VERY PRELIMINARY

R&D AND PRODUCTIVITY: A RE-EXAMINATION IN LIGHT OF THE INNOVATION SURVEYS

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ABSTRACT

1. INTRODUCTION

Many studies have set out to estimate the rate of return to research and development (R&D) expenditures, using aggregate, industry, firm or establishment data, cross-sections, time-series or panel data, and many of them also trying to include spillover effects in the computation of the social rate of return. The rates of return are estimated by relating R&D to some measures of output, cost or profit and controlling for other possible influences.[1] Concurrently to this research effort, another strand of empirical studies has tried to estimate a production function of knowledge relating R&D to patents[2], or innovations.[3] Crépon, Duguet and Mairesse (1998) combined the two types of model to examine the link between R&D as an input into the innovation process, patents or the share of innovative sales as alternative outputs of innovation, and labor productivity as a measure of economic performance within a system of simultaneous equations.

We intend to follow the lines of Crépon, Duguet and Mairesse (1998), CDM for short, and reexamine the R&D-productivity relationship at the light of the information provided by the innovation surveys on innovation output measures and the non-existence of any systematic R&D for some of the innovating firms. We use the data of the innovation surveys of France, Germany, Spain and the United Kingdom from the second wave of CIS (Community Innovation Surveys), namely CIS2, which pertains to the years 1994-1996.

In particular, we want to decompose the rate of return to R&D in terms of productivity into a direct effect and an indirect effect that operates through the production of innovation output, that itself feeds onto productivity. For that we provide a decomposition of inter-country and inter-industry productivity and innovation differences, using a framework similar to the one presented in Mairesse and Mohnen (2002).

The paper is structured as follows.In section 2 we present our simultaneous equations model of R&D, innovation and productivity and the way we go about estimating it. Some indications about the data are given in section 3 and in the two appendices. Section 4 presents the preliminary results.

2. THE MODEL

We shall elaborate on the CDM model. Variants of this model have been estimated on data from France (Duguet, 2000; Galia and Legros, 2003), Germany (Janz, Lööf and

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[1] See the surveys by Mairesse and Mohnen (1990), Mairesse and Sassenou (1991), Griliches (1994, 1995), and Hall (1995).
[2] See for instance the survey by Griliches (1990).
[3] See for instance the studies collected in Kleinknecht (1996) and Kleinknecht and Mohnen (2002).

Peters, 2003), the Netherlands (van Leeuwen-Klomp, 2001; van Leeuwen, 2002), Chili (Benavente, 2002), Sweden (Lööf and Heshmati, 2002a, 2002b), Norway and Finland (Lööf, Heshmati, Apslund and Nås, 2002)), and China (Jefferson, Huamao, Xioajing and Xiaoyun, 2002)).

The basic CDM model consists of a linear model of R&D and innovation: R&D determines innovation output, which in turn determines productivity. Each of the three variables can have its idiosynchratic as well as common determinants. Innovation output can be measured by innovations (in the form of products or processes) or patents.

Our choice of modeling is partly determined by the structure of the innovation survey questionnaires. After a few basic questions on their present and past turnover and number of employees, and the main industry they belong to, respondents are asked three central questions which determine whether they have to respond to the rest of the questionnaire or not, namely whether they have introduced a technologically new or improved product or process or whether they are in the process of, or were unsuccessful in, doing so. If they respond positively to one of those questions, they are asked to give information about the sources of the information relevant to their innovation, the reasons why they have innovated, possible cooperations in innovation, the amount and organization of their R&D activity, and the share in sales due to new or improved products, where new can mean new for the firm or new to the market. Consequently, we have little information about non-innovators, in particular, we have information about R&D activities only for innovators.

Instead of treating non-innovators as non-R&D performers, we have decided to concentrate on innovators. Not all innovators perform R&D (around 15% do not). In order to sharpen the selection, and also in order to concentrate on serious R&D performers, we have decided to examine only the R&D behavior of continuous R&D performers, with positive R&D intensity, positive R&D personnel and R&D/labor ratios contained between roughly 2% and 400%, what we call clean R&D performers. In other words, the R&D-intensity equation will be estimated by a generalized tobit to correct for potential selection bias. Innovation output will be measured by the share of innovative sales, when it comes to product innovations, and otherwise simply by the fact of being a process innovator. Both depend on the R&D-intensity, estimated in the preceding equation.. Labor productivity then depends on the two output manifestations of innovation.

