RESEARCH JOINT VENTURES AND FIRM LEVEL PERFORMANCE

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Abstract

In this paper we test whether participation in EU sponsored Research Joint Ventures (RJVs) has a positive impact on participating firms' performance. We apply our statistical methodology to RJVs sponsored under two different programs: EUREKA and (3^{rd} and 4^{th}) Program Frameworks for Science and Technology (PFST). Overall results show a positive association between participation, labour and total factor productivity, and price cost margin only in the case of EUREKA. On the contrary, firms participating FPST RJVs do not show any clear pattern.

JEL codes: O31,O38.

Key words: Research Joint Ventures, European Union, Economic Performance.

Introduction[1]

In recent years EU policy makers have been deeply concerned with European competitiveness vis-à-vis the US and Japan. In particular, the policy debate has focussed on the relatively poor performance of EU firms in high-tech industries. In turn, this unsatisfactory result has been attributed, among other things, both to the small amount of resources invested in R&D activities in Europe and to the low productivity of these resources.

In the economic literature, Research Joint Ventures (RJVs, hereafter) are commonly seen as a potential solution to both problems. On the one hand, they allow firms to internalise spillovers and then to reduce free riding problems, thus raising overall R&D incentives. On the other hand, after joining a RJV, firms can pool their resources and, as a consequence, can share R&D costs and avoid wasteful duplications.

Not surprisingly, the EU Commission involvement in the co-ordination and in the financing of RJVs, and more generally of co-operative research programs, has substantially increased over the years. However, despite this substantial public effort, the available evaluations of these publicly financed programs have added fairly little to our understanding of their contribution to the competitiveness of European industries.[2] This is rather unsatisfactory not only because it is obviously important to assess the efficacy of alternative research policy schemes but also because RJVs can lead to monopolistic practices to the extent that the co-operation among firms carries forward to the product market.

The main purpose of this paper is to start filling this gap by providing novel empirical evidence on the impact of different EU policy schemes on several firm level accounting measures of productivity and profitability. Thus, contrary to most previous literature on this subject this paper does focus neither on R&D intensity and/or R&D productivity nor on other intangible effects such us learning new skills, creating new network relations, or promoting common standards.[3] One of the main advantages of our approach is to employ performance measures which are more directly related to European competitiveness. However, it must be taken into account that the choice of

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[1] The "STEP to RJVs" was co-ordinated by Yannis Caloghirou, National Technical University of Athens/Laboratory of Industrial and Energy Economics. Project participants are: NTUA/LIEE (Greece), SIRN (UK), FEEM (Italy), IDATE (France), Stockholm School of Economics (Sweden), Universidad III de Madrid (Spain), PREST (UK).

[2] Luukkonen (1998) points out that the main reasons for the lack of satisfactory empirical evidence have to be found in the general nature of the objectives pursued by the EU research funding system and in the ensuing difficulty in measuring its attainment. Also, EU evaluation studies are part of the political process which formulates these schemes, this in turn leading to internal less critical evaluation.

[3] On this issue see also footnote 9.

broad accounting measures makes it more difficult to disentangle the impact of the policy programs under study from other economic phenomena. In this paper we try circumvent this problem by assessing the economic performance of firms involved in publicly funded RJVs both over time and against other firms located in the same country and operating in the same industry.

In particular, the analysis carried out in this paper focuses on the policy schemes supported by the European Union under the 3rd and 4th Framework Program for Science and Technology (FPST, hereafter) and on the EUREKA program in the 1992-96 period. Interestingly from a policy perspective, FPST and EUREKA differ with respect to a number of relevant characteristics. Broadly speaking, the public involvement is larger in FPST since projects are funded and co-ordinated by the European Commission whereas EUREKA projects have a decentralised funding source and research projects are proposed and defined by the participants themselves. Also, research carried out within the FPST framework is more pre-competitive compared with EUREKA where co-operative research projects are targeted to the development of marketable products and services.

The main finding of the analysis is that the two programs have quite a different impact. In fact firms participating in EUREKA show a significant improvement in productivity and price cost margin, while firms participating in RJVs under the FPST scheme do not show any significant change in performance.

The remainder of the paper is organised as follows. In section 2 the empirical literature on this subject is briefly surveyed. Section 3 describes the data-sets used for the empirical exercise whereas in section 4 our empirical strategy is outlined. Section 5 is the core of the paper where our main results are summarised and discussed. Section 6 gives some concluding remarks. Selected references and two data appendices conclude the paper.

