannheim Innovation Panel

Two variables in our model are used to capture effects orginating from a firm's position in input markets on innovation activities. The dummy CREDIT takes the value 1 if the firm does not have an first class credit rating. Therefore, we interpret this variable as a proxy variable for financial constraints which probably have a negative impact on the R&D decision. Moreover, we expect a negative impact of skill shortage in the labour market (SKILL). If firm's are not able to find qualified R&D employees their expenditures on R&D will probably be lower than without such a restriction. Both measures of restrictions arising from other markets are strongly decreasing with firm size. That is to say large firms are in a better position to raise external financial resources for innovation activities and to find additional skilled workers for innovation activities. Moreover, it can be seen from the table that East-German firms have a very weak financial reputation but less problems in finding qualified workers. The figures given in Table 2 are, therefore, in line with our a priori expectations.

Several variables capture further characteristics of the firms and their innovative activities. We introduce these variables to control for otherwise hidden firm characteristics which may be correlated with the variables of interest. It is often argued that German firms are only able to enter foreign markets with products of superior quality. Therefore, one should expect higher R&D and innovation expenditures for exporting firms and firms which intend to do so in the future. This notion is captured by the actual export status of the firm (EXP) and the importance of foreign markets for innovation activities (GLOBAL). The latter variable is generated by a factor analysis on 21 potential objectives of innovation activities contained in the questionnaire (see the Appendix). The variable GLOBAL is based on the firm's rating of the importance of export markets for innovation activities. The variable takes higher values if innovation activities are aimed at West-European, US or other non-European markets. Table 2 illustrates that - on average - East-German firm do not intend to increase their export position through innovations. Not surprisingly, large firms are more oriented towards export markets than small firms. This result, based on a the self-assessment of firms, is fully in line with the distribution of the share of exporting firms over firm size classes. The share of exporting firms increases strongly with firm size and is larger in West-Germany than in East-Germany.

Finally, we consider the fact whether a firm is a daugther company or member of a large group (DAUGTHER). The idea behind this variable is the notion that R&D activities are concentrated within the mother company where central R&D departments develop and design new products for the whole group. Therefore, we should expect below average R&D activities in daughter companies.

6. Regression Results

As far as our data set provides some proxies for the underlying theoretical approach, we try to take account of these factors in our empirical model. Before presenting the results two econometric problems should be mentioned. As already noted by Kleinknecht (1989) small firms are engaged in R&D less likely than large firms. Following the usual practise and estimating the model only on R&D performing firms may result in biased parameter estimates because of the truncation of the error term. The usual solution consists of the application of a tobit model (see e.g. Cohen, Levin, Mowery 1987). But this solution neglects unobserved factors influencing the participation decision in R&D which may also be present in the R&D intensity equation. Instead of a tobit model we prefer a Heckman-type model which allows to identify the parameters of the participation model and the parameters of the intensity model separately.

In order to check the robustness of our specification for the R&D intensity model we first estimate the two-step version of the model (see Heckman 1979) and then the maximum likelihood version.[4] We use both definitions of R&D-intensity which are already presented in Figure 5. Taking the log of the R&D intensity eliminates problems with the non-normal distribution of the R&D intensity. Graphical inspection of the data reveals that the log-values of R&D intensities are more or less normal distributed. Moreover, formal tests of the normality assumption for log(R&D-intensity) do not reject this assumption for the whole sample and for the West-German subsample. The log R&D-intensity distribution for the East-German subsample seems to be non-normal due to a few outliers.

The estimation strategy is first to fit regression models containing the participation as well as the intensity equation with the same set of parameters. Using likelihood ratio tests we eliminate various exogenous variables either from the participation or from the intensity equation. Finally we arrive at different variable vectors for both models which also have the advantage that the identification of the participation models and the intensity model is not only due to the functional form.