In each equation we want to control for industry effects (captured by industry dummy variables), country effects (also captured by dummies), the fact of belonging to a group, and a size effect. R&D is also determined by government subsidies, a demand pull effect, a cost push effect, the proximity to basic research (proxied by the occurrence of cooperation with universities or government labs), and the importance of the enterprise itself, clients, suppliers and patent disclosures as sources of information leading to the innovation. Those same variables affect the two forms on innovation output via R&D and labor productivity via the innovation outputs. Hence they operate indirectly through the R&D-innovation propagation. The only other two equation-specific effects (i.e. effects not necessarily operating exclusively via R&D and innovation output) that we allow for are the demand pull for product innovations and the cost push for process innovations.

In order to visualize the assumed causality effects, table 1 will be helpful:

Table 1
Causality structure of the model

Determinants	Clean R&D performers	R&D intensity	Process innovation	Product innovation	Labor productivity
Industry effects	x	x	x	x	x
Country effects	x	x	x	x	x
Size	x	x	x	x	x
Group belonging	x	x	x	x	x
R&D-intensity			x	x	
Process innovation					x
Product innovation					x
Government support	x	x			
Demand pull	x	x		x	
Cost push	x	x	x		
Proxim. to basic R&D	x	x			
Inform. from enterp.	x	x			
Inform. from clients	x	x			
Inform. from patents	x	x			
Inform. from suppliers	x	x			

The model is thus composed of the following five equations:

(1) $s_i = 1$ if $s_i^* = x_{0i}b_0 + u_{0i} > 0$, and 0 otherwise;

(2) $r_i = r_i^* = x_{1i}b_1 + u_{1i}$, if $s_i = 1$ and 0 otherwise,

where u_{0i} and u_{1i} follow a bivariate normal distribution with correlation coefficient ?, and standard errors 1 (for reasons of identication) and s_1 respectively;

(3) $pc_i = 1$ if $pc_i^* = x_{2i}b_2 + u_{2i} > 0$, and 0 otherwise

where u_{2i} follows a standard (for reasons of identification) normal distribution;

(4) $zinno_i = x_{3i}b_3 + u_{3i}$

where u_{3i} follows a normal distribution with mean 0 and standard error s_3 respectively, and where zinno is the logit transformation of the share of innovative sales; and

(5) $prod_i = x_{4i}b_4 + u_{4i}$

where u_{4i} follows a normal distribution with mean 0 and standard error $s_{4,}$ and prod stands for the logarithm of labor productivity, i.e. gross output divided labor.

As indicated in table 1,
x_{com}={industry, country, size and group},
$x_0=x_1=\{x_{com}$,gov,dp,cp,basic,sent,scli,spat,ssup}
$x_2=\{x_{com}$,r,cp}, $x_3=\{x_{com}$,r,dp},$x_4=\{x_{com}$,pc,zinno}.

We have a system of simultaneous equations with a recursive structure. The parameters of the structural form are estimated by the method of asymptotic least squares (ALS). In a first step, we get consistent estimates of the reduced form equations by maximum likelihood. The log-likelihood function is given by:

$$
\begin{aligned}
(6)\ \ln L = S_i\ \{&0_{RDCON,i}\ \ln F(-z_{0i}p_0) + 1_{RDCON,i}\ [-\ln(?_1) + \ln f((r_i - z_{1i}p_1)/?_1) \\
&+ \ln F([z_{0i}p_0 + ?(\ r_i\text{-}z_{1i}p_1)/?_1]/(1\text{-}?^2)^{0.5}] \\
&+ 0_{PC,i}\ \ \ln F(-z_{2i}p_2) + 1_{PC,i}\ \ \ln F(z_{2i}p_2) \\
&- \ln(?_3) + \ln f((zinno_i - z_{3i}p_3)/?_3) \\
&- \ln(?_4) + \ln f((prod_i - z_{4i}p_4)/?_4)\}.
\end{aligned}
$$

The first two lines of (6) correspond to the log-likelihood function of the generalized tobit, the third line corresponds to the log-likelihood function of a probit, and the last two lines to the log-likelihood function of an ordinary least squares estimation. The way our model has been formulated $z_{0i}=z_{1i}=z_{2i}=z_{3i}=z_{4i}$.