1. A Survey of the Relevant Empirical Literature

In RJVs firms agree to integrate, at least partly, their operations in R&D activities. Compared to joint ventures in other fields, such as production or selling activities, RJVs are a relatively new phenomenon. However, in the last 25 years or so they have become more widespread. Also as a consequence of this increased diffusion, economic literature has started to investigate their determinants and effects.

According to theory, RJVs can have both positive and negative effects on social welfare. Very broadly, as pointed out by Spence (1984), RJVs can be the solution to a double market failure in R&D activities. On the one hand, they can ensure enough appropriability of the results of innovative efforts to induce firms to align R&D investment to the social optimum and then to improve technological performance. On the other hand, RJVs can perform better than other legal protection systems, such as patents, in the diffusion stage since they allow more information disclosure, at least among member firms. In addition to this, economic literature provides other, often complementary motives, for RJVs formation, including firms' access to complementary assets, avoiding cost duplications in R&D activities, and sharing financial costs and risks in large R&D investment projects. A legal regime that permits RJVs formation allows firms to co-operate in R&D activities while constraining them to compete in the post-innovation product market. However, if co-operation in the pre-innovation stage makes it more likely for firms to collude in pricing and output decisions, the aforementioned benefits have to be compared and contrasted with these non-voluntary anti-competitive effects.

While theoretical economists have provided formal theoretical justifications for the determinants and consequences of RJVs[4], empirical evidence on these issues is scant and somewhat contradictory. This unsatisfactory situation depends on a number reasons. Firstly, it is difficult to relate the predictive sharpness of theoretical models to the vagueness of the policy objectives of the actual programs under study. Secondly, in principle the performance analysis can be conducted at the RJV, at the member firms, or at the country level. Thirdly, also as a consequence of the existence of different levels of analysis, the impact of RJVs on "performance" can be assessed in different ways and existing studies are not easily comparable.[5] Fourthly, some of the relevant theoretical variables, including appropriability and spillovers, are very difficult to measure and consequently necessary data are often missing.

As far as methodology is concerned, studies focusing on RJVs' effects can be usefully classified in three categories: descriptive case studies, statistical/econometric case studies and large scale econometric studies.[6]

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[4] A review of these models is in Vonortas (1997), ch. 3.

[5] For instance: i) RJV productivity (number of patents, ...); ii) member firms R&D amount and productivity; iii) member firms total factor productivity and profitability; iv) other more qualitative firm level effects (learning new skills, creating network relations, promoting common standards); v) country level effects including social welfare and dynamic competitiveness.

[6] Of course, this distinction is somewhat arbitrary. Moreover, alongside with these studies in the Industrial Organisation tradition, there is also a very limited strand of literature that employs the so-called "event studies methodology", commonly used in Financial Economics. For instance Zantout (1995) works on a sample of 48 co-operative RJVs

In the first category, qualitative studies looking at the characteristics and focussing on the effects and shortcomings of industry specific RJVs can be grouped. Examples include Odagiri et al. (1997) who study the fifth generation computer system project, promoted by the Japanese government between 1982 and 1995; Martin (1996) on the RJVs' impact on European computer and semiconductor firms; Katz & Ordover (1990), who focus on three large RJVs: Semiconductor Manufacturing Technology Consortium (SEMATECH) and Microelectronics and Computer Corporation (MCC) in the US and the Very Large Scale Integration (VLSI) Consortia in Japan.[7] While rich in anecdotal evidence, this series of papers have two shortcomings: they lack of rigorous statistical tests and they focus only on very large, well known RJVs. Whereas policy relevant they are unlikely to be representative of the entire population of publicly funded RJVs.

Also papers in the second category look at industry specific RJVs. However, they differ from the previous group since they make use of statistical methods to test specific hypotheses, such as the impact of RJVs participation on profitability, R&D expenditures, innovation, and other performance variables. In particular, two recent papers falling in this category focus on SEMATECH. Link et al. (1996) study the effect of SEMATECH on participating firms' profitability. After selecting a sample of 11 research projects carried out within the program framework and surveying managers of participating firms in order to quantify the benefits of participation, they find that participating firms earn a positive return higher than the normal return – i.e. the average return in the semiconductor industry. However, the positive difference between project and normal returns is found to depend on government funding. Hence, the authors stress the importance of government funding in the functioning of these joint ventures.