We find a significant correlation between the error terms in the participation decision and the intensity equation for the two-stage Heckman model. This correlation vanishes when using the ML-estimator. The estimated correlation in the latter case is 0.033 which is far from significant. However, the correlation appears again when we employ R&D employment divided by total employment as a dependent variable. The correlation of error terms amounts to 0.859. This result points to the fact that there are only minor threshold effects with respect to R&D expenditures but more severe threshold effects with respect to R&D employment. However, we should keep in mind that our employment measure does not consider full time equivalents.

The regression results can be found in Table 3. Column (1) and (2) refer to the total R&D expenditure per unit of sales where column (1) contains the R&D intensity part and column (2) reports on participation in R&D. Column (3) and column (4) show the regressions for R&D employment divided by total employment. Again, this model has two parts. Column (4) holds the results for the probability that a firm has at least one R&D employee whereas column (3) shows the second part of the model for the R&D employment intensity.

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[4] Estimations were done by STATA, Version 3.1. We only report the maximum-likelihood version.

Finally, columns (5) and (6) report the results for regression models explaining innovation expenditures per sales. The difference between the models in column (5) and (6) is in the definition of the endogenous variable. The model presented in column (5) reports on total innovation expenditures per unit of sales (i.e. the sum of current expenditures on innovation and capital expenditures directly related to innovation activities), in column (6) we exclude capital expenditures for innovation from the definition of innovation expenditure intensity. As we restrict our attention to innovating firm throughout the paper we omit the decision whether a firm has any innovation expenditures from our model. Moreover, we find no correlations of the error terms with respect to the decision to innovate and the decision how much to invest in innovation activities. Therefore, we neglect the decision to innovate in the empirical models presented in the table. We use tobit models because some innovating firms report zero innovation expenditures.

First, we will comment on the participation decision in R&D. Then we turn to factors determining R&D intensity. Finally, we highlight the differences between determinants of R&D expenditures and of innovation expenditures.

6.1 Participation in R&D

Not surprisingly, we observe a strongly increasing probability for an engagement in R&D with growing firm sizes. The increase -although not significant- is even stronger in East-Germany.

We find an inverted u-shaped relationship between seller concentration and the probability for undertaking R&D. But neither the linear nor the squared term is significantly different from zero. Also, likelihood ratio tests for joint significance revealed no effect of seller concentration on the probability of undertaking R&D. Only in more scarcely specified models seller concentration gains a significant impact. Moreover, adding the linear and the squared term of seller concentration to the intensity equation never yields significant results. In conclusion, our results give little support to the famous Schumpeter hypothesis that market power is conducive to R&D.

Higher technological opportunities increase the probability of an engagement in R&D. This can be seen from our proxy variables for technological opportunity (SCIENCE, OTH_FIRMS, TECH_OPP). However, only firms which evaluate scientific sources as highly important for their innovation projects spend more on R&D and are engaged in R&D with a higher probability. This is in line with Pavitt's (1984) taxonomy of the sectoral patterns of technical change. The results presented here, indicate that this not only applies across sectors but also within sectors. Remember that we already control for industry effects. The effects show that firms from high-tech-industries like chemicals, electronics or medical instruments participate more likely in R&D. We interpret both the industry effects as well as the effect of the sources of information as evidence in favour of opportunity. Moreover, the dummy variable, TECH_OPP, reflecting the firms own assessment of low technological opportunities bears the expected negative sign but is lacking statistical significance. However, one can argue that R&D performing firms have a larger potential for making use of scientific sources. This hypothesis implies the reverse causality between R&D intensity and the importance of scientific sources for innovation activities. To shed some light on this question we estimated our model without the variables SCIENCE and OTH_FIRMS. It turned out that the remaining variable TECH_OPP which is based on the self-asssessment of low technological opportunities gains a significant effect on the probability for undertaking R&D. So, our interpretation that technological opportunity affects R&D behaviour of firms is not affected by whether or not the sources of information is an endogenous or exogenous variable.[5]

Appropriability conditions seem not to influence the probability for an engagement in R&D. As the dummy variable reflecting appropriability was without any effect in all models we do not consider appropriability to be an important factor for the decision to undertake R&D or not. However, one should keep in mind that we only look at the decision whether innovating firms perform R&D or not. As we have no information from our survey on the appropriability conditions of non-innovating firms we cannot look at the effect of appropriability on the more basic decision to innovate or not to innovate.