The structural form parameters are given by b = [b_0, b_1, b_2, b_3, b_4, s_1, $s_{3,}$ s_4, and ?]. The reduced form parameters are given by p=[p_0, p_1, p_2, p_3, p_4, $?_1$, $?_{3,}$ $?_4$, and ?]. There is a relationship between the reduced form and structural form parameters g(b,p) = 0, one for each reduced form parameters, hence g has the dimension of the number of reduced form parameters . The idea of ALS is to choose b so as to minimize

$g(b,\hat{p})'\dfrac{\partial g(.)}{\partial p'}\hat{\Omega}\dfrac{\partial g'(.)}{\partial p}g(b,\hat{p})$ where $\hat{\Omega}$ is the estimated covariance matrix of the estimated p ($\hat{p}$). When there are as many reduced form as structural form parameters, it is possible to reduce the quadratic form to zero. When there are overidentifying restrictions, the distance is not necessarily equal to zero. A Sargan test of the overidentifying restrictions consists in checking whether the quadratic form is significantly different from zero. The test statistic is the quadratic form, which is distributed as a Chi-square with degrees of freedom equal to the number of overidentifying restrictions.

3. THE DATA

We use the microaggregated data from CIS2 for France, Germany, Spain and the United Kingdom. At first, we only examine the manufacturing firm data of the scientific sectors, i.e. chemicals (NACE 23-24), machinery (NACE 29), electrical products (NACE 30-33), and transportation equipment (NACE 34-35). For the UK, pounds were converted to

Euros for turnover and R&D expenditures using the annual exchange rate for 1997 from the Bank of England (1.45€/£).

Details about data cleaning and variable definitions are given in appendices 1 and 2.

4. THE RESULTS

Table 2 presents in five panels the estimates of the five equations of our model. We report the reduced form estimates to show the link between the first stage and the second stage of ALS, but we concentrate on the structural form estimates reported in the last three columns. Germany is the reference country. Among the four countries, France has both the highest propensity to engage in continuous R&D, but also the highest intensity of R&D for continuous R&D performing firms. The other three countries do not significantly differ from each other. Size, government support, demand pull, proximity to basic research, and the information for innovation coming from within the enterprise, clients and patent disclosures all contribute positively to the propensity to do continuous R&D. As far as intensity of R&D is concerned, size and information from clients do not seem to matter, and cost-push elements tend to reduce the R&D intensity. Belonging to a group and information from suppliers do not play a significant role in both dimensions of R&D.

There is a strong difference in the four countries regarding the type of innovation. Spain is much more active than Germany in process innovation and the UK much less. Germany is the leading product innovator, as reflected in the share of innovative sales. In both types of innovations, size helps but being part of a group not. An interesting result is the differential role of cost push and demand pull elements in product and process innovations. In previous runs we noticed that cost push played a strongly significant role in process innovations but not in product innovations, whereas the opposite was the case for product innovations. We used this result to determine the identification of both types of innovations in productivity: cost push is ruled out in product innovations and demand pull in process innovations. The amount of R&D expenditures per employee is positive and sizeable in both types of innovation.

Labor productivity as measured by the amount of turnover per employee is slightly higher in France than in the other three countries. Larger firms and firms that are part of a consortium are more productive. Unfortunately, we have no capital stock data to construct a total factor productivity measure. Both types of innovations seem to foster productivity but the respective coefficients are too imprecise to reach a firm conclusion.

The Chi-square test statistic of overidentifying restrictions with 88 degrees of freedom is 65.91146, with an upper tail area of .96227. It indicates that our model, set up in such a way that with the number of exogenous variables introduced we have the maximum number of overidentifying restrictions, is not rejected by the data.