The result of a positive effect of participation in SEMATECH on profitability is also found and further explored by Irwin & Klenow (1996) in the context of a broader study. These authors use a panel of approximately 80 US firms in the semiconductor industry over the 1970-1993 period, including firms participating in the research program. Their main objective is to discriminate between two alternative hypotheses concerning the RJVs' impact on total R&D expenditures: the "commitment" hypothesis, according to which participation incentives firms to spend R&D resources in addition to in-house R&D activities, and the "sharing" hypothesis, which asserts that participation – allowing firms to avoid duplication of research – has a negative effect on firms' total R&D expenditures. The main finding is that participating firms decrease their R&D expenditures,

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announced in the 1983-90 period and finds that venturing firms earn statistically significant positive abnormal returns, greater than those resulting from the announcement of an increase of in-house R&D expenditures. This result supports the hypothesis of a positive effect of RJVs on firms' performance.

thus supporting the "sharing" hypothesis. Consistently with this finding, the authors also report a positive and significant impact on participating firms' profitability, due to the reduction in R&D costs, while the impact on labour productivity is positive but insignificant.

The last group of studies employs large scale databases, covering RJVs in different industries. Branstetter & Sakakibara (1998) study the impact of participation in Japanese government sponsored RJVs on firms' R&D expenses, patenting activities and spillovers. Using a sample of 226 Japanese firms observed from 1983 to 1989, these authors find that participation in RJVs has a positive impact on R&D expenses and R&D productivity (measured by the number of patents granted to each firm). Interestingly, they are also able to attribute this positive result to a theoretically consistent factor, that is knowledge spillovers.[8]

Finally, both Vonortas (1997) and Siebert (1996) have exploited the rich source of information on US-based RJVs provided by the 1984 National Cooperative Research Act (NCRA) and its 1993 amendment (National Co-operative Research and Production Act (NCRPA)). Vonortas (1997) analyses the RJVs notified in the 1985-1995 period and finds the existence of a negative relation between profitability and RJVs intensity, both at the firm and at the industry level. The author explains this result with "discretionary" differences among firms, where low profitability firms are more willing to engage in RJVs. On the other hand, the impact of participation in RJVs on R&D expenditures is less clear: at the industry level it is negative but not significant. At the firm level, instead, results are mixed depending both on the frequency of RJVs participation and on the specific industries firms belong to. Also Siebert (1996) finds that firms participating in a RJV in the 1985-1992 period have lower profitability than the control sample; however, he shows that this result is due to a size effect (participating firms are much larger than non-participating firms) and that the effect of R&D on profitability is larger for participating than for non-participating firms, suggesting that the former are able to internalise spillovers stemming from joint R&D.

2. Data Issues and Descriptive Statistics

The empirical exercise presented in this paper is made possible by the joint exploitation of three data sources. As far as RJVs are concerned we make use of two data-sets provided by EU

[7] Other descriptive studies on RJVs are surveyed in Vonortas (1997), ch. 1.

[8] See also Sakakibara (1997) for a related analysis – based on questionnaires – on firms' motives to enter RJVs and on their expected and perceived effects.

officials which give detailed information (starting year, duration, venture members, objective, etc.) on EU sponsored RJVs. In the first data-set 1,031 RJVs sponsored under the EUREKA framework over the 1985-96 period are included. Analogously, the second data-set provides information on 3,874 RJVs financed by the EU under the 3rd and 4th Framework Programs for Science and Technology (FPST) over the 1992-96 period. From these two data-sets all manufacturing firms (750 firms from EUREKA and 1339 firms from FPST) have been extracted and balance sheet data for these firms have been collected over the 1992-96 period by using the AMADEUS database (release 44, May 1998). After disregarding firms with either no or incomplete financial data we ended up with a sample of 411 manufacturing firms.[9] Of those, 101 firms entered at least one RJV sponsored under the EUREKA framework (but no FPST RJVs) over the period under study, 253 firms at least one RJV financed under the FPST program (but no EUREKA RJVs) and 57 at least one RJV in both programs. The cross-tabulation of these firms by country and industry is reported in Appendix 1, Table A1. By comparing the distribution of our sample firms with the complete distribution of firms entering EUREKA and/or FPST programs, an overrepresentation of Belgian and Italian firms at the expenses of German and French firms is observed. This bias depends on the limited availability of the required financial data for firms located in these two countries.