Finally, we comment on some firm characteristics. Given the results reported in the sections before it seems surprising that, after accounting for a variety of R&D determining factors, East-German firms are engaged in R&D with the same probability than West-German firms. As expected, exporting firms and firms whose innovation activities aim at expansion in foreign markets are more likely to perform R&D. In addition, firms focusing on process improvements and cost savings are less likely to undertake R&D. Also in line with our a priori expectations, diversification supports the probability that a firm conducts R&D.

It is often maintained that R&D activities are concentrated in the mother company whereas daughter companys get the knowledge neccessary for innovation through internal technology transfer. We do not find evidence for this assumption as the dummy indicating daughter firms is not statistically significant.

Finally, the probability for an engagement in R&D is insignificantly smaller for firms which do not have an excellent credit rating. As this variable is only a rough indicator for financial constraints we should not be surprised of finding no significant effect. However, in more scarcely specified models which includes only industry and region

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[5] Moreover, if we use the industry average of this variable as an exogenous influence instead of the individual valuation of scientific sources, we get nearly the same level of significance.

dummys as well as firm size indicators, this proxy for financial constraints gains a significant negative impact.

6.2 R&D Intensity

To allow for non-linearity of the R&D-intensity and firm size relationship we added the squared terms of log(employment) to the intensity equations. Contrary to the findings of many empirical studies summarized in Kamien and Schwartz (1975) or Cohen and Levin (1989) our model exhibits a u-shaped relationship for West-German firms. R&D effort per unit of sales first declines and then rises with increasing firm size. For East-Germany we could not establish the u-shape but find a negative impact of firm size on R&D-intensity. So, the low overall performance of R&D in the 'Neue Bundesländer' is not only caused be a lack of large firms but also by relatively low R&D expenditures in the existing large firms in East-Germany.

Technological opportunities again have a stimulating effect on R&D. We observe not only a positive impact of technological opportunities (SCIENCE, OTH_FIRMS) on the probability for an engagement in R&D but also technological opportunities are positively related to the amount spend on R&D. The industry dummies as well as our proxy variables (SCIENCE, OTH_FIRMS) are statistically significant and show the expected signs. We can, therefore, conclude that the higher technological opportunities are, the higher is the R&D-intensity of the firms.

Whereas appropriability had no influence on the decision to participate in R&D, it affects the level of R&D intensity. The less firms fear that competitors profit from their innovations the more they invest in R&D. However, this effect is only found for the R&D employment intensity and is lost when using relative R&D expenditures.

Diversification influences the probability of performing R&D but has no impact on R&D intensity. It can also be observed that firms show an above average R&D intensity if the objective of their innovation activities is to expand their exports. Whereas firms which focus on cost reduction have lower R&D expenditure per unit of sales. A shortage of specialized employees seems to have no significant effect on R&D intensity. Again, there are no differences between East-German and West-German firms.

Finally, as already noted, financial constraints seem to have a negative impact on the level of R&D intensity. This is indicated by the coefficient of the variable CREDIT. Given this effect sufficient financial resources seem to be a necessary condition for R&D activities. Especially, small and medium sized firms suffer from shortage of finance.