Tables 3a to 3d present the decomposition of labor productivity, product and process innovation, and R&D in terms of our explanatory variables. Each time we compute the difference with respect to average Europe, defined as taking the average value in the four countries for each variable (each country receiving an equal weight). The numbers in tables 3 are all defined in deviations from average Europe. Labor productivity (table 3a) in France is for instance 12.5 percentage points higher than in average Europe or 18.3 percentage points higher than in Germany. Spain is close to the average country in terms of labor productivity. The sum of deviations over the four countries is by construction equal to zero. Vertically we report the decomposition in terms of the explanatory variables in each equation. The last row in each table represents the unexplained part that is captured by the country dummies. Labor productivity for instance is explained by the effects due to industry composition, size, belonging to a group, product and process innovations. Each component captures its marginal effect multiplied by the difference between the country value and the average European value for the explanatory variable.

If we take the UK as an example, its industry composition accounts for almost half of its deviation from average Europe and the differential share of innovative sales almost one quarter. Size and group advantage are favorable to the UK compared to average Europe. A good deal of productivity remains unexplained by our explanatory variables and their interactions in our model. The two innovations were not significant. We therefore prefer not to reach any conclusion regarding their respective effects on productivity.

The two innovation outputs can themselves be decomposed into their constitutional elements. It is somewhat disappointing at this stage to realize that the country dummies (which in the case of innovations represent what we elsewhere have called the innovativeness, see Mairesse-Mohnen (2002)), are the best predictor of relative innovation performance. The other variables indicate some differential effects, but overall they account for relatively little. Innovation is among other variables “explained” by R&D, which in table 3d is itself decomposed into its building blocks. Again the country dummies (which we interpret as the productivity of R&D, i.e. the R&D unaccounted for by demand pull, cost push, scale effects,…) are the best predictor of relative R&D performance. It is interesting, however, to notice that information derived from patent disclosures is one of the biggest explanatory components. It is particularly R&D-stimulating in Germany. It accounts for almost one percentage point difference in R&D intensity compared to the other three countries.

APPENDIX 1: DATA CLEANING

Criteria for deleting observations:

- Number of employees less than 20 or more than 100000 (224 observations in the UK)
- One observation in the UK where the variable number of employees was missing.
- Logarithm of labor productivity in 1994 or in 1996 was roughly more than four times the sample standard error away from the sample mean (10 firms in France, Germany and Spain combined, 7 in the UK).
- Non-scientific sector NACE 37 (15 firms in the UK, 19 in France, Germany and Spain combined)
- R&D/sales was greater than 50% (25 enterprises in France, Germany and Spain combined, none in the UK) or R&D personnel over the number of employees was greater than 50% (17 enterprises in France, Germany and Spain combined, 2 in the UK)
- Growth in employment lower than –75% and greater than 150%
- Growth of production or labor productivity lower than -100% or greater than 200%

Handling of missing values:

- Missing values for the three questions defining an innovator were considered as zero responses.
- Missing values for the explanatory variables for innovators were also replaced by zero responses.

Variable transformations:

- Due to the logit transformation of the share of innovative sales, shares lower than 1% and or higher than 99% for innovators were replaced by 1% and 99% respectively. The same was done with the various components of innovative sales. For turnover from new products and turnover from improved products, which both sum to turnover from innovative sales, the lower bound was fixed at 0.05.

APPENDIX 2: VARIABLE DEFINITIONS

Innovator: enterprise that reports having introduced or having unsuccessful or not yet completed projects to introduce a technologically new or improved product or process.

Size : measured by the number of employees (in logarithms)

Belonging to a group: dichotomous variable, directly from the survey

Demand pull: dummy variable taking the value one when the four objectives of innovation related to demand ("replace products being phased out", "improving product quality", extend product range", and "open up new markets or increase market share") receive on average a score greater than 2.

Cost push: dummy variable taking the value one when the four objectives of innovation related to cost ("improve production flexibility", "reduce labour costs", "reduce materials consumption", "reduce energy consumption") receive a mean score greater than 1.5. The cut-off points for demand pull and cost push were chosen to cut the sample roughly in two classes of more or less equal size.