To compare the performance of our sample of firms with other firms located in the same country and operating in the same industry we also extracted a control sample of firms from AMADEUS according to the following criteria: i) similar cross-tabulation of firms by country and industry, ii) firms not involved in the RJVs covered in the two data-sets EUREKA and FPST; iii) firms with complete balance sheet data.[10] At the end of this selection process we were left with a sample of 3,621 firms, whose cross-tabulation by country and industry is reported in Appendix 1, Table A2.

In the empirical analysis we focus on three performance measures: labour productivity, total factor productivity, and price cost margin. The first two variables obviously measure productivity. In particular, the former is only a partial measure but it is less likely to suffer from serious measurement errors. In principle, the latter is more satisfactory since it takes into account both

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[9] A firm has been included in our sample only when five years data were available for the following variables: fixed capital stock, employees, labour costs, value added, sales. All financial data were converted in ECUs by using monthly exchange rates provided by AMADEUS. Unfortunately, data on R&D expenditures are not available in the AMADEUS data-base. This has precluded us from measuring relevant variables such as R&D intensity and R&D productivity. We made an attempt to recover these missing information from a companion data-base (WORLDSCOPE). Unfortunately we were able to recover consecutive R&D data only for 41 out of our sample of 411 firms. Furthermore, only 29 of those joined an RJV in the first three years, i. e. in the 1992-94 period (see Section 4).

[10] We also excluded a few firms with negative value added and/or price cost margin greater than one.

production factors (labour and capital). On the other hand, the capital stock is difficult to measure, also because some of the relevant data, including investment flows, are not available in AMADEUS and consequently have to be estimated. Finally, price cost margin can be considered, admittedly rather crudely, a proxy for firm's market power.

Labour productivity has been constructed as the ratio of the value added at constant prices to the average number of employees. To deflate value added a country/three digit industry specific price deflator has been used (Source: DEBA). The price cost margin variable is simply computed as the ratio of value added net of labour costs to sales. Finally, total factor productivity is computed as the ratio of deflated value added to a weighted average of two input factors: labour and capital. To recover factor shares we estimated standard Cobb-Douglas production functions with constant returns to scale for 21 two-digit manufacturing industries. In Appendix 2, Table A3 we report the results of our estimates of the following model:

$$\log(Y_{it}/K_{it})=\beta*\log(L_{it}/K_{it})+\alpha_i+\alpha_t+\varepsilon_{it} \quad (1)$$

where Y_{it} denotes value added at constant prices, L_{it} and K_{it} are the average number of employees and the net stock of capital at replacement value respectively (see below for details about capital construction), α_i is a firm specific and α_t a time specific fixed effect. Total factor productivity (TFP) for firm i at time t has then been computed as:

$$TFP_{it}= Y_{it}/L_{it}^{\beta}K_{it}^{(1-\beta)} \quad (2)$$

Finally, given data constraints, we adopted a very simple procedure for the construction of the net stock of capital at replacement value. Since data on investment flows are not available in the AMADEUS database we used the difference between the accounting stock of fixed capital at time t and t-1 as a proxy for investment at time t. We then adopted the standard perpetual inventory technique by using the first year in the sample – i.e. 1992 – as benchmark:

$$K_t = K_{t-1}(1-\delta)+ I_t*(p^I_{92}/ p^I_t) \quad (3)$$

This strategy implies considering the accounting value of fixed capital stock in 1992 a reasonable proxy for the "true" replacement value in that year. Finally, we set the depreciation rate, δ, equal to 0.625 and we used country specific investment goods price indexes as price deflators, p^I_t (Source: DEBA).

Descriptive statistics of the three performance variables are reported in Table 1 for both our sample of 411 firms and the control sample of 3,621 firms. Summary data are also provided separately for firms entering only EUREKA (101 firms), only FPST (253), and both programs (57). If we focus on mean values, RJVs participating firms show higher TFP, labour productivity and price cost margin values than control sample firms. Also, the ranking is confirmed for all variables but TFP, if the median is used instead as ranking criteria. Interestingly, by comparing FPST with EUREKA firms the latter group is characterised by higher labour and total factor productivity but by lower price cost margins. This casts more than a passing doubt on the potential anti-competitive effects of the "market" oriented EUREKA RJVs.