Table 3: Participation in R&D, R&D Intensity and Innovation Intensity

	R&D Expenditures		R&D Employment		Total Innovation Expenditures (incl. capital expenditures)	Current Innovation Expenditures (excl. capital expenditures)
	Intensity (1)	Participation (2)	Intensity (3)	Participation (4)	Intensity (5)	Intensity (6)
Summary statistics						
Number of obs.	1596		1596		1209	1209
Log Likelihood	-2549.9		-2084.4		-2072.1	-2075.5
Model $chi^2(52)$	446.13		530.41		126.42	191.7
Correlation between the error terms	0.033		0.859			
McFaddens R^2					0.030	0.044
	Coefficients t-values	**Coefficients t-values**	**Coefficients t-values**	**Coefficients t-values**	**Coefficients t-values**	**Coefficients t-values**
log(EMP)	-0.8424	0.2260	-0.9666	0.3017	-0.3048	-0.5157
	-6.09	*6.88*	*-10.16*	*9.61*	*-2.29*	*-3.88*
$\log(EMP)^2$	0.0641		0.0674		0.0183	0.03813
	5.83		*8.44*		*1.57*	*3.28*
log(EMP) * EAST	0.8598	0.0124	0.2095	0.0842	0.1977	0.7671
	2.50	*0.20*	*0.88*	*1.42*	*0.59*	*2.31*
$\log(EMP)^2$ * EAST	-0.0844		-0.02265		-0.0232	-0.0842
	-2.52		*-0.977*		*-0.67*	*-2.45*
SCIENCE	0.2188	0.2018	0.2027	0.2267	0.0900	0.1474
	4.36	*4.33*	*5.49*	*5.14*	*1.75*	*2.88*
OTH_FIRM	0.0775	0.0675	0.0876	0.0710	0.1071	0.9569
	1.48	*1.36*	*2.20*	*1.50*	*1.92*	*1.72*
TECH_OPP		-0.1374		-1.0079	-0.1108	-1.0959
		-1.59		*-1.41*	*-1.07*	*-1.40*
APPRO	-0.9092		-0.1626		-0.0979	-0.0270
	-1.14		*-3.07*		*-1.13*	*-0.31*

(to be continued on the next page)

Table 3: Participation in R&D, R&D Intensity and Innovation Intensity, (continued)

	R&D Expenditures		R&D Employment		Total Innovation Expenditures (incl. capital expenditures)	Current Innovation Expenditures (excl. capital expenditures)
	Intensity (1)	Participation (2)	Intensity (3)	Participation (4)	Intensity (5)	Intensity (6)
	Coefficients t-values	Coefficients t-values	Coefficients t-values	Coefficients t-values	Coefficients t-values	Coefficients t-values
CR10		0.0085		0.0074	-0.0073	-0.0009
		1.28		*1.35*	*-0.989*	*-0.13*
CR10 * CR10		-0.0001		-0.0001	0.0001	0.0000
		-1.27		*-1.53*	*1.10*	*0.31*
DIVERS	0.0288	0.1181	0.0228	0.1174	0.0518	0.0568
	1.00	*3.05*	*1.01*	*3.39*	*1.64*	*1.80*
CREDIT	-0.1762	-0.0658	-0.1566	-0.1288	-0.0381	-0.0510
	-1.84	*-0.60*	*-2.06*	*-1.26*	*-0.34*	*-0.45*
SKILL	-0.1242		-0.0238		-0.0784	-0.1579
	-1.47		*-0.42*		*-0.84*	*-1.69*
GLOBAL	0.2966	0.1547	0.3088	0.1713	0.1753	0.2490
	5.94	*3.02*	*8.39*	*3.56*	*3.31*	*4.71*
COST_SAV	-0.2152	-0.1549	-0.1791	-0.1563	-0.0451	-0.1844
	-4.43	*-3.41*	*-4.97*	*-3.71*	*-0.90*	*-3.70*
EXP		0.5435		0.3050	0.1943	0.2852
		5.43		*3.52*	*1.58*	*2.32*
EAST	-1.3682	0.0369	- 0.0935	-0.2690	0.3170	-1.0960
	1.60	*0.13*	*-0.16*	*-0.97*	*0.41*	*-1.40*
DAUGTHER		-0.1121		-0.8020	0.0010	0.0166
		-1.16		*-1.00*	*0.01*	*0.17*
NC_1	0.3153	0.1854	-0.1480	0.0793	0.4728	0.2747
	1.49	*1.14*	*-0.97*	*0.50*	*2.42*	*1.40*
NC_2	0.7545	0.8443	0.9315	0.9546	0.2228	0.3773
	3.62	*4.81*	*6.67*	*5.65*	*1.14*	*1.92*
NC_3	0.4292	0.4960	0.21507	0.2505	0.3087	0.4200
	1.94	*2.74*	*1.35*	*1.45*	*1.42*	*1.93*
NC_4	0.4459	0.4836	0.1782	0.3499	0.4063	0.3893
	1.85	*2.33*	*1.02*	*1.78*	*1.74*	*1.70*
NC_5	0.1740	0.2417	-0.1332	-0.0464	0.3790	0.2407
	0.70	*1.11*	*-0.72*	*-0.22*	*1.54*	*0.97*
NC_6	0.2660	0.4357	0.0770	0.2930	0.2044	0.2378
	1.33	*2.74*	*0.54*	*1.91*	*1.11*	*1.29*