R&D: is defined as intramural plus extramural R&D

Clean R&D performers : dichotomous variable, defined as enterprises with continuous R&D, positive R&D intensity, positive R&D personnel and R&D/labor ratios contained between roughly 2% and 400%.[4]

Intensity of R&D: measured by the amount of R&D expenditures over employment (in logarithms). This measure was prefered over R&D/sales to minimize errors in measurement bias in the innovative sales equation (same output in the denominator)

Cooperating in innovation: dichotomous variable , directly from the survey

Total innovation expenditures: is measured as the sum of the expenditures connected to product or process innovations for intramural and extramural R&D, the acquisition of machinery and equipment, the acquisition of other external technology, industrial design and other production preparations, training, and the market introduction of technological innovations. Again the intensity of innovation expenditures was defined with respect to employment.

Patenting : dichotomous variable indicating at least one patent application during the 1994-1996 period.

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[4] For France, the response "doing continuous and occasional R&D", was treated similar to the response "doing continuous R&D".

Basic: dichotomous variable taking the value 1 when there is cooperation reported with universities or other higher education institutes, or with government or private non-profit research institutes

We distinguish four **sources of information for innovation**: from within the enterprise, from clients and customers, from suppliers (of equipment, materials, components and software), and from patent disclosures. They are constructed as dummy variables taking the value one when their individual score is above the median response for all innovating firms in our sample. Only innovating firms had to respond to these questions. For suppliers, the variable can also take the value 1 when cooperation with suppliers is reported.

Government support for innovation: dichotomous variable, directly from the survey

Share of innovative sales: share in total sales of technologically new or improved products introduced between 1994 and 1996. We have applied to this variable a logit transformation to have it vary from -8 to +8.

Labor productivity: turnover over number of employees in 1996 (in logarithms). The absence of capital stock data precludes the use of a total factor productivity measure.

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Table 2. Reduced form and structural form estimation

	reduced form estimation			structural form estimation (ALS)		
Parameter	Estimate	St. Error	P-value	Estimate	St. Error	P-value
Selection equation						
chemicals	-2.370	0.171	[.000]	-2.386	0.171	[.000]
machinery	-2.531	0.166	[.000]	-2.552	0.166	[.000]
electrical	-2.360	0.165	[.000]	-2.381	0.165	[.000]
transp. equipm.	-2.804	0.186	[.000]	-2.827	0.186	[.000]
France	0.246	0.096	[.010]	0.251	0.096	[.009]
Spain	0.136	0.095	[.153]	0.138	0.095	[.148]
UK	0.189	0.112	[.093]	0.193	0.112	[.086]
ln(employment)	0.344	0.027	[.000]	0.344	0.027	[.000]
Group	-0.045	0.065	[.487]	-0.045	0.065	[.481]
government support	0.396	0.070	[.000]	0.389	0.070	[.000]
demand pull	0.314	0.061	[.000]	0.305	0.061	[.000]
cost push	-0.054	0.060	[.368]	-0.045	0.060	[.457]
proximity to basic research	0.640	0.080	[.000]	0.642	0.079	[.000]
sources of inform: within enterp.	0.490	0.061	[.000]	0.497	0.061	[.000]
sources of inform: clients	0.175	0.066	[.008]	0.187	0.066	[.005]
sources of inform: patent discl.	0.379	0.061	[.000]	0.377	0.061	[.000]
sources of inform: suppliers	-0.103	0.059	[.083]	-0.089	0.059	[.132]

Table 2. Reduced form and structural form estimation (continued)