3. Empirical Strategy

While suggestive, descriptive statistics presented in the previous section are clearly inadequate as a statistical basis for any serious attempt to test for the impact of RJVs participation on firm performance. Firstly, it is at best naïve to assume that participation in an RJV has an instantaneous impact on performance, also bearing in mind that the average length of EUREKA (FPST) projects is 48 (31) months whereas the median length is only slightly lower (42 and 36 months, respectively). Furthermore, according to a survey conducted on EUREKA project leaders "project results were expected within two years by 8% of respondents and within 3-5 years by 49%" (Peterson, 1993). The bottom line is that joining a RJV in 1995 is very unlikely to have any impact whatsoever as soon as 1995 or even 1996. Secondly, if the impact of RJVs participation is additive also the number of RJVs a firm participates in is likely to matter. Thirdly, as already mentioned, the control sample is constructed in order to mimic the industry/country distribution of our sample of 411 firms. However, given a possibly different industry/country composition of the EUREKA and the FPST samples of firms, comparisons between the different columns in Table 2 do not take fully into account industry and/or country specific differences.

To circumvent the first problem we split the sample period (1992-96) covered by our data in two sub-periods, labelled as "pre" (1992-94) and "post" (1995-96) respectively. The idea here is to focus only on firms participating to RJVs in the "pre" period and to test whether this participation has had an impact on performance in the "post" period. On average, this implies allowing a 2 year period between the RJVs start and the performance evaluation time. Even if the time span is perhaps still too short, data limitations preclude us from taking a longer time interval. Table 2 shows the number of firms participating to at least one RJV in each period. What is relevant for the present paper is to observe that in the 1992-94 period 242 firms (out of 411 firms) have entered at least one RJV. Of those, 55 firms entered at least one RJV sponsored under the EUREKA framework, 199 one RJV financed under the FPST program and 12 at least one RJV in both programs.

As far as the number of RJVs per firm is concerned, whereas in principle it might be potentially quite an important issue, it is likely to be negligible in the present context. In fact, if we focus on the relevant period (1992-94) about two thirds of our 242 firms have entered only one RJV. Furthermore, this figure is much higher if we restrict our analysis to EUREKA RJVs (78.2%), whereas it is slightly lower for RJVs under the FPST framework (65.8%) (see Table 3, 4 and 5 for the details).

The third methodological point refers to the role played by country and industry specific effects. In order to control for these effects, we regressed each performance variable separately in each year (i.e. 15 regressions with 4032 observations for each regression) against a constant and two sets of dummy variables, one to control for industry effects [21 (minus 1) industries] and one to control for country effects [10 (minus 1) countries]. The residuals of these regressions can be interpreted as differences between the value of each observation and its conditional mean given the country and the industry the firm belongs to. These adjusted variables have been used in the empirical exercise presented in section 5.

Finally, to perform the comparison between "pre" and "post" performances, we used two different statistical tests: a standard parametric t-test on differences and the non-parametric Wilcoxon test. As it is well known, the parametric test relies on a specific distribution (in our case, the normal distribution) from which observations are assumed to be drawn. If this underlying assumption is not rejected by the data, the parametric test is more powerful than its non-parametric counterpart. On the contrary the non-parametric test is less powerful but does not rely on distribution specific assumptions. By using and commenting upon both tests we aim at providing a consistency check on the robustness of our results.[11]

[11] A good reference for the Wilcoxon test is Gibbons (1971), ch. 6.

4. Results

The results of our statistical tests are presented in Tables 6, 7, and 8. In particular, Table 6 refers to the pre-post comparisons conducted on the full sample of 242 firms. Instead, Tables 7 and 8 focus on the sub-samples of firms participating in FPST (199 firms) and EUREKA (55 firms) RJVs respectively.[12] The main result of our analysis is that firms participating EUREKA have experienced a significant improvement in their “adjusted” performance measures between the “pre” and the “post” period. Furthermore, for two of the variables (labour productivity and price cost margins) participating firms also show a lower than average in the pre-period but an higher than average performance in the post-period. On the contrary, firms participating FPST RJVs do not show any clear pattern.