(to be continued on the next page)

Table 3: Participation in R&D, R&D Intensity and Innovation Intensity, (continued)

	R&D Expenditures		R&D Employment		Total Innovation Expenditures (incl. capital expenditures)	Current Innovation Expenditures (excl. capital expenditures)
	Intensity (1)	Participation (2)	Intensity (3)	Participation (4)	Intensity (5)	Intensity (6)
	Coefficients t-values	Coefficients t-values	Coefficients t-values	Coefficients t-values	Coefficients t-values	Coefficients t-values
NC_7	0.5135	0.6237	0.4131	0.5201	0.2787	0.4190
	2.83	*4.46*	*3.40*	*3.88*	*1.73*	*2.60*
NC_8	1.1487	0.7365	0.9804	0.7978	0.6673	0.9529
	5.50	*4.15*	*6.97*	*4.70*	*3.45*	*4.92*
NC_9	1.2378	0.6899	0.9352	0.7057	0.8608	1.214
	5.86	*3.86*	*6.48*	*4.17*	*4.32*	*6.08*
NC_10	0.4906	0.4967	0.2703	0.5242	0.3193	0.5574
	2.31	*2.70*	*1.758*	*2.93*	*1.56*	*2.71*
Constant	-2.1845	-1.7930	-0.9771	-1.8778	-2.6430	-3.367
	-3.82	*-6.26*	*-3.01*	*-7.18*	*-5.93*	*-7.57*

Source: ZEW - Mannheim Innovation Panel

6.3 Comparing the regression results for innovation expenditures and R&D expenditures

The empirical model for innovation expenditures per unit of sales contains all variables discussed so far. In principle, the results on innovation expenditures follow the same pattern as discussed for R&D intensities. As can be seen from the low Pseudo-R^2 the empirical model of innovation intensities doesn't not match the power of the R&D models. This suggests that we are either missing some important variables or that the data on innovation expenditures are far more noisy than the data on R&D expenditures. The most convincing interpretation seems to be that a number of firms face problems in reporting total innovation expenditures. This is obvious from interviews with firm representatives. R&D expenditures can be estimated by the firms more easily especially in firms with R&D departments.[6] Therefore, the innovation expenditure variable should be more noisy and this can explain the low explanatory power of our models. We should bear in mind these caveats. The most remarkable differences between R&D expenditures and total innovation expenditure measures can be summarized as follows:

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[6] Moreover, it is also pointed out in this interviews that the R&D numbers given by firms often do not match the Frascati-definition of R&D.