	reduced form estimation			structural form estimation (ALS)		
Parameter	Estimate	St. Error	P-value	Estimate	St. Error	P-value
log(R&D/employee)						
chemicals	0.118	0.227	[.604]	0.032	0.226	[.888]
machinery	-0.399	0.227	[.079]	-0.507	0.225	[.024]
electrical	0.121	0.225	[.590]	0.020	0.223	[.930]
transp. equipm.	-0.487	0.255	[.056]	-0.602	0.253	[.017]
France	0.505	0.089	[.000]	0.525	0.089	[.000]
Spain	-0.229	0.089	[.010]	-0.218	0.089	[.014]
UK	-0.052	0.106	[.627]	-0.036	0.106	[.735]
ln(employment)	0.025	0.025	[.317]	0.024	0.025	[.336]
group	0.048	0.061	[.431]	0.048	0.061	[.432]
government support	0.484	0.060	[.000]	0.463	0.058	[.000]
demand pull	0.257	0.061	[.000]	0.222	0.060	[.000]
cost push	-0.193	0.055	[.000]	-0.156	0.053	[.003]
proximity to basic research	0.288	0.064	[.000]	0.296	0.061	[.000]
sources of inform: within enterp.	0.334	0.065	[.000]	0.370	0.063	[.000]
sources of inform: clients	0.025	0.065	[.704]	0.074	0.062	[.226]
sources of inform: patent discl.	0.365	0.062	[.000]	0.365	0.060	[.000]
sources of inform: suppliers	-0.050	0.056	[.367]	-0.003	0.053	[.962]
standard error of error term	1.081	0.028	[.000]	1.084	0.028	[.000]
corr. coefficient error terms	0.492	0.082	[.000]	0.504	0.082	[.000]

Table 2. Reduced form and structural form estimation (continued)

process innovation

Parameter	Estimate	St. Error	P-value	Estimate	St. Error	P-value
chemicals	-0.766	0.164	[.000]	-0.775	0.160	[.000]
machinery	-0.871	0.156	[.000]	-0.790	0.146	[.000]
electrical	-0.493	0.158	[.002]	-0.485	0.150	[.001]
transp. equipm.	-0.558	0.178	[.002]	-0.460	0.171	[.007]
France	-0.026	0.096	[.788]	-0.094	0.096	[.328]
Spain	0.371	0.099	[.000]	0.398	0.099	[.000]
UK	-0.392	0.111	[.000]	-0.366	0.110	[.001]
ln(employment)	0.214	0.026	[.000]	0.215	0.026	[.000]
group	-0.183	0.065	[.005]	-0.193	0.066	[.003]
government support	0.072	0.069	[.301]			
demand pull	-0.102	0.062	[.099]			
cost push	0.403	0.060	[.000]	0.425	0.057	[.000]
proximity to basic research	0.124	0.074	[.095]			
sources of inform: within enterp.	0.117	0.061	[.054]			
sources of inform: clients	0.007	0.065	[.911]			
sources of inform: patent discl.	-0.011	0.063	[.863]			
sources of inform: suppliers	0.152	0.059	[.010]			
ln(R&D/employee)	x	x	x	0.139	0.064	[.031]

Table 2. Reduced form and structural form estimation (continued)

share of innovative sales (logit transformation)

Parameter	Estimate	St. Error	P-value	Estimate	St. Error	P-value
chemicals	-2.292	0.253	[.000]	-1.999	0.263	[.000]
machinery	-1.646	0.242	[.000]	-1.007	0.243	[.000]
electrical	-1.565	0.245	[.000]	-1.192	0.249	[.000]
transp. equipm.	-1.763	0.276	[.000]	-1.060	0.284	[.000]
France	-1.176	0.151	[.000]	-1.560	0.157	[.000]
Spain	-0.442	0.152	[.004]	-0.392	0.158	[.013]
UK	-1.023	0.180	[.000]	-1.106	0.184	[.000]
ln(employment)	0.122	0.038	[.001]	0.127	0.040	[.001]
group	-0.173	0.103	[.094]	-0.187	0.107	[.081]
government support	0.150	0.106	[.159]			
demand pull	0.520	0.098	[.000]	0.556	0.105	[.000]
cost push	0.148	0.095	[.119]			
proximity to basic research	0.128	0.113	[.259]			
sources of inform: within enterp.	0.258	0.099	[.009]			
sources of inform: clients	0.326	0.106	[.002]			
sources of inform: patent discl.	0.207	0.100	[.038]			
sources of inform: suppliers	0.153	0.095	[.106]			
standard error of error term	2.260	0.031	[.000]	2.260	0.031	[.000]
ln(R&D/employee)				0.486	0.114	[.000]