In more details, statistical tests conducted on the full sample (Table 6) give rather negative results. In fact all tests are statistically insignificant with the only exception of the parametric test on total factor productivity which point out at a positive and significant effect.[13]

As already mentioned, more interesting conclusions can be drawn by comparing the results of the FPST (Table 7) and EUREKA (Table 8) samples. Both parametric and non-parametric tests do not suggest any impact of FPST RJVs on firm performance. In fact, all tests are not significantly different from zero. Furthermore, if we focus only on the count of positive and negative ranks used for the construction of the Wilcoxon tests, the number of negative ranks is systematically larger than that of positive ranks for all three variables. On the contrary, firms participating in EUREKA RJVs show a general increase in the values of the three performance variables. Also, for the labour productivity and price cost margin variables this increase is (rather comfortingly) significant in both the parametric and the non-parametric approach. On the contrary, as far as total factor productivity is concerned we are able to reject the null hypothesis only in the parametric approach.[14]

How should these results be interpreted? In particular, does giving a causal interpretation to our statistical tests make sense? On the one hand, empirical findings are broadly consistent with the common wisdom on EUREKA and FSPT general objectives. In fact, EUREKA RJVs are

[12] Note that firms participating in EUREKA (FPST) can also be members of FPST (EUREKA) RJVs. To check that our results are not biased by this “double” participation, we rerun all the tests after excluding firms involved in both programs. All our conclusions are virtually unaltered.

[13] A graphical analysis reveals that this is likely to depend on both the skewness of the empirical distribution of the TFP variable and the presence of a small number of extreme observations.

[14] Measurement errors of the capital stock are a further possible explanation for the inconsistency in TFP variable results.

commonly perceived to be more “market” oriented than their FPST counterparts. From this perspective, it is not unreasonable to assume that EUREKA RJVs are more likely to have a direct, or at least faster, impact on firm performance. A more radical explanation on the same venue is that FPST projects do not aim at all at improving firm level performance but have more general and indirect objectives such us promoting co-operation between firms, universities and research centres or stimulating the development of European networks.

A different, and perhaps competing, explanation is grounded instead on the institutional differences occurring between the two programs. FPST RJVs broad objectives are defined by EU officials which also directly finance accepted projects in exchange for the monopoly on property rights. On the contrary, within the EUREKA framework, RJVs objectives are defined by participating firms and projects are much more based on decentralised funding. FPST institutional characteristics might then induce an adverse selection process, where firms carry out less profitable, long term and very risky projects only if they can have access to public money through FPST funding. This in turn might explain our results.

5. Conclusions

The main result of this paper is that whereas a positive statistical association is found between participation in RJVs sponsored under the EUREKA framework and improvement in standard accounting performance measures, the same finding does not occur for firms joining RJVs sponsored under the FPST framework in the same sample period. Obviously, giving a causal interpretation to our statistical tests is tempting, also because of the interesting policy implications which directly would follow. On the one hand it is certainly true that, at least to a certain extent, our findings are hardly surprising given the different aims of the two programs. On the other hand, however, our findings seem indeed to suggest that European competitiveness, at least as measured in this paper, can directly benefit from the implementation of applied, bottom-up, market oriented, co-operative research programs. A word of caution is however needed since other competing explanations might exist where participation in RJVs and performance improvement are both explained by other firm level omitted (and often unobservable) variables such as managerial capabilities. Also for this reason the results presented here are not fully conclusive and have to be supplemented by more detailed case studies which can be of great help in deepening our understanding of the causal relations underlying the phenomenon under study.

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Table 1: Labour Productivity (LP), Total Factor Productivity (TFP) and Price-Cost Margins (PCM) for firms participating in RJVs (EUREKA, FPST and BOTH) and for the control sample (five years arithmetic averages).

		TFP			**LP**			**PCM**		
	N	Mean	Std. Deviation	Median	Mean	Std. Deviation	Median	Mean	Std. Deviation	Median
RJVs SAMPLE	411	24.855	14.681	21.510	57.209	29.033	51.855	0.107	0.077	0.092
EUREKA	101	26.079	15.323	22.973	56.897	27.234	51.767	0.101	0.069	0.086
FPST	253	24.754	14.317	21.510	56.090	30.096	50.504	0.111	0.082	0.102
BOTH	57	23.136	15.183	20.349	62.729	27.091	59.030	0.103	0.070	0.083
CONTROL SAMPLE	3621	24.136	14.616	21.707	51.877	31.992	46.191	0.098	0.067	0.089

Table 2: Number of firms by RJV type and sub-periods

		Period		
		1985-1991	1992-1994	1995-1996
Program	FPST	0	199 (187)	183 (172)
	EUREKA	94	55 (43)	42 (31)
	FPST or EUREKA	94	242	214

Note: In brackets number of firms participating only to the specific program.