First, we do not find an effect of our appropriability measure (APPRO) on neither total innovation expenditure intensity nor current innovation expenditure intensity. This may points to the fact that the non-R&D component of innovation expenditures is not affected by appropriability problems. This is most obvious for specific training expenditures related to the introduction of new products or processes or expenditures on primary market research.

Moreover, the results also uncover differences between the non-R&D part and the R&D part of innovation expenditures with respect to technological opportunity. Especially, total innovation expenditures are not significantly related to our proxies for technological opportunities (SCIENCE, OTH_FIRM, TECH_OPP). As is suggested by the results on current innovation expenditures (see column 6) capital expenditures directly related to innovation are not affected by a low technical opportunity, whereas the amount devoted to current innovation expenditures (excluding investments) increases if firms give a low rating on low technological opportunity as a barrier to innovation.

We are not surprised to find no correlation between the variable COST_SAV, which catches the importance of cost savings as an innovation objective, and total innovation expenditures. This should be expected because, if a reduction in average production cost is important to a firm, lower current innovation expenditures are offset by larger capital expenditures related to process innovations.

Finally, we can't observe a negative impact of our proxy of financial restraints on total as well as on current innovation expenditures. This does not contradict the above-mentioned finding of a negative impact of financial restraints on R&D intensity innovation expenditures regularly involve far less firm specific investments than R&D.

7. Summary and concluding remarks

The objective of this chapter was mainly empirical. Using the first wave of the Mannheim Innovation Panel we shed some light on the importance of various innovation input measures. Moreover, we intended to give some empirical content to the ongoing discussion on the relation of firm size, concentration, technological opportunity and appropriability on one side and innovation input on the other. R&D only comprises a small part of the total investment of firms in the generation and improvement of new products and processes. However, we found that despite of these differences in definition and coverage between innovation expenditures and R&D expenditures our analysis leads to similar conclusions with respect to firm size, concentration, technological opportunity and appropriability.

We also showed that once small firms have decided to invest in innovation activities, the amount they invest as a percentage of sales is higher than the innovation intensity of large firms. On the other hand, the probability that a firm is engaged in R&D

increases strongly with firm size. This implies that the participation decision and the intensity decision are ruled by different mechanisms and that fixed costs are associated with performing innovation activities. The large and small firms differential in intensity can even be more pronounced if we use total innovation expenditures instead of the narrowly defined R&D expenditures only. Using a sample of firms which covers all size classes from 5 employees onwards shows that firm size and R&D relationship seems to be u-shaped.

Evidence of a positive relationship between seller concentration and innovation input is rather weak. We found no evidence that concentration significantly determines innovation and/or R&D intensity. Moreover, there seems to be no effect of seller concentration on the probability that a firm performs R&D. As expected, stronger appropriability conditions and higher technological opportunities enhance firms spending on investment in innovation activities and/or in R&D. Surprisingly we found no direct correlation between the appropriability regime and the probability of an engagement in R&D.

Certain other firm characteristics play a more or less important role in determining innovation expenditures and R&D expenditures. Exporting firms and firms which intend to enter foreign markets show higher innovation intensities. There seems also to be some evidence that financial constraints effect the amount invested in new products and new processes. Moreover, the degree of diversification is positively related to the probability that a firm performs R&D and to the total amount spend on innovations.

Further research on the measurement of innovation activities using innovation surveys should seek to incorporate the newly available output measures and try to relate innovation output measures to the innovation input as well as to appropriability and technological opportunity. Furthermore, more attention should be directed toward the measurement of innovation related investment in new technologies.