Table 2. Reduced form and structural form estimation (continued)

labor productivity

	Estimate	St. Error	P-value	Estimate	St. Error	P-value
chemicals	4.610	0.057	[.000]	4.731	0.068	[.000]
machinery	4.134	0.055	[.000]	4.232	0.059	[.000]
Electrical	4.076	0.056	[.000]	4.157	0.054	[.000]
transp. equipm.	4.097	0.063	[.000]	4.189	0.064	[.000]
France	0.045	0.034	[.191]	0.098	0.049	[.045]
Spain	-0.030	0.034	[.378]	-0.024	0.042	[.573]
UK	-0.065	0.041	[.112]	0.003	0.052	[.949]
ln(employment)	0.093	0.009	[.000]	0.079	0.015	[.000]
Group	0.177	0.023	[.000]	0.186	0.025	[.000]
government support	-0.088	0.024	[.000]			
demand pull	0.053	0.022	[.018]			
cost push	0.009	0.022	[.668]			
Proximity to basic research	0.009	0.026	[.726]			
sources of inform: within enterp.	0.043	0.022	[.053]			
sources of inform: clients	-0.019	0.024	[.426]			
sources of inform: patent discl.	0.006	0.023	[.775]			
sources of inform: suppliers	0.030	0.021	[.164]			
standard error of error term	0.513	0.007	[.000]	0.513	0.007	[.000]
process innovation	x	x	x	0.028	0.050	[.571]
share of innovative sales	x	x	x	0.036	0.026	[.178]

Table 3a. **Labor productivity decomposition**

	FRANCE	GERMANY	SPAIN	UK	EUROPE
difference w/t Europe	0.125	-0.058	-0.003	-0.064	0.000
industry composition	0.015	-0.042	0.062	-0.035	0.000
Size	0.022	-0.002	-0.023	0.002	0.000
Group	0.033	-0.028	-0.014	0.010	0.000
product innovation	-0.022	0.032	0.006	-0.015	0.000
process innovation	0.000	0.001	0.003	-0.003	0.000
Unexplained productivity diff.	0.079	-0.020	-0.043	-0.016	0.000

Tbale 3b **Process innovation decomposition**

	FRANCE	GERMANY	SPAIN	UK	EUROPE
difference w/t Europe	-0.016	0.024	0.097	-0.105	0.000
industry composition	-0.013	-0.029	-0.004	0.046	0.000
Size	0.061	-0.005	-0.062	0.006	0.000
Group	-0.033	0.029	0.015	-0.010	0.000
R&D/employee	0.043	-0.008	-0.015	-0.020	0.000
cost-push	-0.052	0.049	0.006	-0.003	0.000
innovativeness in process	-0.085	0.021	0.415	-0.351	0.000

Table 3c **Product innovation decomposition**

	FRANCE	GERMANY	SPAIN	UK	EUROPE
difference w/t Europe	-0.618	0.873	0.173	-0.429	0.000
industry composition	-0.020	0.091	-0.102	0.031	0.000
Size	0.038	-0.003	-0.038	0.003	0.000
Group	-0.030	0.027	0.013	-0.010	0.000
R&D/employee	0.145	-0.026	-0.051	-0.068	0.000
demand pull	-0.011	-0.002	0.024	-0.010	0.000
innovativeness	-0.810	0.782	0.375	-0.347	0.000

Table 3d **R&D decomposition**

	FRANCE	GERMANY	SPAIN	UK	EUROPE
difference w/t Europe	0.307	-0.055	-0.108	-0.144	0.000
industry composition	0.006	-0.033	0.011	0.016	0.000
Size	0.003	0.000	-0.003	0.000	0.000
Group	0.004	-0.004	-0.002	0.001	0.000
government support	-0.011	0.024	0.035	-0.048	0.000
demand pull	-0.005	-0.001	0.010	-0.004	0.000
cost push	0.019	-0.018	-0.002	0.001	0.000
proximity to basic	0.003	-0.004	0.000	0.000	0.000
Inform from within enter	-0.028	0.015	0.051	-0.038	0.000
Inform from clients	-0.004	0.009	0.004	-0.009	0.000
Inform from patents	-0.032	0.070	-0.012	-0.026	0.000
Inform from suppliers	0.000	0.000	-0.001	0.001	0.000
total inform sources	-0.064	0.094	0.042	-0.073	0.000
R&D productivity	0.503	-0.104	-0.299	-0.100	0.000