Table 3: Number of RJVs by firm (conditional on positive number of RJVs) in 1992-94 (All firms in the sample)

Number of RJVs	Frequency	Percent	Cumulative Percent
1	160	66.1	66.1
2	37	15.3	81.4
3	11	4.5	86.0
4	8	3.3	89.3
5	9	3.7	93.0
6	4	1.7	94.6
7	2	0.8	95.5
9	1	0.4	95.9
12	2	0.8	96.7
14	1	0.4	97.1
15	1	0.4	97.5
16	1	0.4	97.9
18	1	0.4	98.3
20	1	0.4	98.8
23	1	0.4	99.2
27	1	0.4	99.6
44	1	0.4	100.0
Total	**242**	**100.0**	

Table 4: Number of RJVs by firm (conditional on positive number of RJVs) in 1992-94 (FPST sample only)

Number of RJVs	Frequency	Percent	Cumulative Percent
1	131	65.8	65.8
2	29	14.6	80.4
3	8	4.0	84.4
4	6	3.0	87.4
5	10	5.0	92.4
6	3	1.5	93.9
7	1	0.5	94.4
8	1	0.5	94.9
12	2	1.0	95.9
14	1	0.5	96.4
15	1	0.5	96.9
16	1	0.5	97.4
18	1	0.5	97.9
20	1	0.5	98.4
23	1	0.5	98.9
26	1	0.5	99.4
39	1	0.5	100.0
Total	**199**	**100.0**	

Table 5: Number of RJVs by firm (conditional on positive number of RJVs) in 1992-94 (EUREKA sample only)

Number of RJVs	Frequency	Percent	Cumulative Percent
1	43	78.2	78.2
2	7	12.7	90.9
3	2	3.6	94.5
4	1	1.8	96.3
5	2	3.6	100.0
Total	**55**	**100.0**	

Table 6: Statistical tests on performance measures (Full sample, 242 firms)

	t test					Wilcoxon		
	μ pre	μ post	Δμ	t	p-value	Positive Ranks	Negative Ranks	p-value
LP	2.85	4.96	2.09	1.53	0.127	126	116	0.267
TFP	-0.93	-0.05	0.88	1.89	0.061	118	124	0.887
PCM	0.01	0.01	0.00	1.04	0.301	113	129	0.785

Table 7: Statistical tests on performance measures (FPST sample, 199 firms)

	t test					Wilcoxon		
	μ pre	μ post	Δμ	t	p-value	Positive Ranks	Negative Ranks	p-value
LP	3.95	5.26	1.32	0.82	0.415	96	103	0.832
TFP	-0.78	-0.13	0.65	1.24	0.217	93	106	0.659
PCM	0.01	0.01	0.00	0.52	0.603	84	115	0.242

Table 8: Statistical tests on performance measures (EUREKA sample, 55 firms)

	t test					Wilcoxon		
	μ pre	μ post	Δμ	t	p-value	Positive Ranks	Negative Ranks	p-value
LP	-0.83	4.56	5.39	2.92	0.005	36	19	0.034
TFP	-1.75	-0.02	1.73	2.06	0.045	30	25	0.307
PCM	-0.01	0.03	0.04	3.20	0.002	35	20	0.004

APPENDIX 1: Country and Industry Cross-tabulations

Table A1: Firms participating in RJVs by country and industry (NACE REV. 1)