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Appendix 1: List of Abbreviations and Aggregation of Industries

NC_1	Wood, wood products, pulp, paper, paper products, printing, furniture, jewellery, toys a.s.o.
NC_2	Chemicals, chemical products, refined petroleum products
NC_3	Rubber, plastic products
NC_4	Glass, ceramic goods and manufacture of other non-metallic mineral products
NC_5	Basic metals
NC_6	Fabricated metal products
NC_7	Machinery and equipment
NC_8	Office machinery and computers, electrical and communication equipment
NC_9	Medical, precision and optical instruments, watches, clocks
NC_10	Transport equipment
NC_11	Tabacco, Beverages, Food (used as base category)

Appendix 2: Factor analysis of sources of information for innovation activities

			Factor 1 SCIENCE	Factor 2 OTH-FIRMS	
Eigenvalue			2.94	1.04	
Proportion			0.77	0.27	
Cumulative			0.77	1.04	
Variable	**Mean**	**Std. Dev.**	**Factor loadings Varimax-Rotation**		**Commu-nalities**
			1	**2**	
Suppliers of material and components	3.67	1.13	-0.02	0.50	0.25
Suppliers of equipment	3.24	1.21	0.04	0.46	0.21
Customers	4.31	0.95	0.16	0.37	0.16
Competitors	3.54	1.19	0.18	0.39	0.19
Consultancy firms	2.15	1.10	0.38	0.32	0.24
Industry financed research institutes	2.05	1.15	0.64	0.23	0.45
Universities	2.53	1.33	0.72	0.11	0.54
Technical institutes	1.95	1.14	0.78	0.15	0.63
Agencies of technology transfer	1.93	1.10	0.64	0.22	0.46
Patent disclosures	2.60	1.34	0.49	0.17	0.27
Fairs/ehxibitions	3.83	1.00	-0.02	0.55	0.30
Journals/conferences	3.70	0.98	0.09	0.52	0.28

The largest factor loadings in each row are shaded.

Average interitem covariance:	0.28
Number of items in the scale:	12
Cronbach's Alpha:	0.77

Appendix 3: Factor analysis for objectives of innovation activities

			Factor 1 COST_SAV	Factor 2 GLOBAL	Factor 3	
Eigenvalue			3.91	2.19	0.97	
Proportion			0.55	0.31	0.14	
Cumulative			0.55	0.86	1.00	
Variable	**Mean**	**Std. Dev.**	**Factor Loadings Varimax-Rotation**			**Commu-nalities**
Replacing old products	3.79	1.41	0.09	0.28	0.22	0.13
Increasing market share	4.50	0.82	0.15	0.12	0.30	0.13
Extending product range						
Within main product field	3.89	1.11	0.13	0.09	0.27	0.10
Outside main product field	2.33	1.39	0.11	0.10	0.16	0.05
Creating new markets						
In West-Germany	3.60	1.35	0.10	0.08	0.61	0.38
In East-Germany	3.51	1.43	0.15	-0.02	0.61	0.40
In Eastern Europe	2.54	1.45	0.07	0.34	0.44	0.31
Within the European Union	3.22	1.44	0.06	0.52	0.45	0.47
In Japan	1.69	1.20	0.05	0.74	-0.01	0.55
In North Ameria	2.08	1.44	0.01	0.82	-0.02	0.67
In other countries	2.25	1.41	0.03	0.68	0.16	0.49
Improving product quality	4.34	0.90	0.43	0.03	0.16	0.21
Environmental sound products	3.38	1.43	0.39	0.14	0.18	0.20
Improving production feasability	3.84	1.16	0.53	0.01	0.20	0.32
Reducing the share of wage cost	4.09	1.11	0.46	0.05	0.09	0.22
Reducing materials consumption	3.70	1.22	0.56	0.08	0.10	0.33
Reducing energy consumption	3.36	1.31	0.68	-0.03	0.07	0.47
Reducing production lead times	3.47	1.26	0.63	0.08	0.10	0.42
Reducing goods with defects	3.76	1.28	0.65	0.05	0.02	0.43
Improving working conditions	3.37	1.15	0.64	0.00	0.08	0.42
Reducing environmental damage	3.20	1.38	0.61	0.05	0.01	0.37

The largest factor loadings in each row are shaded.

Average interitem covariance:	0.27
Number of items in the scale:	21
Cronbach's Alpha:	0.81