		COUNTRY								
		Italy	**Belgium**	**Germany**	**France**	**U.K.**	**Netherlands**	**Austria**	**Ireland**	**Total**
INDUSTRY	Food and beverage	3	3	1	2	2	5	0	3	**19**
	Tobacco	0	0	0	0	0	1	0	0	**1**
	Textile	5	6	1	2	2	0	0	0	**16**
	Leather and leather goods	0	0	0	0	4	1	0	1	**6**
	Wood products	1	0	0	1	1	0	0	0	**3**
	Paper and paper products	0	0	0	1	2	3	0	1	**7**
	Publishing and printing	3	0	2	1	1	0	0	0	**7**
	Chemical products	12	12	16	11	8	3	0	0	**62**
	Rubber and plastics	0	5	1	0	0	3	0	0	**9**
	Non-ferrous production	6	5	4	2	3	1	0	0	**21**
	Ferrous production	1	4	4	3	5	2	0	0	**19**
	Ferrous products, except machinery	3	1	0	4	2	4	0	0	**14**
	Machinery products	35	5	15	7	9	2	0	0	**73**
	Office machinery and computer	2	0	4	3	3	0	0	1	**13**
	Electrical machinery	8	3	4	4	4	1	0	0	**24**
	Radio, TV and telecommunication equipment	12	3	7	6	8	2	0	0	**38**
	Medical equipment, measuring instruments and watches	7	4	9	6	6	1	1	0	**34**
	Motor vehicles	3	1	8	3	3	2	0	0	**20**
	Other transportation equipment	5	3	5	7	2	0	0	0	**22**
	Furniture and other manufacturing goods	2	0	0	0	1	0	0	0	**3**
	Total	**108**	**55**	**81**	**63**	**66**	**31**	**1**	**6**	**411**

Table A2: Firms in the control group by country and industry (NACE REV. 1)

		COUNTRY										
		Italy	**Belgium**	**Germany**	**France**	**U.K.**	**Netherlands**	**Austria**	**Luxembourg**	**Ireland**	**Portugal**	**Total**
INDUSTRY	Food and beverage	77	53	11	30	49	10	0	3	3	1	**237**
	Tobacco	1	3	1		2		0	0	0	0	**7**
	Textile	144	22	2	20	36	6	0	0	2	1	**233**
	Clothing	11	2	0	2	5	1	0	0	0	1	**22**
	Leather and leather goods	74	2	0	4	16		0	0	0	0	**96**
	Wood products	20	9	0	9	7	3	0	0	1	0	**49**
	Paper and paper products	32	8	3	16	24	5	0	0	0	0	**88**
	Publishing and printing	32	14	2	17	44	7	0	1	0	0	**117**
	Chemical products	244	63	26	79	127	22	0	0	7	1	**569**
	Rubber and plastics	83	25	4	24	51	7	0	1	0	0	**195**
	Non-ferrous production	85	30	7	17	26	14	0	0	1	0	**180**
	Ferrous production	133	24	15	24	52	8	1	1	1	0	**259**
	Ferrous products, except machinery	99	28	5	47	42	9	0	0	0	0	**230**
	Machinery products	239	26	32	76	117	23	1	1	2	1	**518**
	Office machinery and computer	6	0	2	4	18	3	0	0	1	0	**34**
	Electrical machinery	61	18	6	23	43	6	0	0	4	0	**161**
	Radio, TV and telecommunication equipment	50	7	7	28	60	1	0	1	4	0	**158**
	Medical equipment, measuring instruments and watches	72	13	5	29	59	5	0	0	0	0	**183**
	Motor vehicles	45	13	5	25	33	8	0	0	0	2	**131**
	Other transportation equipment	26	3	6	10	34	7	0	0	0	0	**86**
	Furniture and other manufacturing goods	33	9	1	5	17	2	1	0	0	0	**68**
	Total	**1567**	**372**	**140**	**489**	**862**	**147**	**3**	**8**	**26**	**7**	**3621**

APPENDIX 2: Factor Shares Estimates

Table A3: Estimates of equation (1) by industry

Sector	**# firms**	**# observations**	**β**
Food and beverage	256	1280	0.841
Tobacco	8	40	0.893
Textile	249	1245	0.729
Clothing	22	110	0.847
Leather and leather goods	102	510	0.843
Wood products	52	260	0.822
Paper and paper products	95	475	0.879
Publishing and printing	124	620	0.933
Chemical products	631	3155	0.829
Rubber and plastics	204	1020	0.630
Non-ferrous production	201	1005	0.560
Ferrous production	278	1390	0.589
Ferrous products, except machinery	244	1220	0.785
Machinery products	591	2955	0.755
Office machinery and computer	47	235	0.955
Electrical machinery	185	925	0.800
Radio, TV and telecommunication equipment	196	980	0.712
Medical equipment, measuring instruments and watches	217	1085	0.822
Motor vehicles	151	755	0.685
Other transportation equipment	108	540	0.621
Furniture and other manufacturing goods	71	355	0.977
Total	**4032**	**20160**	